THE EFFECTS OF EDUCATION ON FERTILITY AND ON LABOUR MARKET OUTCOMES: REGRESSION DISCONTINUITY EVIDENCE FROM GHANA

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ABSTRACT

This dissertation aims to identify the causal effects of education on reproductive and labour market outcomes, using two educational reforms in Ghana as a natural experiment. The first reform, which was implemented in 1987, shortened pre-tertiary education in Ghana from 17 years to 12 years. In addition to the shortening of the years of pre-tertiary education, vocational and technical subjects were added to the junior secondary school curriculum. The second reform involved the implementation of Free Compulsory Universal Basic Education (FCUBE) in 1996. It aimed to increase enrolment in basic schools by removing tuition fees and all other forms of educational charges at the basic level. I adopt these two policies to construct a regression discontinuity design.

Girls who benefited from the 1996 FCUBE reform received one more year education than those who did not. That increase in years of education led to an increase in age at first time marriage and age at first birth. The impact of the reform on adolescent fertility and early marriage decreases as age increases, and the effect becomes statistically insignificant after age 19. The impact of the FCUBE on adolescent fertility and early marriage affect different subgroups in the population differently.

In my analysis of the 1987 reform, I still find a negative causal relationship between education and fertility and also find that educated women, even though they give birth late, still give longer spacing between any two births. The possible mechanisms through which education affects total fertility and the timing of birth are knowledge acquisition, improved intra-household bargaining and assortative mating.

Turning to labour market effects, introducing 13 percent vocational and technical subjects into the previously purely academic curriculum did not affect the decision of post reform students to enter into vocational related careers after school relative to those who were not affected by the reform. A possible explanation for that zero effect may be associated with the underdeveloped vocational job market in the country. The fact that people pursue careers based on the economic benefits they would receive from that career lends support to the above explanation. The second possible cause of the insignificance may be the small number of JSS workshops that serve as training workshops after classroom lessons.

Nevertheless, It is observed that the reform increased the number of students who had access to secondary and tertiary education, reflecting an overall increase in access to higher education. The impact of the reform on access to secondary education was about three times higher than on access to tertiary schooling. It is also found that the reform reduced labour participation in agriculture and the informal sector, but also led to an increase in the number of professionals, service sector participation and the probability to work for an employer. I hypothesize that the changes in the distribution of the labour

market resulting from the reform were brought about by the enhanced access to higher education rather than the introduction of vocational subjects into the JSS curriculum.

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CHAPTER 1

INTRODUCTION

Every nation desires its citizenry to acquire as much education as possible. This is because the returns to education at both micro and macro level of the economy are huge. There are several macroeconomic evidence that demonstrate that education have a strong positive relationship with economic growth and development. At the individual level, a series of microeconomic research has demonstrated that education provides several economic and social benefits. For example, education improves individual productivity and income, reduces civil conflicts, improves an individual's health outcomes, and reduces fertility (Becker, 1991; Lipset, 1959). Furthermore, high fertility is linked to low family income, poor human capital, health deficiencies and conflict between couples (Lloyd and Mensch, 2008). Based on the empirical evidence on the importance of education, many African countries after independence have tried to implement policies that will increase access to education and improve the quality of education.

The numerous education policies in Sub-Sahara Africa (SSA) in making education accessible to every child have yielded a positive results by increasing educational attainment in the sub-region. Coinciding with the increase in educational attainment is reduction in fertility and early marriage. On the other hand, pursuing such mass educational expansion policies with little or no emphasis on how best to facilitate the transition of youth from school to work has greatly contributed to the serious problems of school-leaver unemployment (Ozier, 2015). Ghana introduced two important education reforms in 1987

and 1996. The objectives of the first reform were to revert the downward trend in enrolment ratio at all the levels of education in the country and also to streamline the school curriculum to help in the transition of students from school to work. The second reform on the other hand was purposefully launched to increase access to education at both primary and junior secondary school (JSS) levels. It is against this background that this dissertation seeks to find out whether there is a causal relationship between education and fertility in Ghana, and to also investigate the effects of education on labour market outcomes. A study on the effect of education on fertility and on the labour market in SSA is very important since the subregion has the highest fertility rate in the world and is characterized by high youth unemployment.

1.1 Overview

Formal education in most Sub-Saharan African countries has seen great improvements in the past 60 years. The evolution of formal education in Sub-Sahara Africa (SSA) during that period included massive construction and rehabilitation of primary school buildings and cancelation of primary school fees (Thakur, 1991). The massive school construction in Sub-Saharan Africa over the past six decades has led to an increase in average schooling from 2.6 years in 1970 to 6.1 years in 2005 (Barro and Lee, 2010).During this period fertility in the region declined from 6.73 to 5.54 births per woman. Even though fertility in Africa is falling, it still remains the highest in the world compared to other continent. One important empirical question is, do these observed associations

between education and fertility and the timing of marriage represent just correlation or actual causality?

Despite the strong empirical evidence of correlation between education and fertility or the timing of marriage, there are important challenges in estimating the causal relationship because educational attainment is endogenous to the timing of marriage and fertility due to the following reasons: (1) omitted variable and (2) reverse causality. Since school attendance is incompatible with the responsibilities and expectations of marriage and motherhood in many cultures, marriage and pregnancy often lead to school dropout (Lloyd and Mensch, 2008; Lloyd, 2005). This reverse causality can create an endogenous problem which needs to be dealt with in efforts to explain causality of education on fertility and the timing of marriage (Bledsoe et al., 1999; Lloyd et al., 2006).

The increase in educational attainment has also coincided with a rising formal sector employment across the continent (Ozier, 2015). An increase in education without a corresponding increase in the demand side of the labour market has contributed to school-leaver unemployment in the subregion. Curricula diversification policies have generally been seen as a solution to the growing youth unemployment problems. The term curriculum diversification or vocationalisation of curriculum refers to a deliberate attempt by schools to include practical subjects in the whole formal educational system so as to provide students with some basic knowledge and skills that might prepare them for the world of work even if their education terminates at primary or secondary school level (Lauglo, 2010; Lauglo, Akyeampong, Mwiria& Weeks, 2003).

Diversified curriculum is however considerably more expensive than general education and demands more managerial expertise in the maintenance of school workshops. Several studies have hypothesized that diversified curriculum would give a labour market advantage to primary and secondary school leavers in an increasingly difficult labour market environment (Lauglo and Narman, 1987; Narman, 1988; Chin-Aleong, 1988). On the contrary, Psacharopulos (1987) and Geoff (2004) provides an alternative view that vocationalisation of the school curriculum is more costly than academic curriculum, and that the outcomes of graduates from vocational schools do not usually justify the investments. It also imposes an unnecessary cost to the educational system that cannot meet the expected skills that are best learned at the workplace (Geof, 2004). Students in a purely academic track are more likely to have enough contact teaching hours in the academic subjects than those using vocationalised curriculum. Thus, the opportunity cost of vocationalisation of curriculum can adversely affect the performance of students in the academic subjects. In spite of the different opinions on the importance of curriculum diversification and the fact that curriculum diversification has been a major educational reform in most African countries[1], yet there is no empirical study that has evaluated the importance of the curriculum diversification on employment or academic performance.

[1]Lesotho, Botswana, Ghana, Kenya, Zimbabwe, Ethiopia, Somalia, Uganda, Cameroon, Gabon, Nigeria, Swaziland, Tunisia, Morocco and Tanzania are examples of countries in Africa that have diversified either primary or secondary school curriculum.

1.2 Objectives

This dissertation seeks to address two main objectives. The first objective is to investigate the effects of female education on fertility and on the timing of marriage. Specifically, the study estimates the causal impact of education on fertility and on the timing of marriage. I also inspect if there is fertility convergence after educated women delays their fertility. Furthermore, the study aims to find out the possible mechanisms through which education affect fertility and the timing of marriage and finally explore whether the effects of education on fertility and on the timing of marriage is heterogeneous. The second objective of this dissertation is to find the effects of education on some labour market outcomes. Specifically, I investigate the effects of vocationalisation of academic curriculum on careers that are related to the vocational subjects introduced at the JSS level. In addition, I explore the effects of higher education on a number of labour market outcomes.

1.3 Main Findings and contributions

In 1987, Ghana introduced an educational reform called The New Education Reform Program (NERP). The Reform reduced pre-tertiary education from 17 years to 12 years. Ten years after NERP implementation, a new policy known as Free Compulsory Universal Primary Education (FCUBE) policy was implemented in 1996. Introduction of FCUBE has resulted in an increase in primary school enrollment and student retention rate (Akyeampong et al., 2007). This drastic change in the average years of schooling of cohorts affected by the policy or reform, forms the basis of my empirical design to investigate the

impact of education on fertility and on labour market outcomes. The implementation of the 1987 education reform gave rise to a situation where individuals born before 1973 with at least basic education certification to have more years of schooling than women born in 1973 or later. On the contrary, the FCUBE policy increased the years of schooling of women born in 1989 or later than women born before 1989. This discontinuity in education is the basis of the regression discontinuity design used in this study.

Regarding the impact of the NERP, I find that it reduced the average years of female education by one year. The one year reduction in education for the treatment group led to a 9 percent increase in fertility relative to the comparison group, and the probability for an individual of ever giving birth increased by four percentage points. It is also shown that education not only delays the timing of birth but also broadens the spacing of births. Concerning the mechanisms through which education affects fertility, some evidence is found that education affects fertility through knowledge acquisition increase in household bargaining power, and assortative mating which means that women are matched to men of similar characteristics in the marriage market. However, I find little evidence that education reduces fertility through labour force participation and "incarceration effect", which refers to the possibility that women who are in school have less time to engage in practices that can lead to unplanned births (Black et al., 2008).

By analyzing the impact of FCUBE, I find that the average years of education for the treatment group increased by 15 percent. Compared to the comparison group, adolescent girls who benefited from FCUBE are less likely to marry early or give birth early. I find the effects of FCUBE to be homogenous across location, economic status and

religion. I find no evidence in support of abstinence as a possible mechanism through which education affect fertility and early marriage. Girls who benefited from the FCUBE policy have the same likelihood of engaging in sexual intercourse as their peers who did not benefited from the policy. However, there is some evidence to support "knowledge effect" as a possible mechanism through which female education affects fertility. The treated cohort is more likely to be informed about the use of modern contraceptive and is also more likely to read or listen to information provided in the media.

By examining the effects of NERP, I fail to find significant positive effect that students affected by NERP have jobs related to the vocational training than those students that were not affected by the reform. On the other hand, I find that NERP increased access to secondary education by 15.5 percentage points and access to tertiary education by 5.1 percentage points, reflecting a general increase in access to higher education. The reform also caused an increase in formal employment, service sector participation and probability to work for someone. I find10.8 and 6.3 percentage points drop in participation in the agriculture and informal sector, respectively.

1.4 Organization of the dissertation

The rest of the dissertation is organized as follows: chapter 2 reviews the relevant literature and clarifies gaps in the literature. Chapter 3 provides background to education system in Ghana including the two major policies that are used as natural experiments in this study. Chapter 4 provides information on the sources of data and the empirical framework for the study. Chapter 5presents the results of the effects of education on

fertility using FCUBE as natural experiment. Chapter 6 examines the impact of education on fertility using NERP as a natural experiment and Chapter 7 analyzes the impact of education on occupational distribution. Finally, Chapter 8 concludes the dissertation and discusses implications for future research and policy debates.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Governments around the world spend a significant proportion of their countries budget on education. This is because there is a large body of literature that provides quantitative and qualitative evidence on the importance of education. In developing countries, a significant proportion of recent studies in education for the past decade have primarily focused their attention on Universal Primary Education (UPE). Literature on benefits of education in developing countries can broadly be categorized into three major groups. The first body of literature adopts implementation of UPE policies to access the benefits of education on a range of outcomes (Breierova and Duflo, 2004; Grogan, 2008; Osili and Long, 2008; Nishimura, Yamano and Sasaoka, 2008; Glewwe, Kremer and Moulin, 2009; Bold et al. 2010; Duflo, Dupas and Kremer, 2014; Lucas and Mbiti, 2012a & 2012b; Keats, 2014; Duflo, Dupas and Kremer, 2015; Masuda and Yamauchi, 2017). The focus of the second body of literature is on the importance of access to higher education including an assessment of the Universal Secondary Education (USE) policy which its implementation is less than 10 years in the sub-region (Férré, 2009; Ozier, 2015; Chicoine, 2012;Tequame and Tirivayi2014; Moussa et al., 2015). The third and final body of literature emphasize on the benefits of quality education (De Hoop, 2010; Duflo, Dupas and Kremer, 2015; Lucas and Mbiti, 2014).

This chapter reviews the literature on education outcomes emphasizing on fertility and labour market outcomes. The overriding goal is to highlight the important gaps in the existing literature that this dissertation seeks to fill. The first part of the review briefly provides an overview of the theories of returns to education. Section 2.3 presents a review of empirical studies on the effects of education on fertility, section 2.4review literature on the impact of education on labour market outcomes and the final section summarizes the gabs in literature that this study seeks to address.

2.2. Theories of returns to education

Labour market studies draws on three important theories to explain the positive relationship between education and earnings. The first theory is what is called the human capital theory. The human capital theory argues that education imparts skills to an individual and the skills that the individual attained whiles in school directly increase his productivity. Since productive employees are more beneficial to organizations than non-productive employees, human capital theorists explain that productive employees are rewarded with higher wages. Therefore the skills acquired in school which lead to an increase in productivity brings about earning differences of laborers with different educational level achievement (Becker 1964; Mincer 1991). The second theory is what is termed as screening theory. According to the screening theory, employers use education as a signaling device to determine productivity, reliability and competency of a potential employee irrespective of whether an individual possess the attributes that he signal to prospective employers. Since productivity of a laborer cannot be observed by the employer

during the period of screening of prospective employees, rational employers therefore respond to signals from education attainment and then pay higher premium for individuals with higher level of education. The high premium received by the educated individual is as a result of the signal he sent out to prospective employer not because his productivity has been enhanced as a result of education attainment (Arrow, 1973; Spence, 1973; Brown, 2001). A widely used empirical method to test the validity of the screening hypothesis is to test for the existence of sheepskin effect in the returns to education (Bauer, 2002). The final theory that tries to explain the returns to education is termed as social closure theory. This theory contends that the differences in labor earnings arise as a result of limiting access to some section of the labour market to distort supply and demand. The distortions created in the labour market result to an increase in earnings for individuals employed in the restricted industry (Murphy, 1988).

The above three theories of returns to education may also help in explaining the quantity-quality model of fertility (Becker & Lewis, 1973; Becker & Nigel, 1976: Becker, 1991). The quantity-quality model of fertility suggests that the quantity and quality of children strongly depends on parental education. Quality children refer to the desire to have healthy children with higher education attainment. Suppose the time spent by fathers on their children is insignificant relative to women and that child-care in the household is a primary responsibility of women, then female education is important in determining the quantity and quality of children in the household. Given that the human capital theory suggests that education enhance knowledge and skills acquisition, then the knowledge acquired as a result of education may lower educated women cost of raising quality

children. The above is likely to happen because schooling may expose educated women to better child-care practices. The reduction in marginal cost of quality children for educated women relative to less educated women leads to a situation whereby educated women substitutes quantity of children with quality children. However, because it is more expensive to raise quality children, educated women tend to give birth to fewer children. In addition to the above explanation, all the three theories of returns to education suggest that educated women are likely to earn higher wage in the labour market. The likelihood of receiving higher wage rate by educated women will increase the shadow price of quantity of children demanded by them since time for child care can be used to earn higher wages in the labour market. An increase in the shadow price of quantity of children may cause educated women to substitute quantity of children with quality children. Thus, the quantity-quality model of fertility and the theories of returns to education suggest that an increase in education may cause a shift from more children to quality children. The substitution of more children for quality children lead to a total reduction in fertility.

2.3Education, fertility and early marriage

2.3.1 *Empirical evidence on the impact of education on fertility and early marriage*

Empirical evidence on the causality of education on fertility and the timing of marriage are mixed. Despite the mixed findings in the literature about causality between education and fertility and the timing of marriage, mixed results have only been seen in studies from developed countries that already have higher levels of education and low

fertility rates. The situation is different in developing economies with low levels of educational attainment and higher rates of fertility. Empirical evidence from developing countries consistently shows a causal effect of education on fertility.

There is simultaneous causality between education and fertility and this create an endogeneity problem when one wants to study the impact of education on fertility and on the timing of marriage. Other sources of endogeneity are individual ability and community resources, which may also correlate positively with schooling, early marriage and fertility decisions (Bledsoe et al., 1999). Many studies have taken various measures to deal with the problem of endogeneity between education and fertility using either experimental or quasi-experimental design. Several empirical studies on the impact of education on fertility and on the timing of marriage have tried several ways to deal with the endogeneity problem (Breierova and Duflo, 2004; Black et al. 2008; Osili and Long, 2008; Férré, 2009; Berthelon and Kruger, 2011; De Paoli, 2011; Chicoine, 2012;Grönqvist and Hall, 2013; Keats, 2014; Ozier, 2015;Masuda and Yamauchi, 2017;Monstad et al., 2008; Black et al., 2008; McCrary and Royer, 2011; Cygan- Rehm and Maeder, 2012;Duflo et. al., 2017; Hicks et al., 2015).

Hicks et al. (2015) use a design where they randomly select half of the sample and award them vouchers. The vouchers given could be use in attending vocational school. Though their results show that individuals who were awarded a voucher acquired more vocational education, they did not find difference in fertility between voucher holders and non-voucher holders. On the contrary, Duflo, Dupas and Kremer (2017) followed a similar

RCT design in Ghana. Students who had just completed JSS but could not afford the cost of secondary education were asked to participate in a lottery. Those who won the lottery conducted by the research team were awarded scholarships. They found total years of secondary education of scholarship winners increased by 1.26 years compared to non-winners. Scholarship winners adopted more preventive health behavior and had fewer children by the age of 25.

Quasi-experimental studies in developing countries have consistently demonstrated a causal relationship between education and fertility. Nigeria universal primary education is used as an instrument for education to study the causal impact of education on fertility. Exploiting differences in program exposure by region and age, Osili and Long (2008) demonstrated that an increase in female education by one year as a result of universal primary education policy in Nigeria reduces early fertility by 0.26 births. Using a similar UPE policy in Uganda, two studies have found that women exposed to the UPE reform had an increase in education by almost one year and the increase in education by one year caused a reduction in fertility preferences, a delay in age at first birth, and overall reduction in adolescent fertility (Keats, 2014; Masuda and Yamauchi, 2017).(Férré, 2009; Chicoine, 2012) adopted an extension of primary education by one year in Kenya in the year 1985 as a natural experiment. They found that the gain in the years of education by the treated cohort as a result of the reform reduced teenage fertility and the timing of birth. Ozier (2015) uses the sharp increase in probability to get admission into government secondary school in Kenya to conduct a regression discontinuity design. He finds that secondary schooling has substantial impact on fertility.

Using the actual date of birth of a female student to circumvent the endogeneity problem, McCrary and Royer (2011) found no causal effect of education on fertility in the United State. On the other hand, Black et al. (2008) found that gains in education as a result of compulsory schooling laws in the United States and Norway decreased adolescent fertility in both countries. Using a sharp increase in education of Arabs in Israel as a natural experiment, Lavy and Zlotsky (2011) concluded that the strong association in education is actually a causal effect.

2.3.2: *Pathways through which education affect fertility and the timing of marriage*

There are several theoretical pathways that have been suggested as an explanation to the impact of female education on fertility. In broad terms, education can delay fertility and marriage via the following mechanisms. First, education increases individual's knowledge, therefore an increase in female education could likely enhance women's ability to use contraception effectively and efficiently (Rosenzweig and Schultz, 1989). Second, female education increases the opportunity cost of early marriage and fertility. Child care is more time intensive than other activities. As the value of a woman's time increases, she would likely want to spend less time on child care related activities and therefore would desire fewer children so as to increase her labour force participation (Schultz, 1981; Becker, 1991). Third, educated women are more likely to contribute to household-decision making regarding issues including the ideal number of children for the household. Increase in female years of education increases women's bargaining power and their freedom to take independent decisions (i.e. without consulting their husbands). Fourth, keeping women in

school reduces the probability that they will engage in activities that could lead to unplanned births. Black et al. (2008) term this mechanism "incarceration effect". Finally, the marriage market operates in such a way that there is a high probability that an educated woman will be matched to an educated man. This kind of education related husband-wife pairing is referred to in the fertility literature as assortative matching (Becker, 1991; Breierova and Duflo, 2004; Clark et al., 2014; Lavy and Zablotzky, 2011, Tequame and Tirivayi, 2015).

2.4. The effects of education on labour market outcomes

2.4.1. *Impact of vocational education or training on labour market outcomes*

There are few good studies that examine the effects of vocational training on labour market outcomes in Africa and all the studies heavily rely on randomized control experiment. The results on impact of vocational education or training on labour market outcomes in Africa are mixed. A randomized control experiment in Ghana by Duflo, Dupas and Kremer (2017) demonstrates that student who won scholarship to attend vocational secondary school were likely to work more hours and receive higher total earnings than those who did not received scholarship. They explained that the higher total earnings were as a result of increased in employment but not higher hourly earnings for those who were observed as working. Bandiera et al. (2015) examined the impact of training Uganda women on women empowerment. They find that the intervention raises the likelihood that girls engage in income generating activities by 72 percent (driven by increased self-employment), and raises their expenditure on private consumption goods by 38 percent.

Recent studies in Uganda, Malawi, and Kenya provide training to the youth (cho et al., 2013; Blattman et al., 2013; and Kremer et. al., 2015). Kremer et. al. (2015) and choet. al. (2013) finds no significant effect of the youth vocational training intervention on earnings in the short run. On the contrary, Blattmanet. al. (2013) finds that the vocational training intervention increased earnings by 38 percent and working hours by 17 hours per week. Results from RCT studies usually have strong internal validity but the high cost associated with RCT designs only allows the experiment to be conducted in small communities. As a result of this weakness in RCTs, one can make little inference on general equilibrium effect on studies that use RCT interventions as compared to natural experiments which usually affect a larger proportion of the population.

Although there are no quasi-experimental studies on the impact of vocational education on labour market outcomes in developing countries, one can find some good studies in developed countries. The result from the quasi-experimental studies in developed countries documents no significant effect of vocational education on either long-term or short-term wages. Oosterbeek and Webbink (2007) took advantage of Dutch educational reform to conduct a difference-in-differences analysis. They found that the 1975 Dutch educational reform that extended the three-year vocational tracks by an additional year of general education did not improve graduates' long term wages. Hall (2016) used a similar policy implemented in Sweden and finds no evidence that having attended a longer and more general vocational program reduced the risk of unemployment. Rather, Hall found that extending upper secondary school with more general content can have a negative effect in terms of higher dropout rate for weaker students and this will in turn lead to a poorer

labor market outcome for that category of students. Malamud and Pop-Eleches (2010) took advantage of the 1973 educational reform in Romania, which shifted a large proportion of students from vocational to general education, to conduct a quasi-experiment. Using a regression discontinuity design, they found no significant difference in both earnings and unemployment between pre-reform and post-reform cohorts. They also found that the more demanding the program, the higher the likelihood of increase in dropout rate among weaker students.

2.4.2. *Impact of education on labour market outcomes*

Studies on the impact of education on labour market outcomes can be categorize into two; (1) effect of access to education on labour market outcomes and (2) effect of quality of education on labour market outcomes. Findings of empirical studies on the impact of access to education on social and economic outcomes in developing countries are mixed. Duflo, Dupas and Kremer (2017) employed an RCT design in Ghana in which JSS graduate who won a lottery conducted by the research team were awarded scholarships for secondary education. Scholarship students who followed vocational track of education were not likely to access tertiary education than those children who did not received scholarship. However, the scholarship increased the likelihood of earning money by 8.8 percentage points. On the contrary, the scholarship increased the chance of having enrolled in tertiary education by 5.3 percentage points for students that enrolled in the general education track. They could not reject the hypothesis that among those admitted to academic tracks,

scholarships did not affect average labor market participation and earnings by age 25. They argued that it was too early to assess labour market impacts in the study population since more scholarship winners than non-winners were still in school as of the last survey which was conducted in 2016.

Taking advantage of secondary school expansion in East Africa, Knight and Sabot (1990) examined the impact of secondary school expansion on labour market outcomes. They found that secondary school expansion compressed labour market wages of secondary school graduates. They observed that job opportunities of secondary school leavers gradually deteriorated to lower-skill and lower-wage occupations. Ozier (2015) uses a sharp increase in probability of admission into government secondary school in Kenya to conduct a regression discontinuity design. He finds that secondary schooling has a substantial impact on human capital accumulation and also reduces the probability of low skilled unemployment for men. Duflo (2001) adopted the large school expansion in Indonesia as an instrument for education, she concluded that construction of primary school for every 1000 pupils increased years of education by 0.12 to 0.19 and also increased wages by 1.5 to 2.7 percent.

Findings of empirical studies on the effects of quality of education on labour market outcomes are mixed. Variations in class size have been exploited as natural experiments to study the impact of class size on labour market outcomes. Using data from Sweden, Fredricksson et al. (2013) and Chetty et al. (2011) finds that smaller classroom size has significant effect on earnings at age 27. Card and Kruger (1992) adopts the variation across cohorts and within regions of birth to estimate the impact of school quality on earnings.

They found that lower pupil-teacher ratio increases earnings. Dustmann et al.(2003) used UK dataset to study the effects of quality education on earnings. He found that lower pupil teacher ratio increase earnings. However, using the same dataset, Dearden et al. (2002) concluded that pupil teacher ratio does not have effect on earnings.

2.5. Conclusion

In this chapter, I have reviewed the relevant empirical studies relating to the impact of education on fertility and on labour market outcomes. This dissertation adds to the existing literature by adding new information to literature that has not been sufficiently addressed. The contributions of this dissertation are in three fold. First, the study investigates the various mechanisms through which education affect fertility. Several studies that use UPE as a natural experiment indicate several possible mechanisms through which UPE affect fertility. However, there is no study that provides mechanisms through which education affect fertility, if the reform or policy used as natural experiment only affects girls in secondary school or just about to enter secondary school. Since UPE affect every child, it is likely that the possible mechanisms through which UPE affect fertility may be different from policies and reforms that affect women who are in secondary school. The dissertation fills this gap in literature by discussing the possible mechanisms through which education affect fertility using a reform that affected girls just about to enter secondary school.

Second, this dissertation uses a unique natural experiment which caused the years of education of the treatment group to decline. All the quasi-experimental studies before this dissertation have the years of education of the treatment group increased but this dissertation provide evidence to answer the question "what if the treatment group education is rather reduced". The dissertation provides an interesting revelation that the causal effects of education is independent on whether the treatment group education is increased or reduced. In addition to this, the study adds to literature by providing evidence on whether the impact of the FCUBE policy is the same across different subgroups.

Finally, the dissertation provides more insight into the vocationalization of curricula in several Sub-Saharan African countries which was not well implemented across all the countries in SSA. This study adds to literature as the first study in the sub-region that tries to empirically quantify the impact of vocationalisation of school curriculum (which was widespread policy in SSA in the 1970's and 1980's) on labour market outcomes.

CHAPTER 3

EDUCATION SYSTEM IN GHANA

This chapter explains the institutional context of education in Ghana. It also discusses the sources of data and definition of main outcome variables. The chapter is concluded by providing a brief discussion of the econometric model used in analyzing the data.

3.1 Background on Ghana's education policies before 1987

European settlers introduced formal education in Ghana in 1529 (McWilliam and Kwamena-Poh, 1975).Access to formal education by indigenous Ghanaians before independence was very low. After reclaiming power from the Europeans in 1951, the main vision of the first indigenous Ghanaian Prime minister was to increase access to education for all Ghanaians. He initiated the Accelerated Development Plan for Education (ADP). The six years of primary education were made free under the ADP and huge investment went into construction of primary and middle school buildings. By the time the first president was overthrown by a coup d'état in 1966, the number of primary and middle schools across the country stood at 10,421 compared to the 1,622 received from their colonial rulers in 1951(Keichi and Nishimura, 2015).

A succession of military and civilian governments failed to manage the economy well and this led to serious stagnation of infrastructural development in the educational

sector. In 1973, an educational committee was setup to review and give recommendations to the central government on the ways to avert the falling in the standard of education and reduction in enrolment ratio. The Committee proposed a new educational structure known as 'The New Structure and Content of Education (NSCE)' which demanded a restructuring of the pre-tertiary education in the country. Before the recommendation of NSCE, the existing educational structure required 6 years of primary education, 4 years of Middle School and 7 years of secondary school (SS) education. The 7 years SS education was divided into two. The first 5 years were a requirement for all tertiary education and the last 2 years were a requirement for university education. The proposal of the NSCE was to reduce the length of pre-tertiary education from 17 years to 13 years. The 6 years primary education was to be maintained and the 4 years of Middle School were to be reduced to three years. The first 5 years of SS were to be reduced to two years, and the last 2 years of SS were to be maintained (Dzobo, 1974). One hundred and eighteen Junior Secondary Schools (JSS) were piloted with the purpose of beginning full implementation in the following year. Unfortunately, the piloting of the NSCE coincided with the decline of the Ghanaian economy and could not be extended to the whole country. In total, only 2 percent of existing junior secondary schools were used for the pilot study. Even though the NSCE was not fully implemented, the experimental JSS piloted in 1974 continued until the 1987 educational reform.

3.2 The 1987 educational reform

In 1987, the New Educational Reform Programme (NERP) was introduced with the focus of restructuring the entire pre-tertiary educational system in Ghana. There were two major policies in the 1987 reform. First, the reform reduced pre-tertiary education from 17 years to 12 years. Second, the curriculum for junior secondary school (JSS) was vocationalized. The main purpose of the reform were to increase access to education at all levels, improve quality of education, diversify junior secondary school curriculum by introducing technical and vocational subjects, and to shorten the years of pre-tertiary education. The rationale for reducing the years of pre-tertiary education was to reduce per capita government expenditure on pre-tertiary education so as to make funds available to improve both access and quality (Osei, 2004).

In restructuring the years of pre-tertiary education, the 1987reform maintained the existing 6 years of primary education. However, the existing four years of Middle School[2] was reduced to 3 years and the name was changed to JSS. Prior to the reform, all tertiary institutions required a minimum of 5 years secondary school education apart from university education which demanded a minimum of 7 years of secondary school education. After the reform, years of secondary education was standardized to 3 years as a basic requirement for every tertiary institution (Akyeampong et. al., 2007). Appendix 3B1 provides a detail explanation of educational system in Ghana before and after the reform. Figure 3.1summarizes the years of pre-tertiary education in Ghana indicating total years of schooling at every level in pre and post reform. Prior to the reform, the first 10 years of

[2]In the rest of the dissertation, I will also refer to the Middle School as Junior Secondary School.

education in Ghana was to prepare students to study only academic subjects. Upon completion of the first 10 years of schooling, the most successful students proceed to enroll in academic secondary schools where only general education were offered, and the less successful students proceeded to enroll in technical vocational education and training (TVET) track. The remaining unfortunate students who could not continue their education after elementary school proceed to learn a trade in the informal sector.

Under the 1987 reform, vocational and technical subjects were introduced into basic education curriculum[3]. The vocational and technical subjects introduced at the JSS level are prevocational in nature. According to framers of this policy, the purpose of introducing these subjects into the curriculum is to expose pupils at this level to a range of practical activities in the vocational field in order to make them familiar with, and stimulate their interest in vocational subjects. The reform demanded every JSS student to study technical skills and technical drawing and must also select two or three of the pre-vocational skills subjects. Technical skills and technical drawing syllabi include the study of Metal Work, Block/Brick Work, Wood Work, and Plastic Designing. The Prevocational comprised of 12 subjects which were; Graphic Design, Picture Making, Textiles, Basketry, Bead making, Sculpture, Sewing, Paper Craft, Catering, Leatherwork, Gourd and Calabash work, and Pottery and Ceramics. The pretechnical and prevocational[4] subjects were allotted three periods a week each, and this formed 13 percent of the instructional time in a week (akyeampong, 2002).

[3]Basic education in Ghana is the first nine years of pre-secondary education. This comprise of 6 years primary and 3 years JSS

[4] Vocational and Technical subjects thought at the JSS level when NERP was implemented was called prevocational and pretechnical

3.3 Returns to education and NERP

As mentioned in chapter 2subsection 2.2, there are three theories that explain returns to education. Two of the three theories, human capital development theory and screening theory, can more likely explain outcomes in the labour market as a result of implementation of NERP. Proponents of human capital development theory argue that education lead to higher earnings, since education enhances labour productivity. Considering that NERP reduced the years of pre-university education from 17 to 12, human capital development may also have decreased as a result of the reduced years of schooling for individuals affected by NERP. However, the implementation of NERP was not intended to reduce the quality of education but to rather to enhance the quality of the Ghanaian educational system. The 17 years of pre-tertiary education in Ghana far exceeded the average of 12-14 years required in most of the world. One significant problem that might arise for students affected by NERP is that performance of students with lower academic abilities is likely to be affected more by NERP than that of students who enrolled in the old educational system, since under the old system, teachers would have had more time for explanation to students with lower academic ability. However, insufficient secondary school facilities at the time of the implementation of NERP led to a raising of the criteria for secondary school admission. That kind of sorting indirectly denies access to students with lower ability, who would have benefited from more years of secondary education. At the time of writing, no study was found that compares productivity of students affected by NERP and that of students enrolled under the old educational system. Whether students

from the old educational system were able to acquire more human capital as a result of the long years of pre-tertiary education is a matter of empirical question.

The shortening of years by NERP automatically made it easier to complete secondary education. Requiring 12 years in pre-tertiary education instead of the 15 or 17 years required before NERP is likely to increase access to higher education. Prior to NERP, individuals who completed 14 years of schooling would only have a junior secondary school certificate as evidence of their productivity for employers. However, the cohort affected by NERP only needed 12 years of education to obtain a secondary school certificate. It was difficult to get formal employment with a JSS certificate or a middle school living certificate (MSLC)[5] in the early 90s when the first batch of students affected by NERP were completing secondary school, so secondary school certification was an important indicator to employers, since it was the minimum condition for individual employment in the formal sector. For example, senior secondary school certification was the minimum requirement to teach as an untrained teacher in public primary schools in the early 90s [6] (Tanaka, 2012). Several advertisements for low paid jobs in the formal sector (e.g., secretary, messenger) required at least secondary school certification but made no mention of years of education. Since there is no clear theoretical prediction on which theory of returns to education dominates, then the question of whether human capital or signaling

[5]Is the name of certificate awarded to students who partake a nationwide exams organized for students at the final year of basic education prior to NERP.

[6] Trained teachers usually refused postings to the rural communities. The government of Ghana usually employs secondary school graduates and posts them to the rural communities to teach at the primary level since there were limited number of trained teachers compared to available classrooms.

theory of returns to education dominates as a result of implementation of NERP is a matter of empirical question.

3.4. The FCUBE policy

The FCUBE initiative is a constitutionally mandated policy in Article 39 (2) of the 1992 Constitution of the Fourth Republic of Ghana. In the article, is the formulation 'Basic Education – A Right: Programme for the provision of Free, Compulsory and Universal Basic Education by the year 2005' (Akyeampong, 2009). Basic education in the constitution of Ghana is defined to include 6years primary and 3 years junior secondary school education. The full realization of the policy as stated in the 1992 constitution was to be accomplish within 10years after its implementation in 1996. With the help of financial assistance from the World Bank and the country's development partners, implementation of FCUBE began in 1996 to address the weaknesses of the 1987 educational reform. The financial assistance received from development partners went into three broad activities. First, investments went into reducing fees and levies in order to increase enrollment. Second, investment went into improving head teachers' management skills and motivation levels, and also to improve school supervision so as to improve the quality of learning. Finally on the supply side, investments primarily went into improving existing physical infrastructure and increased the number of basic schools through large-scale construction of additional classrooms and school buildings (Akyeampong, 2009). At the initiation of the FCUBE policy, the government embarked on the abolishment of tuition fees officially.

The policy sought to abolish unsanctioned tuition fees that proliferate at the local level and reduce expenditure by parents on textbooks and other related direct costs on primary education. Tuition fees were made free in all the public primary school, but the 13 percent of pupils enrolled in private schools in 1996 continued to pay tuition fees (World Bank, 2004). Nevertheless, other direct costs such as textbooks, uniforms, stationery, sports kits, and contribution for PTA were still imposed on parents during the implementation of the policy in 1996 (Avotri, Owusu-Darko, Eghan, & Ocansey, 2000). All the direct costs that were not instantly abolished at the implementation stage in 1996 were to be faced off gradually and completely abolished at the end of 10 years after implementation. In 2005, when the policy cycle ended, any remaining official direct fees imposed on students were finally abolished (Kazuma & Oketch, 2008). Every student irrespective of his/her level at the basic education benefited from the tuition waiver and all the other subsidies that went into reducing direct fees and levies when the policy was implemented in 1996. Children who dropped out from school before 1996 due to inability to pay school fees and levies could go back to school after 1996 due to the reduction of fees after the reform. Although FCUBE demands compulsory basic education for every Ghanaian child, the compulsory aspect is yet to be enforced. An assessment in the first half of the implementation period showed that quality of teaching and learning significantly improved, and student enrollment and retention had a tremendous improvement especially among the lower income group (Ansu-Kyeremeh et al., 2002).

Unlike other countries in Sub-Sahara Africa which introduced similar policy and witnessed significant rapid increase in enrolment (e.g. Uganda), the policy in Ghana had a

slower but steadier growth (Akyeampong, 2009). The reform led to some significant increase in primary school attendance for both boys and girls with the main beneficiaries been children who were 10 years and below when the policy was first implemented. Figure 3.2 represents the gross enrolment ratio before and after the reform. The graph shows that over the five year period before the reform, enrolment ratio increased from 80 percent to almost 84 percent after the implementation of the FCUBE policy and then continued to increase steadily. Before FCUBE, Primary one enrolment rate between 1990 and 1996 ranges between 405,000 children to 415,000 children. However, enrolment to primary one jumped to 490,000 in the new academic year and this represent 19.5 percent increase in primary one intake. Primary one enrolment stagnated around 490,000 for the next three years and then continued to grow steadily for the subsequent years. Similarly, enrolment into primary two and primary three experienced a marginal increase of about 20,000 pupils which represent 5 percent and 6 percent respectively. There was no significant increase in upper primary and lower secondary immediately after the reform (Akyeampong et. al., 2007). Appendix 3B2 represents primary school attendance rate for both gender using the 2014 DHS household survey dataset. On average primary school attendance for the five-year cohort group of children in post-reform is 9 percent higher than the five-year cohort group in the pre-reform. This jump in educational enrolment at the cutoff point forms the basis of the empirical strategy to unearth the impact of education on fertility using FCUBE as a natural experiment.

CHAPTER 4

DATA AND EMPIRICAL FRAMEWORK

4.1 Sources of Data

The main sources of data analyzed in the dissertation come from two sources. The data used in analyzing the impact of education on labour market outcomes in chapter 7 comes from 2010 Ghana population and housing census (GPHC).Information on education, gender, ethnicity, religion and occupation are taken form 2010 GPHC dataset for the analysis. In analyzing the impact of education on fertility and the timing of marriage in chapters 5 and 6, I used the last four waves of Demographic and Health Survey (DHS) dataset from Ghana. Surveys of the last four waves of the DHS dataset were conducted in 1998, 2003, 2008 and 2014. Information on education, ethnicity, religion, wealth index, fertility, marital status and age at first sex are taken from the individual women dataset of DHS. The individual women dataset in DHS database contains fertility information for women from the ages of 15 to 49.

4.2. Sample frame and definition of variables for fertility and marriage outcomes

In analyzing the impact of education on fertility and on the timing of marriage using FCUBE, I constrain the sample in each of the four waves to only females who were age 15 to 20 during the survey period since the interest of the study is on adolescent girls. For some of the girls in the treatment group, education may be censored since the variable of interest, years of education is sensitive to age, the age distribution should be comparable

between the treated cohort and control cohort. To ensure this, women born between 1978 and 1983 for the 1998 survey are included in the sample. In a similar manner, I considered women born during the periods 1983-1988, 1988-1993 and 1993-1998 for the 2003, 2008 and 2014 surveys, respectively. Figure 4.1 illustrates the sources of total sample used in studying the impact of education on fertility using FCUBE as a natural experiment. The total sample size for pooling all four waves is 5797, of which 2711 are on the left hand side of the cutoff. In all the analysis, I used the pooled sample.

In analyzing the impact of education on fertility and the timing of marriage using NERP as a natural experiment in chapter6, I used the same last four waves of DHS dataset that was used to analyze the impact of education on adolescent fertility. In Figure 4.2, the Ghana Living Standard Survey (2005) shows that about 98 percent of women in Ghana are out of school by the age of 25[7]. The youngest of the women in the treatment group for the 2014 dataset is 37 years. Therefore, I constrain the sample in each of the four waves to include females from the age of 26 to 37 years. For the 1998 survey, only women born between 1961 and 1972 are taken to be part of the sample. In a similarly manner, I considered women born during the periods 1966 and -1977, 1971 -1982, and 1977- 1988 for the 1998,2003, 2008, and 2014 surveys, respectively. Figure 4.3 shows how the sample is obtained. Pooling all the four waves and restricting the age interval from 26 to 37 years gives a total sample size of 8665. Panel b of Table 4.1 contains percentages of religious affiliation, and ethnicity. Table 4.2 gives sample statistics for the variables used as mechanisms through which education affect fertility. Data for all the variables used for

[7] Women less than 26 years old are excluded to avoid censuring in education

analyzing the mechanism through which education affect fertility and fertility timing are also from the same dataset.

Marriage is simply defined as a consensus union between a man and a woman with or without legal, religious or traditional approval. I use the questions "ever married or in union" and "the age at which the respondents first got married" in the dataset to construct the marriage variable. In this paper, fertility is defined as a live birth by an adolescent girl prior to the time of the interview. The information provided on total live births and birth orders for each of the respondents in the DHS dataset is used to construct the fertility variable. Sexual involvement refers to all the women in the sample who had engaged in sexual intercourse before the time of the survey. The questions in the DHS dataset that asks the "age at first sex" is used to construct the dummy for sexual involvement. DHS dataset contains imputed age at first sex that factors into consideration inconsistencies in reporting the age at first sex. I compared the reported age at first sex with the imputed age at first sex, and out of a sample size of 5797, only 32 responds were inconsistent.[8] This implies that the inconsistency in responses on age at first sex account for only 0.55 percent of the total sample size. The variable wealth index is taken directly from the DHS dataset. It is calculated by using consumer assets like televisions, bicycles, and cars, as well as dwelling characteristics such as source of drinking water, sanitation facilities, and type of flooring material. The characteristics of the community in which the household lives are included in

[8]The five ways in which DHS treats responds to be inconsistent are; (1) age at first sexual intercourse exceeds her current age, (2)reported age at first sex occurs more than one year of conception of her first child, (3) reported age at first sex occurs at the time of marriage but respondent is not married,(4) reported that her first sexual intercourse was at the time of her first marriage, but her first marriage occurred after the conception of her first child, (5) reported her first sexual intercourse as being after her first marriage.

the national wealth index estimation. In the dataset, the wealth index is divided into 5 categorical variables; poorest, poor, middle, richer, and richest. However, I regrouped these five categorical variables into two categorical variables. Poorest and poor households are combined and relabeled as poor and similarly middle, richer and richest households are combined and relabeled as rich.

4.3. Sample and definition of variables for the labour market outcomes

The main source of data to analyze the labour market outcomes comes from the 10 percent public-use micro-data sample of the 2010 Ghana Population and Housing Census. Ghana Statistical Service provides 10 percent of the entire Population and Housing census to the general public. The 10 percent of the total observation that GSS releases to the public are selected randomly from the population survey. Table 4.3 compares the 10 percent sample with the population[9]. The summary statistics presented in Table 4.3demonstrate that the sample is a representative of the population. The data identify age, occupation, household income, marriage, religion, ethnicity and education, as well as residential and household details. I find ethnicity, religion[10] and gender as the only pretreatment covariates in the dataset. Years of education is constructed from two questions in the questionnaire (highest level of education completed and highest grade completed at that level).

Since implementation of NERP in 1987 maintained the existing 6 years primary education but reduced the years of completing JSS education by 1 and that of secondary by 2 to 4 years, any student whose education exceeds 6 years primary and entered JSS in 1987

[9]The population figures were obtained from 2010 GPHC report.
[10]Religion is categorized into Christian, Islam and others. Christian and Islamic religion forms about 80 percent of the population and an individual education does not affect his choice of religion.

or later is treated. Highest levels of education for individuals with less than tertiary education prior to the reform are coded differently from cohorts affected by the reform. Thus, the treatment status of persons with pre-tertiary education as their highest level of education is easily determined in the data. However, the treatment status of persons with tertiary education cannot be determined using responses from the two questions in the 2010 GPHC questionnaire used to construct the years of education. I therefore assume that any individual with tertiary education and born on or after the cutoff point is treated. This affects the analysis of the exposure to the new education regime, and that the analysis of labour market outcomes. Overall, 8.7 percent of individuals in the sample had tertiary education[11]. Appendix 4B1 plots the discontinuity for persons with less than tertiary education as their highest level of education. The discontinuity in Appendix 4B1 is similar to that of Figure 7.1, which uses all the observations. This indicates that the assumptions on the treatment status of individuals with tertiary education are unlikely to significantly biased estimated results. To avoid censuring in education and also to ensure that greater percentage of the treated cohort are either working or learning a trade at the time of the survey, I restricted the sample to include age 26 to 60 years. Restricting the sample from 26 to 60 years produced a total of 830,640 observations. The dummy variables indicating the labour market outcomes are directly created from the occupation information in the dataset.

[11]Late entry, early entry, and repetition create a problem when I use the cutoff to estimate treatment status for people who had access to tertiary education. Suppose the treatment status of individuals within a bandwidth of 4 at either side of the cutoff is likely to be wrongfully estimated using the cutoff year. The total sample size of individuals with tertiary education and within the bandwidth of 4 at each side of the threshold is 1.5 percent of the entire sample size used in the analysis. If late entry, early entry and grade repletion caused 20 percent error in estimating treatment status of individuals within this group, this will result in only 0.3 percent error in estimating treatment status of individuals with tertiary education for the study. 0.3 percent is statistically insignificant to affect the estimates.

They indicate 1 if individuals are informal workers, craft, manufacturing, agriculture, construction; those who are employed, self-employed.

Table 4.4 provides descriptive statistics for the whole sample. Part (a) of Table 4.4 provides mean, standard deviation and the size of the sample for the dummy variables indicating labour market outcomes. Panel b of Table 4.4 lists group percentages for religious affiliation, ethnicity, gender, and level of education. Comparing the means of the control and treatment cohort indicates that the treated cohort had higher socioeconomic outcomes. For example, whiles 38.9 percent of the control cohort works in agriculture, only27.4 percent of the treated cohort works in agriculture. Again, 70.5 percent of the control cohort works in the informal sector but it dropped to 66.5 for the treated cohort. In panel b of Table 4.4, 36 percent of the control cohort has zero years of education but only 27.22 percent of the treated cohort has zero years of education.

4.4. Empirical framework

The 1987 and 1996 educational reforms both altered the years of educational attainment of the treated cohort. The exogenous implementation of the 1987 and 1996 reform which created a discontinuity in pre-tertiary education can be used to evaluate the effects of education on fertility and on labour market outcomes. Birthyear is used as the running variable for the fuzzy regression discontinuity design (FRDD). Since there can be late or early entry into primary school and grade repetition of students, treatment status is not a deterministic function of the running variable. Therefore, the fuzzy regression discontinuity is used in the analysis.

4.4.1 Empirical framework for the analysis of NERP

In this subsection, I present the basic empirical framework used in analyzing NERP. The first model under this subsection analyzes the impact of education on fertility in chapter 6 and the second model is used to analyze the impact of exposure to NERP on labour market outcomes in chapter 7. Let Y_i represent fertility, the dummy variable indicating ever giving birth or ever being married for individual *i*. Let$X_i$be the running variable (birthyear), *c* the cutoff point and $S_i$beyears of education and Z_i a dummy 1 if an individual is born in 1973 or later in the NERP analysis and it is also a dummy 1 if an individual is born in 1989 or later in the FCUBE analysis. The data generating process of the FRDD is expressed as:

$$Y_i = \beta S_i + f(X_i) + U_i \qquad (1)$$

$$S_i = \pi Z_i + g(X_i) + V_i \qquad (2)$$

$$Z_i = 1(X_i \geq c) \qquad (3)$$

$U_i$are other factors that affect Y_i, and V_i are other factors that affect S_i. Combining equation (1), (2), and (3), and

a. continuity of U_i and V_i at the cutoff
b. The first stage should not be zero
c. Monotonicity assumption, and
d. Independence and exclusion restriction assumption which means thatZ_i does not directly affect Y_i, but it affect Y_i only through S_i;

The FRDD estimand in (4) identifies β if there are cross-overs (individuals in the control group who received treatment).The estimand of the FRDD identifies local average treatment effect (LATE), which is expressed as:

$$\beta = \frac{\mathbb{E}[Y_i|X_i = c] - lim_{x_i \uparrow c}\mathbb{E}[Y_i|X_i = x]}{\mathbb{E}[S_i|X_i = c] - lim_{x \uparrow c}\mathbb{E}[S_i|X_i = x]} \qquad (4)$$

The estimand β is a weighted average per-unit treatment effect at the cutoff. The estimand of fuzzy RDD expressed in (4) is numerically equivalent to the two stage least square (2SLS) estimator (Lee &Lemiux, 2010). Thus, I estimate equation (1) and (2) using the 2SLS where Z_i is used as an instrument forS_i.The results obtained in the 2SLS are weighted average of a unit causal effect (Angrist &Imbens, 1995).[12]

The above framework is used to analyze the effect of years of education on fertility, ever given birth and ever married. In the case of NERP, it also of interest to examine the effect of exposure to the new secondary school education system on occupational type, employment status and the possibility of accessing higher education. The exposure to NERP can be measured as the educations of individuals exposed to NERP were coded differently from those who were not exposed to NERP.[13]

Let T_i represent educational attainment and labour market outcomes. The data generating process of the FRDD can be expressed as:

[12]Suppose that each individual *i* would obtain Y_j if he or she attain *j* years of schooling, for j taking values in the set {0,1, 2,…,$\bar{s}$}, then there are $\bar{s}$ unit causal effects (β_{si}), each of which is defined as $Y_{isj} - Y_{is-1,j}$. This framework is based on the notion that a full set of Y_j exists for each person, even though only one is observed for every individual.

[13]The exposure to FCUBE is not known from the data

$$T_i = \beta D_i + f(X_i) + \beta_z Z_i + U_i \quad (5)$$

$$D_i = \pi Z_i + g(X_i) + V_i \quad (6)$$

$$Z_i = 1(X_i \geq c) \quad (7)$$

Combining assumptions (a), (b), (c) and (d) and the fact that there are cross overs, the causal impact of exposure of NERP on our interest variable can be expressed as;

$$\mathbb{E}[\beta | X_i = c, \pi = 1] = \frac{\mathbb{E}[Y_i | X_i = c] - lim_{x_i \uparrow c} \mathbb{E}[Y_i | X_i = x]}{\mathbb{E}[D_i | X_i = c] - lim_{x \uparrow c} \mathbb{E}[D_i | X_i = x]} \quad (8)$$

$\pi = 1$is for compliers (Lee and Lemiux, 2010).

The fuzzy RDD expression in (8) is numerically equivalent to the two stage least square (2SLS) estimator. Thus, I estimate equation (5) and (6) using the 2SLS where Z_i is used as an instrument for D_i. Regression results reported in chapter 7 use this framework. Regional fixed effects are included in equation (5) and (6), and standard errors are clustered at the district level.

4.4.2Empirical Framework for the analysis of FCUBE

If S_i is not censored as in the case of all the analyses that used NERP to determine the cutoff, we can consistently estimate equations (1) to (3) using the 2SLS. However, directly estimating equations (1) to (3) using the 2SLS when S_i is censored as in the case of all the analyses that use FCUBE to determine the cutoff point may lead to an inconsistent estimate since censoring may cause a measurement error. However, we can obtain a consistent estimate for β if the error terms are normally distributed (Gang and Xuyang, 2014).

Consider the diagram below:

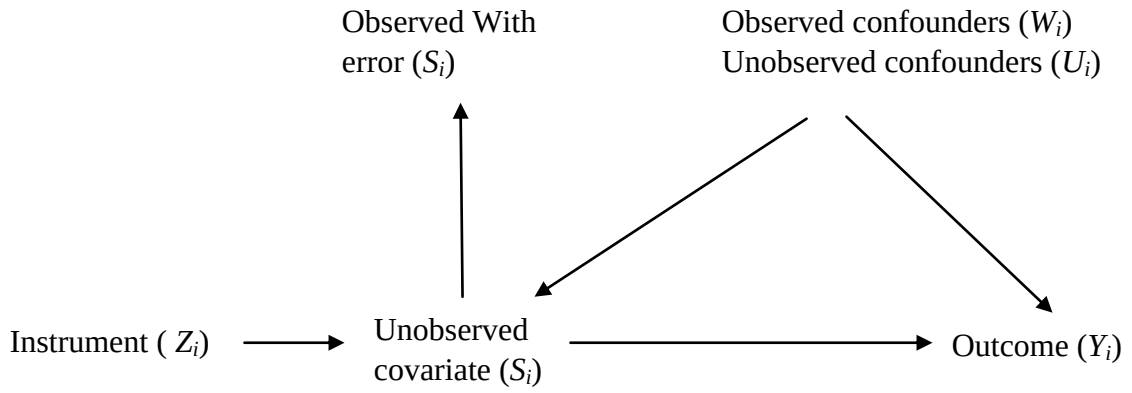

Figure1 presents graph of instrumental variable model in the presence of unobser l measurement errors. The causal effect of S^*_i on Y_i; that is the parameter β_1 is of primary interest.

Suppose the true equation of the 2SLS have linear relationship among all the variables and let Y_i be the time-to-event outcome and C_i be the corresponding right censoring time. If T is the time to the event, then $T_i = min(Y_i, C_i)$ can be observed. Suppose S^*_i is the unobserved continuous covariate of interest and S_i is what is observed for S^*_i, suppose W_i is a vector of observed confounders, U_i is a vector of unobserved confounders, and Z_i is a vector of instruments (in this case $Z_i = 1[X_i \geq C]$ and 0 otherwise). Our research interest is to estimate the causal effect of S^* on Y_i on the basis of the observed right-censored consisting of the observations $(T_i, \delta, S_i, W_i, Z_i,)$ where δ=I$[Y_i \leq C_i]$ is the censoring indicator. The above diagram can be modeled as:

$$Y_i = \beta_0 + \beta_1 S^*_i + g(X_i) + \beta_2 W_i + \beta_3 U_i + \varepsilon_{i2} \quad (5)$$

$$S^*_i = \alpha_0 + \alpha_1 Z_i + f(X_i) + \alpha_2 W_i + \alpha_3 U_i + \varepsilon_{i1} \quad (6)$$

$$S^*_i = S_i + \varepsilon_{i3} \quad (7)$$

Where $\varepsilon_{i1}, \varepsilon_{i2}, \varepsilon_{i3}$, are independent random errors with mean 0 and finite variances. The measurement error in S^* is ε_{i3}. The variables $\varepsilon_{i1}, \varepsilon_{i2}, \varepsilon_{i3}$, U_i, and Z_i are assumed to be independent. By substituting equation (7) into equation (5) and (6), the three stage equation reduces to:

$$Y_i = \beta_0 + \beta_1 S_i + g(X_i) + \beta_2 W_i + \beta_3 U_i + \varepsilon_{i2} + \beta_1 \varepsilon_{i3} \quad (8)$$

$$S_i = \alpha_0 + \alpha_1 Z_i + f(X_i) + \alpha_2 W_i + \alpha_3 U_i + \varepsilon_{i1} - \varepsilon_{i3} \quad (9)$$

Thus, ϵ_1, ϵ_2 in equation (1) and (2) can be represented as $\epsilon_1 = \alpha_3 U + \varepsilon_1 - \varepsilon_3$ and $\epsilon_2 = \beta_3 U + \varepsilon_2 + \beta_1 \varepsilon_3$.

With the normality assumptions on the error terms of equation (5)-(7), the error terms ϵ_1, ϵ_2 can be shown to follow a jointly bivariate normal distribution and the estimator is the maximum Likelihood Tobit IV estimator provided in Gang and Xuyang (2014). Even though the estimator is derived based on the strong assumption of a normal distribution of the error terms $\varepsilon_{i1}, \varepsilon_{i2}$ and ε_{i3}, simulation results provided in Gang and Xuyang (2014) show that the estimator still works well when the distribution of the error term is Exponential, Weibull or a Normal mixture.

In analyzing the effects of education on fertility outcomes in chapter 5, I report regression results of the 2SLS and IVtobit since the endogenous variable education is likely to be censored. The pretreatment covariate included in the regression tables in chapter 5 are religion and ethnicity.

CHAPTER 5

IMPACT OF EDUCATION ON FERTILITY AND EARLY MARRIAGE USING FCUBE

This chapter investigates the effects of education on adolescent fertility and early marriage using FCUBE as a natural experiment. As discussed in section 3.4, the main reasons for implementation of FCUBE were to reduce fees and levies in order to increase enrollment, improve existing physical infrastructure and to increase the number of basic schools through large-scale construction of additional classrooms and school buildings. The sample frame presented in Figure 4.1 consists of women from age 15 to 20 and therefore it is likely that the years of education of some of these women are censored. Hence, the regression results reported in sections5.1.3 and 5.1.4 presents estimates of2SLS and IVtobit. The coefficients of the 2SLS and IVtobit can be interpreted as the weighted average of a unit causal effect. I begin the analyses of the effects of education on fertility and on early marriage using FCUBE by discussing the identification and validity of the design. Second, I estimate the impact of FCUBE on education, and then using FCUBE as an instrument for education, I estimate the impact of education on adolescent fertility and early marriage. Finally I present heterogeneity analysis of the policy and then discuss the possible mechanisms through which education affects fertility and early marriage.

The effects of education on adolescent fertility and early marriage appear to operate through two main mediums. The first medium is the ability of the adolescent girl to effectively understand the proper utilization of modern methods of contraception. Educated women are more likely to access the media frequently and to the extent that information on

the negative effects of early marriage and adolescent fertility are explained in the media, the better informed the educated adolescent girl will be (Keats, 2014).The second channel through which education can affect fertility is what Black et al. (2008) term the "incarceration effect," i.e. keeping women in school to prevent them from engaging in behaviours that could lead to unplanned births.

The effects of FCUBE policy on adolescent fertility may be heterogeneous for several reasons: first, background characteristics of children, such as the economic wellbeing of their parents, are likely to determine whether the poor benefit more from the policy or there is no difference between the two subgroups. The second effect is that FCUBE is likely to have different impact at different locations. The average education of residents of the three northern regions of Ghana is lower than that of those living in the remaining seven regions. In the remaining chapters, I will refer to the three northern regions in Ghana as northern-savanna and the remaining 7 regions as coastal tropical-rain-forest.[14] The northern savanna differs from the coastal tropical-rain-forest not only in terms of education but also in terms of religion and economic development. The predominant religion in the northern savanna is Islam whereas that in the tropical rain forest is Christianity. Communities in the tropical rain forest have better infrastructure than communities in the northern-savanna. Third, FCUBE is likely to have a different impact on different communities, depending on the level of development of the community. There is a lack of educational infrastructure in many rural communities in the country. Thus, females living in rural communities without educational infrastructure have to walk several miles to

[14]Ghana has a total of 10 administrative regions which was officially established in 1987 and the regional boundaries have remained the same since its establishment in 1987.

nearby village before they can attend school. In addition, most rural communities have customary practices that include early marriage of female children but such customs are usually absent in urban communities. Finally, FCUBE policy may not only directly manipulate children in basic schools, but may extend beyond considerations regarding basic education.

5.1 Identification and internal validity checks

The identification and estimation of local average treatment effect (LATE) by the use of FCUBE as an instrument demands four assumptions. First is the independence and exclusion restriction assumption. The potential concern here is that other government policies are likely to be related to FCUBE at the specified cutoff. If this were to happen, the estimated results will identify the combined causal effect of FCUBE and other policies. To the best of my knowledge, there are no other government educational programs that coincided with the 1989 cutoff. Aside other government policies, any private investment in education that created discontinuity in education in 1989 is likely to affect the internal validity of the results. If such investments created a discontinuity in education in 1989, then my estimation is the combined effect of FCUBE and these associated private policies but there were no such policies. The discontinuity graphs of pre-treatment covariates presented in Appendix 5B1 show that the covariates are smooth at the cutoff. Appendix 5B1 suggests that it is unlikely that there was any parallel policy that created a discontinuity in 1989. I assume therefore that all other parallel policies that affect education were smooth at the cutoff year of 1989.

Second, implementation of FCUBE reduced the cost of education and increased the number of classrooms, therefore the correlation between FCUBE and years of education is unlikely to be weak.

Third, the assumption that pretreatment covariates are continues at the cutoff. The graphs presented in appendix 5B1 show no jumps in the pretreatment covariates[15]; mother education, father education, mother occupation and household wealth. The DHS dataset only contains information on parents of children 17 years of age or younger. 50.5 percent of respondents are 17 years or younger. Considering the fact that only parents who live in the household information are available in the dataset, characteristics of real parents of the respondents is likely to be less than 50 percent of the sample. Thus, the parents characteristics provided in Appendix 5B1 are not those of the real parents observed in the data. The mean age of giving birth for the first time is 18 years in the DHS dataset, so I assume that any woman who is 18 years old or older than the respondents in the dataset can serve as a mother for these adolescents.

Finally, FCUBE satisfies the monotonicity assumption of LATE. Suppose the population is divided into affluent families and poor families. Children from affluent families would surely attend basic school irrespective of been born before or after FCUBE. Therefore, the years of education of children from affluent families are unlikely to be affected by FCUBE. However, there are some parents who could not afford basic education

[15] The pretreatment covariates used in the regression estimations are religion and ethnicity. The other pretreated covariates used in Appendix 5B1 were only used for checking smoothness around the discontinuity. The observations total education of mother, total education of father, andthe occupation of mother are not observation of actual parents of women in the dataset.

for their wards because of higher tuition fees that was charged at that level prior to FCUBE. It was also difficult for some children in certain communities to attend school because of unavailability of school in that community or nearby communities. Since FCUBE made education more accessible to children from poor families, there are some parents who are unlikely to send their children to school prior to FCUBE but are more likely to send their children to school because of FCUBE. However, there would still be some poor families that FCUBE would not cause them to send their children to school. This is because the opportunity cost for these parents to send their children to school is likely to be higher than the benefits from FCUBE. Thus, the years of education of children from such families are unlikely to be affected by FCUBE. Thus, FCUBE would affect the years of education of children from poor families whose parents would change their decision to send them to school because of FCUBE. It is unlikely to have group of persons in the population that FCUBE would affect their education negatively. Therefore FCUBE affected years of education of members in the population in a monotone way.

Two important concerns are likely to be raised about the use of FCUBE as a natural experiment to examine the impact of education on fertility and on the timing of marriage. The first concern is, parents with limited resources and preview to the year of implementation of FCUBE are likely to postpone the education of their children so as to benefit from FCUBE from the onset. This is unlikely to happen since the policy implementation was set out to provide all children with basic education in 1996 irrespective of grade level. In addition, if parents had postponed the education of children whose primary one education took place close to the policy implementation year, the gross

enrolment ratio presented in figure 3.2 would have shown a significant drop in the enrollment ratio for the year 1995 and 1994, but that is not the case.

The final concern about the validity of the discontinuity estimate is the treatment of children 8 years, 9 years and even 10 years as a complete control group. However, these cohorts are likely to be partially treated. Since the policy affected all ages and all levels from stage 1 to stage 9, children above 8 years who dropped out from school would still benefit from the policy if they returned to school. Similarly, children 8, 9 or 10 years of age who were unlikely to have attended school if FCUBE had not been implemented are likely to attend school. If the effect of late entry and dropout students re-entering school after FCUBE is significant, the effect of the policy would be underestimated and thus the actual discontinuity for the FCUBE policy would be greater than my estimate since a significant number of children who were eight years and above when FCUBE was implemented may have received treatment or partial treatment but fuzzy regression discontinuity design treat all these children as control. The data available is insufficient to explain the effect of the drop-outs from primary 2 or higher who went back to school as a result of the policy.[16] However, the sixth wave of the Ghana Living Standard Survey provides the age at which a respondent first begins primary 1[17]. The estimation results shown in Appendix 5A1 indicate that the inclusion of children with late entry to primary 1 in the estimation did not significantly alter the discontinuity. The slight reduction in the size of the discontinuity

[16]It is more likely for children who drop out in primary 2 or primary 3 to be admitted to primary 1 when they return to school after the implementation of FCUBE policy. Children who dropped out from school 3 years or more prior to the policy implementation are unlikely to go back to school since they would be uncomfortable studying at the same level with students whose ages are far below their age.

[17] Primary 1 is the same as stage one in Primary education

when late entry students are added in column 2, 3 and 4 in Appendix 5A1 indicates that cohorts close to the reform received some partial treatment although the effect may not be significant[18].

The first identification procedure in regression discontinuity analysis is graphical representation to show a jump in the policy variables at the cutoff point. Children in Ghana are expected to begin primary 1 at the age of 6 years. However, due to late entry into primary 1, especially in the rural communities in Ghana, the mean age of entering primary 1 is 7.5 years (Akyeampon et al., 2007). Graph (A) in Appendix 5B2 shows that the average age of girls entering primary 1 is approximately 7.2 years for cohorts close to the cutoff year. I therefore use the mean age of entry into primary one to be 7 years and therefore the discontinuity occurs for children born in 1989 given that FCUBE affected every child in basic school. Figure 5.1 provides the discontinuity graph centering year of birth on the cutoff year. If the discontinuity is credible, then there should be no jumps in any of the pretreatment covariates.

Recent literature on regression discontinuity design advocate for local linear regression estimation to global polynomial estimation. The remaining paragraphs under this section explain how the bandwidths for the local linear regressions are determined. Following Hahn et al., (2001), Imbens and Lemieux (2008) and Lee and Lemiuex (2010), I estimate a local linear regression for both the right hand side and left hand side of the cutoff point allowing for different slopes at each side of the cutoff to estimate the discontinuity.

[18]Since there is evidence of cross-overs, the estimand of the FRDD using FCUBE as a natural experiment identifies local average treatment effect (LATE).

The average effect of treatment close to the cutoff can simply be estimated using the 2SLS framework in chapter 4 subsection 4.4.1 when there is no censoring or subsection 4.4.2 when there is censoring in education. To select the optimal bandwidth and the correct model specification, a series of estimations and tests are conducted. Each birthyear cohort in the sample is treated as a bandwidth interval. From the pooled data, there are 10 birthyear cohorts at the right hand side of the cutoff and 15 birth-year cohorts at the left hand side of the cutoff. To obtain the optimum bandwidth for the linear specification for both the first stage and the second stage regression, I first select a window of 10 birthyear cohorts since the largest birthyear cohorts at the right hand side of the cutoff is 10 years.

I run the leave-one-out cross-validation from bandwidth of 1 to the maximum bandwidth of 10 using the regression discontinuity cross-validation bandwidth specification function in Lee and Lemiuex (2010). Appendix 5B3graphically show the results obtained from the leave-one-out cross-validation for both the first stage and the second stage regression. In Appendix 5B3a, the bandwidth for the first stage regression falls sharply from a window of 1 and stabilizes from window 2 to window 5 and the minimum occurring at window 4. Therefore the optimum bandwidth selected for the linear specification for the first stage regression is 4 birthyear cohorts on either side of the cutoff. The cross-validation result for the instrumental variable estimation for the outcome variable ever involved in sex is shown in Appendix 5B3b. In Appendix 5B3b, again the cross-validation function falls sharply and stabilizes at window 4 and window 5 and becomes unstable again after window 5. Appendix 5B3a and Appendix 5B3b in the appendix suggest a bandwidth of 2 to 5 on either side of the cutoff as the appropriate window for the local linear regression. Therefore

the optimum bandwidth for both the first stage and second stage regressions are bandwidth of 4. On the other hand, Appendix 5B3c and Appendix 5B3d suggest a bandwidth which is different from the bandwidth of 4 selected for the first stage regression. Appendix 4B3a suggests window 4, both Appendix 5B3c and Appendix 5B3d suggests window 1.

Imbens and Lemiux (2008) suggest that the best bandwidth for both the first stage and the second stage should be the minimum cross-validation value for both the first stage and the second stage regression. However, I decided to limit the bandwidth selection using only the first stage regression for the outcome variables married and adolescent fertility, for two reasons. First, the first stage regression which actually determines the size of the discontinuity is more stable from a window of 2 birthyear cohorts to a window of 5 birthyear cohorts. Thus, the estimated discontinuity from bandwidth 2 to bandwidth 5 would be more stable. In addition, choosing a bandwidth of 1 on both sides of the cutoff would significantly reduce the sample observation, which would in turn affect the statistical power of the instrumental variable estimator. Restricting the bandwidth selection to only 1 birthyear cohort will reduce the total sample size to 586 data points with 393 observations falling on the left hand side of the cutoff. In view of the fact that only 16 percent of the teenagers had ever married and only 13 percent had ever given birth, choosing a very small bandwidth around the cutoff, as shown in Appendix 5B3c and Appendix 5B3d, will not yield enough observations and may be insufficient for the purpose of hypothesis testing in the second stage regression.

To further check the validity of the discontinuity, I estimate different polynomial models using a bandwidth of 4 on either side of the cutoff. Table 5.1 shows the estimated results for three different polynomials. Columns 1&2 and 3&4in Table 5.1 show linear and quadratic respectively. The results presented in column 1, 3, and 5 have no additional control variables, whereas all the even columns add control variables. The results are robust for all model specifications. The coefficient for the discontinuity at the bandwidth of 4 is significant for all the different model specifications. The size of the discontinuity does not significantly change when different model specifications are used. The sizes of the discontinuity without pretreatment covariates are not significantly different from the size of the discontinuity with pre-treatment covariates. Although adding pretreatment covariates does not significantly affect the size of the discontinuity, it gives a more precise estimate for it (especially when there are outliers). In appendix 5A2, results for linear and quadratic estimations of the running variable controlling for other pretreatment covariates are provided for four different bandwidths. The sizes of the discontinuities from birth-year cohorts 2 to birth-year cohort 5 are very stable and robust.

5.2. Impact of FCUBE on education

The first stage regression estimates the jump in years of schooling at the cutoff point[19]. For all the different model specifications in Table 5.1, the discontinuity varies from 0.86 to 0.98, and the coefficient of each specification is significant either at the 1 percent or 5 percent confidence level. The smallest confidence interval among the six estimations is

[19]I used all the last four waves of DHS dataset to select the bandwidth. However, the selection of bandwidth 4 limits the regression estimates to only three waves of the DHS dataset. Thus, the Local linear regression estimates reported in this study restrict the dataset to only 2003, 2008 and 2014 waves.

given as [0.27, 1.55] and the widest is [0.03, 1.6]. The coefficient of the local linear regression without covariates only differs by 0.09 when pretreatment covariates are added. Similarly, the quadratic specifications do not significantly change when pre-treatment covariates are added. These results suggest that there was an increase of almost 1 additional year in education after the implementation of FCUBE policy[20]. Given that the average years of schooling for the comparison group is 6.02, the results suggests that the FCUBE policy resulted in a 15 percent increase in average years of schooling.

5.3. Impact of education on adolescent fertility and on early marriage

This section analyzes the impact of education on fertility and on early marriage by presenting results from OLS and 2SLS. The OLS estimation in Table 5.2 shows a reduction in adolescent fertility by 0.03 for every additional year of schooling. However, the preferred IV regression in columns (2) and (3) shows a decrease in fertility by 0.11 to 0.13 births for every additional year of schooling, far greater than the 0.3 decrease obtained in the OLS estimation. The FCUBE policy increased total schooling years for the treated group by one year; therefore the coefficient of the IV regression in Table 5.2 is interpreted as a one year increase in education causing adolescent fertility to drop by 0.11 to 0.13births. In addition, the OLS result in Table 5.2 shows a one percentage point decrease in the probability of ever given birth by an adolescent girl whereas the IV results suggests 8 to 9 percentage points decrease in the probability of ever given birth by the adolescent girl.

[20] Tobit results also indicate that the reform caused almost 1 year increase in education

Appendix 5B4 shows the discontinuities of adolescent fertility at specific ages. From the graph, the effect of FCUBE policy on fertility continues to decrease as age group increases, and significance disappears for ages 19 and 20. The results of this study are similar in magnitude and sign to the results of other quasi-experimental fertility studies carried out in sub-Saharan Africa.[21]

The policy affected the years of education of men as well. This therefore suggests that, if age difference between husbands and wives in Ghana were close to zero, then the reform might have affected the fertility and marriage outcomes through changing the education of husbands as well as wives. However, Appendix 6B4 indicates that husbands in Ghana are 7 to 10 years older than their wives. Given that the optimal bandwidth of regression results is 4 years, all women in this bandwidths are unlikely to have the education of their husbands to be affected by the reform. In fact Appendix 5A3 presents regression estimates on education of men likely to be husbands of women in the sample and the regression results suggests that there is no discontinuity in the education of these men at the policy threshold[22].Therefore there is unlikely to be a marriage market equilibrium effect on fertility through the policy impact on boys.

I also estimate the effect of education on the likelihood to marry at the age of 15 to 20 years. OLS regression (see Table 5.2) shows a 4 percentage point decrease in probability

[21]Férré, 2009; Chicoine, 2012; and Ozier, 2015 in Kenya, Osili and Long, 2008 in Nigeria; and (Keats, 2014; Masuda and Yamauchi, 2017) in Uganda

[22] Less than one percent of the women from 15 to 20 years in the DHS survey provided education of their husbands. Thus, Appendix 5A3represents all the men in the GLSS6 survey who are likely to be husbands to the women in the dataset to estimate the impact of the reform on the education of these men and the result confirms that the reform did not affect the education of the men who are likely to be husbands of the women in the dataset.

to marry for one additional year of schooling but the IV regressions indicate a 14 to 17 percentage point decrease for one additional year of schooling. The regression in Table 5.1 shows an increase of almost one year in average years of schooling. These results suggest that a one year increase in education causes teenage marriage to drop by 14 to 17 percentage points. The result in this study is consistent with Masuda and Yamauchi (2017) but contradict the findings of Keat (2014)

5.4. Mechanism

This section discusses the possible mechanisms through which FCUBE affect fertility and early marriage. The OLS regression (see table 5.2) shows a 2 percent decrease in sexual intercourse for every additional year of schooling. The coefficient for the 2SLS estimation has an expected negative sign, but it is not significant. This means that the fraction of women whose education is affected by the FCUBE policy is similar to that of women whose education is not affected by the policy. This finding is similar to that of Keats (2014), who posits that the sexual behavior of Uganda adolescent girls who are in school is not different from that of those who are not in school.

As discussed in the beginning of the chapter, education may also affect adolescent fertility and early marriage as a result of acquired ability to understand issues related to the consequences of early marriage and fertility. I provide estimations in Table 5.3 for three variables that may correlate positively with knowledge of fertility and early marriage. I postulate that accessing the media, knowledge on ovulation, and knowledge on any method

to control pregnancy may positively correlates with knowledge on adolescent fertility. The results from the OLS estimation in Table 5.3 show that education has positive correlation with all the three variables and they are all statistically significant. In the case of the 2SLS estimations, all the three variables are positively correlated with education but knowledge on ovulation is not significant. From the results of the 2SLS, the treatment group has 8 percent more likelihood to use the media than the comparison group. Since information on dangers of early marriage and fertility are often transmitted through the media, it may be an important channel through which education indirectly affect adolescent fertility and early marriage. In addition, Table 5.3 shows that the coefficient of the treated cohorts is 4 percentage points higher than the control cohort in knowing modern methods of preventing pregnancy. This results suggest that, the treated cohorts are less likely to get pregnant even if girls from both the comparison group and the treatment group engage in similar sexual activity.

5.5Heterogeneity

One would expect effect of schooling interventions on social and economic outcomes to be heterogeneous because of distinct characteristics of different subgroups in a particular population. In contrast, evidence from the FCUBE policy interventions on adolescent fertility is homogenous. Table 5.4 presents heterogeneity estimates of the FCUBE policy intervention on fertility[23]. The OLS results shows the FCUBE policy intervention have

[23] Heterogeneity analysis is conducted for 4 subgroups namely: Wealth status, urban rural communities, geographical location and religion.

homogenous effect for all the subgroups except religion. The results of the 2SLS are not different from the OLS. Although the effect of the policy on the probability of becoming a mother is homogenous, columns 4 and 5 of Table 5.4 shows that the impact of the policy is slightly stronger among the rural community subgroup, poor women subgroup, other religion subgroup and individuals with lower education subgroup. Interestingly, effects of the policy are significant for both Christians and those of other religions. However, evidence shown in Table 5.4 shows that FCUBE policy interventions have no significant impact on fertility of Islamic girls.

As in the case of fertility, FCUBE policy is expected to have heterogeneous effect on adolescent marriage. The OLS results show some evidence of heterogeneity effect of schooling on adolescent marriage. The more reliable 2SLS results shown in Table 5.5 suggest heterogeneous effect on level of education. There are some interesting differences in wealth status, rural urban, and geographical location, even though they are homogeneous. For example, the effect of the policy on the rich is somehow smaller than on the poor, and similarly the effect of the policy in rural communities is larger than that in urban communities. If the effects of FCUBE policy on marriage is linear, one would expect no significant difference in the coefficient of cohort groups whose highest education is at most basic school and those groups with more than basic education. However, Table 5.5 indicates that the effect of the policy on marriage is nonlinear. The impact of the policy is greater for lower level of education than higher level of education. The huge difference in the effect of the FCUBE policy on early marriage between the upper and lower level of education indicate that the FCUBE policy substantially manipulates lower levels of

education. I envisage that any policy on education that will manipulate upper secondary may further reduce adolescent marriage.

CHAPTER 6

THE EFFECTS OF EDUCATION ON FERTILITY AND MARRIAGE TIMING USING NERP

This chapter examines the effects of education on fertility as in chapter 5. However, in this chapter, I use a different policy as a natural experiment. All tables, graphs and analyses reported in this chapter use NERP as a natural experiment. The implementation of NERP shortened pre-tertiary education in Ghana from 17 years to 12 years. In addition to the shortening of the years of pre-tertiary education, vocational and technical subjects were added to the junior secondary school curriculum. In section 6.1, I discuss identification and validity of the design. In section 6.2 I discuss the impact of NERP on education and then using NERP as an instrument for education, I estimate the impact of education on fertility, ever married, and on ever given birth. Finally I provide the possible mechanisms through which education may affect fertility and the timing of fertility. All the regression results presented in chapter 6 are based on the 2SLS specification in section 4.4.1 since the endogenous variable education is not censored.

6.1 Identification and internal validity checks

The identification and estimation of local average treatment effect (LATE) by the use of NERP as an instrument demands four assumptions. First is the independence and exclusion restriction assumption. The potential concern here is that other government

policies are likely to be related to NERP at the specified cutoff. If this were to happen, the estimated results will identify the combined causal effect of NERP and other policies. To the best of my knowledge, there are no other government programs that created discontinuity in education in the cutoff year of 1973. Aside other government policies that may create discontinuity in education for cohorts born in 1973 or later, any government policies on tertiary education or on the labour market that is likely to benefit the treatment group at the time when they were completing secondary school is likely to affect the exclusion restriction assumption on NERP. One may argue that the establishment of two new universities and the upgrading of six technical institutes to polytechnics in 1992 may benefit the treated cohort in accessing tertiary education and this may improve their labour market outcomes. The increase in tertiary education and improvement in labour market outcomes for the treated cohort may also affect their fertility outcomes. If we assume no repetition; then every child born in 1967 should have finished secondary school in 1992, the year when tertiary education was massively expanded. This implies that cohorts born during the period 1966-1972 benefited from the 1992expansion of tertiary education. Since the massive expansion of tertiary education did not benefit the treatment group alone but persons in the control cohort born between 1966-1973 also benefited, any discontinuity in access to tertiary education around the threshold is likely to be a result of NERP. For the concern regarding government labour market policies that benefited the treatment group when they were entering the labour market, I found no report of a major economic reform in the early 1990s that could have affected the Ghanaian labour market. In addition, the last batch of the comparison group completed their secondary education in 1996 and the first

batch of the treatment group completed in 1993.Hence, any labour market reform that coincided with the time when the first four batches of the treatment group were completing secondary education would benefit both the treatment and comparison group. Thus, there were no government policies that affected access to tertiary education or labour market outcomes just at the time when the treatment group was entering tertiary schooling or entering the labour market. Hence, any discontinuity in the outcome variables would be a result of the 1987 reform.

Second, implementation of NERP reduced the years of pre-tertiary education and therefore the correlation between NERP and years of education is unlikely to be weak. Third, validity of the results rests on the assumption that women who are born close to the cutoff have similar predetermined characteristics. Discontinuities in predetermined characteristics would imply some form of self-selection around the cutoff point. Because of limited information on predetermined characteristics in the DHS dataset, I used information on women of age 26 years or older prior to the reform to examine smoothness around the threshold.[24] The graphs presented in appendix 6B1 show no jumps in the variables used as proxies for pretreatment covariates.

The final assumption is whether NERP affected the years of education of every individual in the population monotonically. Suppose the population is divided into affluent families, average families and poor families. Children from affluent families would surely attend and complete secondary school irrespective of whether years of secondary education

[24]The characteristics of this age group are used as a proxy for sisters of the cohorts close to the reform. Women who were 26 years or older before 1987 reform were already out of school and the majority of them were likely to have married and started working, so the 1987 reform is less likely to affect their outcomes. In constructing Figure 4B5 I assumed that the discontinuity occurs for women born in 1961.

require three or seven years. This is because the cost of secondary school education is unlikely to be a financial burden on affluent families. Therefore, the years of education of children from affluent families are likely to be reduced since NERP shortens the years of pre-tertiary education. The education of children from poor families is likely to be reduced by NERP. Some poor families could afford JSS education for their children but are most likely not to send their children to secondary school because secondary school education is far more expensive than JSS. Since NERP reduced the years of JSS education from four to three, the total years of education of children in this category is likely to be reduced. However, the problem is children from the average families. There are some households in the average family subgroup who would be induced to send their children to secondary school because of the reduction in the years of secondary education from seven years to three years. If NERP could induced some household to send their children to secondary school, then the years of education of children from these household is likely to increase as a result of NERP. Children from this household are likely to have 10 years of education (i.e. completion of middle school) if they were not affected by NERP. However, the years of education for this same group of children if they happen to be affected by NERP would be at least 12 (i.e. completion of at least secondary school). The monotonicity assumption of LATE would be violated if NERP induced some children who were unlikely to attend secondary school to attend. The limited information in the dataset did not allow me to investigate whether there are such group of persons who violates the monotonicity assumption. This is therefore a limitation of this study.

Three important concerns are likely to be raised about the use of NERP as a natural

experiment to recover the policy parameters analyzed in this chapter. The first concern is the existence of international schools and the experimental Junior Secondary Schools (JSS) in the pre NERP time. These schools demanded fewer years of education than the normal system. The number of experimental JSS was 2 percent of the total number of Middle Schools; the international schools accounted for only 1 percent of primary schools in the country prior to the reform. These percentages are very small and unlikely to change the estimation results significantly.

The second concern is manipulation of the running variable at the threshold. Birthyear was determined many years before the reform so the running variable is unlikely to be manipulated. Using the density function proposed by McCrary (2008), no evidence was found in the data that there was manipulation of year of birth at the cutoff. This can be seen in Figure 6.1.

Finally, one might think that the elite class largely opposed to the implementation of NERP might be able to influence the education of their children, who in 1986 were not yet in primary six to register for the secondary school entrance examination so as to avoid the new reform. Considering the fact that the formulation and implementation of the policy took less than a year, the timing was too short for individuals to manipulate their children's education at the cutoff, even if some parents in the elite class were still able to have their children who were not yet in primary six to write the secondary school entrance examinations. The number of such children would likely to be small since the number of international schools was approximately 1 percent of the total number of primary schools.

In determining the birthyear of the cohorts that were affected by NERP, I used information from other data sources and literature on education in Ghana. Children in Ghana are officially expected to begin primary one at the age of 6. However, due to late entry in the rural communities of Ghana, the mean age of primary one students is 7.5 years (Akyeampon et al., 2007). Graph B in Appendix 5B2 shows that the average age of entry into primary one for Ghanaian girls was 7.4 during the period when the cohorts close to the threshold were entering primary one.

In this study, I assigned mean age of entry into primary one to be eight. Then with no grade repetition, a child would be in the first year of Junior Secondary School by age 14 if she began primary one at age eight. Since the reform affected children who were in their first year of Junior Secondary School (JSS) when it was first implemented in 1987, the discontinuity in education therefore affected individuals born in 1973 or later. Figure 6.2plot years of education with year of childbirth at the horizontal axis.

Treatment effects of individuals close to the cutoff can simply be estimated using 2SLS. A series of estimations and tests are conducted to select the optimal bandwidth. Each birthyear is considered as a bandwidth interval. From the sample, there are 15 birth-year cohorts to the right of the cutoff and 13 birth-year cohorts to the left of the cutoff. Imbens and Lemieux (2008) suggest that the best bandwidth for both the first stage and the second stage should be the minimum cross-validation value for both the first and second stage regressions. To select the optimum bandwidth for the linear specification for both the first stage and the second stage regression, I first select a window of 13 birthyear since it has the

minimum number of birth years at each side of the threshold. I run leave-one-out cross-validation for bandwidth of 1 through to the maximum bandwidth of 13 using the regression discontinuity cross-validation bandwidth specification function presented in Lee and Lemieux (2010). Appendix 6B2 provides graphical representations of the results obtained from the cross-validation for both the first stage and the second stage regression. In appendix 4B6a, the bandwidth for the first stage regression falls sharply from window 1 and stabilizes from window 2 to window 5, with a minimum in window 4. Therefore the optimum bandwidth selected for the linear specification for the first stage regression is 4 birthyear on either side of the cutoff. The cross-validation results for the instrumental variable estimation using fertility as the outcome variable are shown in Appendix 6B2b. The cross-validation function first increases and then falls, but it is stable between windows 4 and 9, and the minimum occurs in window 6. Similarly, in Appendix 6B2c and Appendix 6B2d, the minimum cross-validation value occurs in windows 4 and 7 respectively. Following Imbens and Lemieux (2008), a bandwidth of 4 is selected for all the second stage regression since the bandwidth selected by the cross validation for the first stage is less than or equal to each of the bandwidths selected from the second stage regression. All the regression estimates reported in this study are clustered on the survey cluster (i.e. enumeration area).[25]

To further check the validity of the discontinuity, I estimate different polynomial models using a bandwidth of 4 birthyear cohorts at either side of the cutoff. The results of

[25] The results are still robust for all the regression estimations when clustering is done on year of birth except fertility for women from 26 to 37 years.

the estimation are presented in Table 6.1. The first two columns are linear in the running variable with column one having no controls and column two having controls. Columns 3 & 4 presents a quadratic specification of the running variable with columns 4 and 3 estimated with and without controls respectively. The discontinuity is at least 5 percent significant for all the model specifications. Adding pretreatment covariates should not affect the size of the discontinuity; rather, it only improves and gives a more precise estimate (especially when there are outliers). Results for linear, quadratic and cubic estimations for the running variable are provided in appendix 6A1 for different bandwidths. The discontinuity coefficient estimates given a bandwidth of 2, 4, and 8 are very stable and robust. The remaining estimations are based on a bandwidth of 4 years and a local linear regression.

6.2 Impact of NERP on education

The first stage estimation in Tables 6.1 and Appendix 6A1 gives an estimate of the jump in years of schooling at the threshold. In all the different specifications in Table 6.1 the discontinuity in education varies from -1.26 to -0.65 years and all are significant. From the preferred linear model specification in appendix 6A1 column (1), the coefficient of education at the discontinuity varies from -0.77 to -1.15 for a bandwidth of 2, 4 and 8. Combining all the results in Table 6.1 and Appendix 6A1, we can say that the reform caused a one year drop in average schooling years. The years of education of children from affluent households (who can attend international schools) is unlikely to be reduced by the reform, since students who attended international schools prior to the reform spent 6 years

in secondary school, compared to the 10 years spent by majority of Ghanaians, who studied in the public school system. Therefore, I interpret the one-year decrease in years of education resulting from the 1987 reform as a decrease in the years of schooling for children from the ordinary households who are likely to complete at least junior secondary school.

Even though the 1987 reform reduced by one year the years of education of females with JSS as their highest level of education and reduced the years of education of women with at least secondary education by 3 to 5, data from GLSS6 (2012) shows that only about 2.27 percent of the women using the pre-1987 educational reform were able to continue their education beyond three years of secondary education. Women from affluent households were more likely to enroll in secondary and tertiary school than women from non-affluent households. However, average years of education of women from affluent households was unlikely to be reduced by the 1987 educational reform because those women were more likely to enroll in international schools, which only required six years to enter secondary school. The GLSS6 dataset shows that 33.35 percent of women obtained at least JSS Certificate or Middle School Living Certificate, and that out of that group, only 2.27 percent of those in the pre-reform educational system obtained more than three years of secondary education. Thus the 1987 reform largely affected women from non-affluent households who had the potential to complete at least middle school.

6.3 Impact of education on fertility and the timing of marriage

This subsection focus on the impact of the reform on fertility and on the timing of marriage using the instrumental variable specification, described in section 4.4.1. As shown in section 6.2, the discontinuity in education as a result of the reform has a significant impact on the years required to complete school. I used a treatment dummy for cohorts born after the 1987 reform as an instrument for years of education in my analysis. The graphs in Figure 6.3 show discontinuity in fertility, first birth and marriage. Table 6.2 quantifies by means of regression analysis the jumps at the threshold for these outcome variables. Column (1) in Table 6.2 presents the results of the OLS regressions, which ignore endogeneity of schooling.

The OLS results shows 1.3 percentage points decrease in the probability of ever married for every additional year of schooling. The 2SLS estimate shows the impact on the probability of ever married to be insignificant. The 1987 educational reform affected women who had completed at least basic education. The mean age for completion of basic education is 19 years. In the dataset, 57 percent of the women had married by the age of 19 years. This implies that only for a small proportion of women would their marriage timing likely be affected by the reform. It is therefore not surprising that the impact on the probability of ever married is insignificant. This finding is consistent with evidence presented by Lavy and Zablotsky(2011) and Keats (2014), but contradicts the findings of Breierrova and Duflo, (2004), Duflo et al., (2012) and Masuda and Yamauchi (2017).

In analyzing the impact of the reform on fertility, I first present the results of the effect of education on ever given birth from age 26 to 37. The impact on ever given birth

reported in Table 6.2 is significant for both OLS and instrumental variable estimates. The OLS coefficient indicates a reduction of only 1.7 percentage points for an additional year of schooling, but the instrumental variable estimate shows a greater effect on timing of first birth. Given that the reform reduced years of education by one, the instrumental variable result suggests a 4 percentage point increase in the probability of ever given birth for women of age 26 to 37 years who have just surpassed the threshold. The size of the coefficient estimate of the effect of education on the probability of ever given birth is slightly smaller than that reported in other quasi experimental studies in SSA. Férré (2009) and Keats (2014) found that a one year increase in education reduces the probability of giving birth for the first time by 15 and 14 percent, respectively. One important factor that explains the smaller impact reported here is that the 1987 reform affected a smaller proportion of women than was the case in other quasi-experimental studies of the sub region. Those other studies used universal primary education (UPE) policy, which naturally affected all women of school going age.

The OLS results show that a one year increase in education leads to a statistically significant fall in fertility of 0.15. The more reliable IV estimate, which addresses the problem of endogeneity, shows a greater effect of education on fertility than the result obtained by OLS estimation, as reported in Table 6.2. The IV estimate suggests that a one year increase in education leads to a statistically significant drop in fertility of 0.26. In the DHS dataset the average number of children in the comparison group is 3 for women from age 26 to 37 years, so the IV estimate suggests a nine percent drop in fertility for one additional year of schooling. Combining the results from Table6.1 and Appendix 6A1 we

can interpret the results as, fertility of the treatment group increased by 9 percent as a result of a decrease of one in the years of education. The IV results for effect of education on fertility presented in this paper have the same sign but are smaller in magnitude than those of other quasi experimental studies in SSA. Osili and Long (2008) showed that a one year gain in education reduced fertility by 13 percent in Nigeria. Férré (2009) concluded that teenage fertility in Kenya was reduced by 15 percent as a result of a one year gain in education, and Keats (2014) found a 22 percent reduction in fertility in Uganda.

The reform affected the years of education of men as well. This therefore suggests that, if age difference between husbands and wives in Ghana were close to zero, then the reform might have affected the fertility and marriage outcomes through changing the education of husbands as well as wives. However, Appendix 6B4 indicates that husbands in Ghana are 7 to 10 years older than their wives. Thus, the educations of husbands of women close to the threshold are unlikely to be affected by the reform. The optimal bandwidth of regression results is 4 years and hence all women in this bandwidths are unlikely to have the education of their husbands to be affected by the reform. Table 6.3 provide regression estimate on the effects of the reform on education of husbands of women in the dataset. The table shows that the reform did not affect the education of husbands of women in the dataset[26]. Therefore there is unlikely to be a marriage market equilibrium effects on fertility through the policy impact on men.

[26] Not all the women in dataset are married and not all the married women provided information on years of education of husband. This situation may lead to sample selection which might affect the regression results. In appendix 6A2, I used all the men in the GLSS6 survey who are likely to be husbands to the women in the dataset to estimate the impact of the reform on the education of these men and the result confirms that the reform did not affect the education of the men who are likely to be husbands of the women in the dataset.

All the experimental and quasi-experimental studies aimed at determining the causal impact of education on fertility in developing countries report that an increase in years of education leads to a delay in the timing of first birth. However, the evidence is inconclusive as to whether educated women who delay their fertility as a result of schooling are still able to bridge the fertility gap at the completion of fertility, or the fertility gap either remains the same or widens. For example, Keats (2014) and Lavy and Zablotsky (2011) find no convergence in fertility after educated women fertility is delayed. However, Monstad et al. (2008) and Breierova & Duflo (2004) find that more educated women who delay childbearing in adolescence eventually catch up in terms of total fertility. The results presented in Table 6.4 show a significant difference between the treatment and comparison groups. Table 6.4shows that the fertility gap between educated and less educated women continues to widen with age. In Table 6.4 columns (1) to (4), it can be seen that a one year reduction in education among the treatment group leads to an increase in fertility of 0.04 births by age 15, of 0.08 births by age 20, of 0.17 births by age 25, and 0.26 births for the age group from 26 to 37. Thus, women with higher education not only delay their first birth but they also allow longer intervals between births than those with less education. This finding is consistent with those of Keats (2014) and Lavy and Zablotsky (2011), which found no evidence to support convergence in fertility.

6.4. Mechanisms

From the review of literature, five main channels are identified through which education might affect fertility: knowledge effect, opportunity cost, household bargaining

and autonomy, incarceration effect, and assortative mating. Table 6.5 shows the results of investigations of the impact of education on various outcomes likely to reflect each of those mechanisms. The OLS estimation results are mostly significant, but the preferred specification is the IV estimation, as it accounts for the problem of endogeneity.

First, education may affect the stock of knowledge that would enable women to read. This in turn can also make it easy for women to understand the instructions for efficient implementation of family planning techniques to prevent unplanned births. The IV results indeed show that an increase in education by one year leads to an 8 percentage points increase in the probability of being able to read.[27] Similarly, a one year increase in education leads to a 7 percentage point increase in the probability of knowing a source of male condoms. These results imply that cohorts on the right hand side of the cutoff point were less likely to be able to read or know a source of male condoms. However, the IV estimates on knowledge of any pregnancy preventive method is insignificant, which indicates that educated and uneducated women have similar amounts of information concerning modern methods of family planning. The insignificant result for knowledge on pregnancy preventive method is not surprising because most family planning education is usually communicated via radio and television and the majority of the media houses in the

[27] Appendix 6A3 shows an improvement in pupil-teacher ratio and an increase in budget allocation to education after the reform. However, the short-run evidence on individual ability to read and do simple arithmetic depicts that, theincrease in budget allocation and improvement in pupil-teacher ratio after the reform did not translate into improvement in quality of tuition to compensate for the years that have been slashed down as a result of the reform. UNESCO (2000) education report on Ghana summarized the short-run assessment of the reform as; on quote: "It was, however, not until the first batch of the Senior Secondary School students graduated in 1993 that the weaknesses in the implementation of the reform came to the fore. The reform had failed to achieve quality targets and exposed the education sector to public criticism and government responding to the public criticism of the reform set up the Education Reform Review Committee in 1993/94".

country use the local language in transmissions. Thus knowledge of family planning methods is accessible to all classes of women irrespective of their level of education. One overall explanation for these results is that given the same amount of information, educated women are more likely than uneducated women to be able to search for a source through which these family planning methods can be obtained. In addition, because educated women can read, they are more likely to be able to follow the procedure for self-administration of family planning medication correctly and thus prevent unplanned pregnancies.

Secondly, female education may increase the opportunity cost of child bearing and rearing. Education is likely to increase the probability of being employed in a well-paid institution, and thus to increase the value of a woman's time, and the woman will be inclined to spend less time on child care and to have fewer children. The results presented in Table 6.5 indicate that educated women are more likely to work for an employer and receive payment for work rendered. However, the effect of education on probability of working is not significant. The informal sector in Ghana is huge and the demand for labour in the informal sector usually does not require substantial education. This may be a contributing factor to the finding that effect of education on probability of working is insignificant.[28]The result is consistent with that of a similar study conducted in Uganda by

[28]Ideally it would have been more appropriate if informationon the formal or the informal employment sector isavailable in the dataset since educated women would be more likely to work in the formal sector, and the formal sector in Ghana pays higher wages than the informal sector. However, the DHS dataset does not contain such information. According to a 2014 Ghana Statistical Service labour force report, 88 percent of the working population is employed in the informal sector, which is predominantly made up of small to medium-scale businesses consisting of producers, wholesale and retail traders, and service providers. Workers in the sector include contributing family workers, casual wage workers, home-based workers and street vendors,

Keats (2014) which finds that educated women are likely to work and receive payment for their services.

Thirdly, higher level of education is likely to increase a woman's bargaining power and thus improve her autonomy in the household with regard to freedom to make decisions without consulting her partner. Table 6.5 shows that an increase of one year in female education increases by 11 percentage points the probability that a woman will take part in the decision making regarding large family purchases, and reduces the probability that the woman will feel that it is justifiable for her husband to beat her if she refuses to have sexual intercourse with him. However, the effects on the two other proxies (i.e, beating is justified if the wife goes out without telling her husband; and beating is justified if the wife neglects a child) are insignificant.[29]

Fourthly, there is some evidence of incarceration effect. Estimation results show that for women from age 19 to 22, higher education reduces the likelihood of engaging in risky behaviours that may lead to childbearing.[30] Although the results shown in Table 6.5 indicate that education did not alter the sexual activity of the women, one additional year of schooling did reduce the coefficient for fertility for the women between age 19 and 22 by 0.22 births, with high significance. This evidence for incarceration effect is similar to that found in a study conducted in Uganda by Keats (2014), who found no differential effect of

most of whom are self-employed (e.g., farmers, artisans and craft-workers, traders, and food processors). Clearly the informal sector generally demands less formal education than the formal sector.

[29] Additional questions exploring whether respondents are beatenby their husbands would have contributed to an explanation of the measure of bargaining power. Nevertheless, relying on their perception about beating explains how they value their freedom in the marriage.

[30]If we assume no repetition and late entry, the treatment group should finish pre-tertiary by the age of 18 years. The reform reduces secondary education by 4 years and therefore if there is an incarceration effect, it is more likely to occur between the ages of 19 years to 22 years.

education on the frequency of sexual intercourse but did find a significant effect of education on fertility.

Finally, there is evidence on assortative matching as a possible mechanism through which education affect fertility. In Table 6.5, one additional year of schooling for the treatment group leads to the likelihood of having a husband with 0.82 year more schooling than the comparison group. In addition, one additional year of schooling leads to a 9 percentage point reduction in the probability of marrying a farmer[31]. Since educated women are likely to work for someone with pay, they might also prefer marrying husbands with equally higher income. However, education has no effect on the age of the partner. Results presented in Table 6.5, show that a one year increase in female education leads to a fall in her fertility preference by 0.3 relative to the mean fertility preference of 4.65. However female education has no significant effect on the probability of marrying a husband who has the same or lesser fertility preferences. To the extent that education affects literacy and household bargaining power, then through assortative mating, husbands of educated women might appreciate the arguments from their wives for the need to have a smaller family even though they might have a fertility preference that might be higher than their wives. Lavy and Zablotzky (2011) and Tequame and Tirivayi (2015) also found assortative matching as a possible mechanism through which education affect fertility and the timing of birth.

[31] The 2014 Ghana statistical service report on poverty show as high as 46 percent incidence of poverty among self-employed agricultural workers as against only 16 percent of incident of poverty among self-employed non-agricultural workers.

CHAPTER 7

EDUCATION AND THE LABOUR MARKET

This chapter investigates the impact of NERP on access to higher education and on labour market outcomes. Implementation of NERP caused pre-tertiary education in Ghana to be shortened from 17 years to 12 years. In addition to the shortening of the years of pre-tertiary education, vocational and technical subjects were added to the junior secondary school curriculum. Since implementation of NERP in 1987 maintained the existing 6 years primary education but reduced the years of completing JSS education by 1 and that of secondary by 2 to 4 years, any student whose education exceeds 6 years primary and entered JSS in 1987 or later is treated. The chapter is organized as follows: In section 7.1, I estimate the impact of NERP on completed years of education and on the probability of assignment to treatment. Using NERP as an instrument for exposure to the new secondary school reform, I estimate the impact of exposure to the new secondary education system on labour market outcomes and on the choice of careers related to the vocational training received at JSS. The regression results presented in section7.2 to 7.5are based on the 2SLS specification in section 4.4.1.

7.1 Identification and internal validity checks

The identification and validity of the use of NERP as a natural experiment is discussed thoroughly in chapter 6 subsection 6.1. We saw in chapter 6 that children born in

1973 or later were affected by NERP and therefore the discontinuity in education occurred in 1973 birthyear. The validity of the fuzzy design rests on the assumption that individuals born close to the cutoff year have similar predetermined characteristics. If there are discontinuities in predetermined characteristics, this would suggest that there is some form of self-selection into assignment at the threshold. I examined this issue by looking at gender, ethnicity and religion, which are the only predetermined covariates in the 2010 GPHC dataset. There are no jumps in these three predetermined covariates as shown in Appendix 7B1. Figure 7.1 presents the first stage results graphically. There is a clear and statistically significant jump in the years of education and the probability of treatment assignment at the threshold. If the reform is the only policy creating the discontinuities in Figure 7.1, then there should not be a jump at the threshold for individuals with primary as their highest level of education, since the reform did not change the years of primary education. In fact, the graph in Figure 7.2 demonstrates no discontinuity in the probability of an individual having primary school education as the highest level of education. On the other hand, we can clearly see a discontinuity in education where years of education are more than nine. Figure 7.2 suggests that the reform is the only policy that created the discontinuity in education of individuals born in 1973 or later.

7.2. First stage results

Table 7.1 presents the first stage results of quadratic specification using the full sample and a local linear regression that uses an ad hoc bandwidth of 7. Columns (1) and (3) present results without covariates, and columns (2) and (4) present results with

covariates. In column (3), the local linear regression shows that 32.6 percentage points of the cohort that has just surpassed the cutoff received treatment. The result of quadratic specification in column (1) is not significantly different from that of the local linear regression. The coefficient of the local linear regression and the quadratic specification decreased slightly to 31.9 and 30.9 percentage points respectively when I controlled for predetermined characteristics. While the inclusion of pretreatment covariates slightly affects the impact estimates, the confidence intervals show substantial overlap. For example, the 95 percent confidence interval for the quadratic specification without covariates is [0.307, 0.317] and with covariates is [0.304, 0.314]. In the results for years of education, presented in Table 7.1, it can be seen that NERP reduced total years of schooling by 0.55 years. Thus, the complier population constitutes the 31.2 percentage points of those who have just crossed the threshold. The first stage results suggests that the compliers studied technical and vocational subjects, and that their average years of schooling decreased by 0.55. In the graph presented in Figure 7.1 and the graphs of outcome in the labour market, it can be seen that the quadratic line fits the data very well. However, recent empirical studies in RDD advocates the use of local linear regression to uncover policy parameters, therefore I report the results of quadratic specification for the full sample and that of local linear regression using an ad hoc bandwidth of 7 in the rest of the estimations[32].

[32]Ad hoc bandwidth is used instead of optimal bandwidth due to matrix invertibility problem in using the codes provided by CCT to select the optimal bandwidth.

7.3. Impact of exposure to new secondary education system on career choice

The principal objective of NERP was to impart vocational skills to JSS drop outs to enable these drop outs to find job or create their own jobs from the skills they have acquired in school. However, the evidence in data suggests that the reform did not achieved this objective. Figure 7.3 presents graphs of the probability of engaging in three different occupations related to the vocational and technical subjects introduced in the JSS curriculum. The graphs show that the distributions of all the three outcomes are continuous at the threshold for the quadratic fitted lines, though the local linear line for construction suggests a possible discontinuity at the threshold. The regression results presented in Table 7.2 quantify the jumps in Figure 7.3.

The result of the local linear regression reported in Table 7.2 show that the impact of NERP on the dummy variables indicating the career choice in construction, manufacturing and craft is not significant. The confidence interval for craft, construction and manufacturing are (-0.014, 0.016), (-0.002, 0.01) and (-0.016, 0.01) respectively. The tight confidence interval for craft, construction and manufacturing suggests that modest impacts can even be ruled out. The result of the quadratic specification in column (1) is similar to that of the local linear regression in column (2). Thus, the regression results in Table 7.2 suggest that introduction of vocational and technical related subjects into the JSS curriculum did not increase the choice of careers related to the type of vocational training received at the JSS level.

There may be two possible explanations for the failure of the reform in relation to the choice of vocational career. First, the prevocational skills provided in the JSS

curriculum have not provided an employment advantage because employers still need to provide additional training to cohorts affected by NERP. Vocationalizing the JSS curriculum for the entire country was overly ambitious and implementations of the reform were initiated without serious assessment of means of equipping and staffing junior secondary schools for the new vocational and technical subjects introduced into the curriculum. As of the year 2000, 15 years after implementation of the 1987 reform, fewer than 25 percent of the JSS schools had workshops (Ansu-Kyeremeh et al., 2002). Due to this lack of workshops, the teaching and learning of the technical and vocational subjects at the JSS level has become more academic than was intended. The inadequate workshops for practical orientation are likely to explain why the reform did not have an impact on student choice of vocational jobs after school.

Second, JSS education is terminal for many school children in Ghana. This fact is used to justify the need to provide JSS graduates with employable skills, at least for the lower level of the labor market. However, Ampiah (2002) found very low interest in technical and vocational education at the JSS level in Ghana; this implies that students at the early stages of their education are drawn more to liberal arts and science education for reasons that probably include their realistic assessment of labour market demand. Academic track graduates from the countryside earn more and their professions are more respected than those from vocational track. A combination of future aspirations and the economic reality of the labour market may influence the decision of students as to the kind of career they pursue. The Ghana Statistical Report on the labour market in 2015 showed that 88 percent of the Ghanaian economy remains informal. Most of the poor Ghanaians work in

the informal sector, which largely employs individuals as farmers, construction workers, craftsmen, manufacturing workers and retailing. The income reward for pursuing careers related to the type of prevocational training received at the JSS level is not attractive at present.

7.4. Impact of exposure to new secondary education system on higher education attainment

Figure 7.4 shows the relationship between the running variable and two dummy variables; secondary (one if highest level of education is secondary or higher) and tertiary (one if highest level of education is tertiary) respectively. The two graphs show clear, statistically significant jumps in the probability of attaining secondary and tertiary education at the threshold.

Table 7.3 quantifies the effects of exposure to the new secondary education system on access to secondary education and tertiary education. The local linear regression coefficient of access to secondary education is 15.5 percentage points and that of quadratic specification is 17.9 percentage points. These estimates are both significant at the one percent level. The results also show that NERP increased access to tertiary education by 5.1 and 6.2 percentage points by local linear regression and quadratic specification respectively. The estimates are precise given that the confidence intervals for the coefficients are very small and show a substantial overlap for the two specifications. For example the confidence intervals for the local linear regression and quadratic specification for tertiary are (0.038, 0.065) and (0.048, 0.076) respectively. On average, 16.95 percent of the comparison group

has as highest level of education at least secondary school education. The preferred local linear regression indicates that the reform led to an increase in secondary education for the treatment group by 91.4 percent relative to the mean among the comparison group. Similarly, the local linear regression result suggests a 69.8 percent (0.051/0.073) increase in access to tertiary education relative to the mean among the control group.

The massive increase in access to secondary education is likely to reflect the fact that the reform made a lot of classrooms available to allow for admission of more students. The reduction in years of secondary education from seven to three years automatically increased the number of classrooms for secondary education by 133 percent. This is an indication that the previously low enrolment in secondary school was largely as a result of a lack of secondary school infrastructures.

7.5. The effects of the 1987 reform on labour market outcomes

7.5.1: Impact of exposure to new secondary education system on occupational distribution

An increase in education attainment is likely to shift labour from occupations with low remuneration to occupations with high remunerations. Figure 7.5 presents graphs of the four major occupational classifications in the dataset. The variable skilled agriculture, forestry and fisheries is a dummy (1 if a person works in agriculture, forestry or fisheries). The other variables; service and sales workers, professionals, elementary occupations[33], craft and related workers, and others are similarly defined. We can see from the graphs that

[33]Elementary occupations consist of simple and routine tasks which mainly require the use of hand-held tools and often some physical effort.

the likelihood of working in the agricultural sector dropped significantly for the treatment group. The graphs in Figure 7.5 show that the reform shifted labour supply from agriculture to service, elementary occupation and professional work. Table 7.4 presents a regression estimate quantification of the discontinuity in occupational distribution.

The results presented in Table 7.4 show that the reform did affect likelihood of working in craft and related trade. The local linear regression shows a reduction in the likelihood of working in agriculture, forestry and fishery by 10.8 percentage points. The result of quadratic specification is 6.2 percentage points. Given that 38.9 percent of the comparison group were in agriculture prior to the reform, the point estimate for the preferred local linear regression suggest that the treatment group were 27.7 percent less likely to work in agriculture after the reform. This significant reduction in the likelihood of working in agriculture led to an increase in the number of service and sales workers, professional workers, and individuals working in elementary occupations. Since most people working in the agriculture sector are peasant farmers with a very low income, the regression estimates in Table 7.4 suggest that the increase in access to secondary and tertiary education as a result of the reform shifted people from low paying peasant farming to higher paying professional occupations.

7.5.2 Impact of exposure to new secondary education system on employment status

The variable employee is a dummy (1 if an individual works for an employer). The variables self-employed without employees, self-employed with employees, family worker and other are defined similarly. As can be seen in the three graphs in Figure 7.6, there is a

clear and statistically significant drop in likelihood of being self-employed without employees. This category of employment is not innovative entrepreneurship, but it includes individuals working as petty traders, peasant farmers, and casual workers with few or no skills. In Figure 7.6 it can be seen that NERP caused a shift away from low income self-employment to higher income self-employment with the ability to employ others. The discontinuity graph of employee indicates a positive jump at the threshold for cohorts affected by NERP.

Table 7.5 presents regression results of the variables under employment status. We can see from the local linear regression results in Table 7.5 that the impact of NERP on likelihood of working as a family worker is insignificant. The local linear regression and quadratic specification indicate that the probability of being a self-employed worker without an employee decreased by 4 to 9 percentage points as a result of the reform. These results suggest that the reform caused people to move away from low income self-employment towards work as employee. This is likely because NERP caused an increase in secondary school and tertiary education, which is likely to serve as a positive signal to employers about labour productivity (Spence, 1973). Interestingly, not only did NERP cause an increase in work as an employee, but it also led to an increase in self-employment with employees. Though the impact of NERP on the likelihood of working as a self-employed with employees is small, it is significant in both the local linear regression and the quadratic specification. Cohorts affected by NERP were 0.8 to 1 percentage points more likely to be self-employed with employees. The increase in the likelihood of being self-employed with employees as a result of NERP is important for a developing country like

Ghana where the rate of unemployment is high. The results reported in this study are similar to those of Ozier (2015), who found that access to secondary education reduces the probability of becoming self employed by 40 to 50 percentage points.

7.5.3 Impact of exposure to new secondary education system on sector of employment

Figure 7.7 provides graphical representations of likelihood of working in the informal sector, formal private sector, or as a government worker. The variables informal sector, formal private sector and government worker are all dummies with representation 1 if an individual is employed in that sector. The graph for the informal sector shows that the treatment group is less likely to work in the informal sector. The other two graphs in Figure 7.6 indicate an increase in the probability of being a government worker or employed in the private formal sector.

Table 7.6 quantifies the discontinuity shown in Figure 7.7 using regression estimates. The regression results in Table 7.6 indicate that the impact of NERP on the likelihood of being employed by the government or by a formal private institution is positive and both are significant at the 1percent confidence level. The local linear regression indicates that for the treatment cohort the probability of being employed by the government or by a private formal employer increased by 6.1 and 2.1 percentage points respectively. These results suggest that the reform caused an employment shift in the economy from informal employment to formal employment. Informal sector employment decreased by 6.3 to 7.4 percentage points. The findings in this paper have the same sign though smaller in magnitude as those of the study conducted in Kenya by Ozier (2015),

who found that access to secondary education reduced the number of informal sector employees by 30 percentage points.

CHAPTER 8

CONCLUSIONS AND POLICY RECOMMENDATION

Fertility rate in Ghana has dropped from seven in the 1960s to four in 2016.This downward trend is similar to that in other SSA countries over the same period. Although there has been a significant reduction in fertility rate in SSA over the past 5 decades, it still remains the highest in the world compared to other continent. Access to education in Ghana is increasing but the economy of Ghana has not been able to grow sufficiently to provide suitable employment for graduates of those schools. The high fertility rate and the growing unemployment problem in Ghana create a problematic situation seen in all developing countries. High fertility is linked to low family income, poor human capital, health deficiencies and conflict between couples (Lloyd and Mensch, 2008). Many developing countries have high wage inequalities among workers with similar characteristics but happened to be employed in different sectors of the economy and this usually make some sectors of the economy to be bereft with skilled laborers whiles other sectors have excess skilled laborers. In addition, most developing countries find it difficult to structure their school curriculum to be in line with the needs of industries so as to smoothen the transition of students from school to work. These challenges in the labour market and fertility problems necessitate the need to study fertility and labour market outcomes in developing countries. The chapter summarizes the findings of this study and concludes the dissertation with policy recommendations and future research based on observations drawn from data.

8.1. Conclusion

I investigate the causal link between education and adolescent fertility and early marriage by adopting Ghana's universal free compulsory primary education policy as a natural experiment. The main reasons for the implementation of FCUBE were to reduce fees and levies in order to increase enrollment, improve existing physical infrastructure and to increase the number of basic schools through large-scale construction of additional classrooms and school buildings. Officially children in Ghana are supposed to begin primary one by the age of 6, a child who begins primary one at age 6 and does not repeat at any stage of his education would complete basic education at the age of 15 years. Hence, it is expected that FCUBE affected children from age 6 to 15 years. However, FCUBE affected all children in basic school irrespective of their age. The evidence presented in chapter 5 is based on a quasi-experiment that compares outcomes of women who were in school close to the policy implementation year but never benefited from the policy to those women who did benefit from the policy. The study confirms a negative effect of education on adolescent fertility and early marriage. The implementation of FCUBE led to an increase in educational attainment by the treatment group by one year. I find that the one year increase in education for the treatment group reduces adolescent fertility by 11 percent and early marriage by 14 percent. Evidence from the estimations provided in chapter 4 shows that the impact of the policy on adolescent fertility and on early marriage is homogenous across all subpopulations. There is no evidence to support the claim that access to education reduces the sexual intercourse of the adolescent girl. However, I do find evidence to

support the idea that education improves the knowledge of adolescent girls. I find that the effect of the policy is stronger among younger girls and dissipates along the age transition.

In chapter 6, I investigate the causal link between education and reproductive outcomes by using NERP which differs from FCUBE in terms of implementation and focus. The implementation of NERP shortened pre-tertiary education in Ghana from 17 years to 12 years. In addition to the shortening of the years of pre-tertiary education, vocational and technical subjects were added to the junior secondary school curriculum. The reform caused the control cohort to have one more year of schooling than the treated cohort. Using regression discontinuity design I confirm a negative causal relationship between education and fertility, but there is no evidence to support the effect of education on the timing of marriage. The results imply that a one year decrease in education due to the 1987 reform increases total fertility by 9 percent and the probability of giving birth for the first time by 4 percentage points from age 26 to 37. I find that not only do educated women delay their timing of giving birth, they also allow longer interval between any two births. In addition, I show that education affects fertility through the following mechanisms; knowledge effect, bargaining power and autonomy effect, and assortative mating. However, the evidence on opportunity cost and incarceration effect is not as strong as that of these three mechanisms through which education affects fertility.

The two policies provide interesting revelation that the causality of education on fertility is independent on whether the treated group education is increased or shortened. We saw that whiles FCUBE increased the years of education of the treated group, NERP

reduced the years of education of the treated group and yet the negative causal relationship between education and fertility is seen when these two policies are used as instrument.

In addition to the impact of NERP on fertility, I explored the impact of NERP on several labour market outcomes. The implementation of NERP not only reduced pre-tertiary education from 17 years to 12 years but also introduced 13 percent of vocational and technical subjects into a purely academic curriculum for all JSS students. However, I fail to find significant positive effect that students affected by NERP entered into vocational related careers than those students that were not affected by the reform. The findings do not mean that it is a total waste of resources to incorporate prevocational subjects into a general academic curriculum. A possible explanation for the zero effect may be associated with underdeveloped job market for careers that relate to vocational subjects. Therefore many individuals might have found it unbeneficial to pursue the careers related to the vocational subjects studied at school. The second possible cause of the insignificance may be as a result of the few number of JSS workshops that serves as training workshops after classroom lessons. Assessing the impact of the reform on higher education, I find that, the reform increased the number of students who had access to higher education particularly secondary and tertiary education. I do find that the reform reduced labour participation in agriculture and the informal sector. It also led to an increase in formal employment, service sector participation and the probability to work for someone. The results suggests that the changes in the distribution of the labour market is as a result of the increase in access to higher education rather than the introduction of vocational subjects into the JSS curriculum. Access to higher education for individuals affected by NERP aided

them to send a better signal to employees about their productivity than individuals with similar characteristics who could not complete senior secondary school due to long years of schooling prior to NERP.

8.2 Policy implications and future research

In the past three decades, there has been a sharp increase in completion of primary and JSS in the country because the cost of education at this level has been made virtually free. However, there is a huge drop out in the entry into Senior Secondary School due to high fees charged at this level. There is an ongoing policy debate in the country for the past three years as to whether Senior Secondary School education must also be made free since most of the children still complete junior secondary school while they are still in their mid-teens but are unable to continue their education due to high fees charged at the Senior Secondary School level. This study has demonstrated that investments that went into the implementation of FCUBE caused an increase in educational attainment which in turn led to a reduction in fertility and early marriage. Although FCUBE affects children at the basic level, the results from this study shows that, the FCUBE intervention did not only manipulated fertility and marriage behaviour at the primary and JSS level but it did also manipulated fertility and marriage behaviour at the senior secondary. This suggests that policies that will directly manipulate the schooling years of females in secondary schools are likely to reduce fertility and early marriage.

Based on my findings in chapter seven, I propose that the vocational content in the JSS curriculum should be removed. It would cost the central government huge sums of

money to finance the vocational content in the JSS curriculum if the policy is to be properly implemented. Proper implementation of the vocational content in the JSS curriculum demands the government to construct workshops for these vocational and technical subjects in every junior secondary school, which as at the year 2000Akyeampong et al. (2002) documents that less than 25 percent of the JSS had workshops. Evidence from this study suggest that vocationalizing the JSS curriculum did not affect career choice but rather the increase in secondary and tertiary education changed the composition of labour market outcomes. Thus, the 13 percent that is allocated every week on vocational subjects can be spent on academic subjects like mathematics, English and science which is believed to improve numeracy and literacy skills that serves as foundation for science and technology education in secondary and tertiary.

The results presented in this paper indicate that the FCUBE policy has positive effect on education and an increase in education reduced adolescent fertility and early marriage. Given the homogeneity of application of the FCUBE policy, the findings support the side of the debate that favors extending free secondary education to all parts of the country which students from the northern-savanna are the only beneficiaries. The study could not examined long run characteristics of the study population since the cohorts affected by FCUBE are still young at the time of writing this dissertation. However, it appears that FCUBE may improve human capital, as in the case of Uganda (Keats, 2014). Thus, the returns of FCUBE policy in the long-run may be substantial.

In this study, the quality of graduates from pre-1987 educational system and post 1987 educational system has not been investigated due to data limitations. Future research

can investigate the impact of the policy on quality of graduates from JSS and senior secondary schools in order to provide empirical evidence to support or debunk the popular believe in the country that quality of students from JSS and secondary school graduates in post reform are significantly lower than graduates at the same level before the reform.

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List of Tables

Table 4.1: Descriptive statistics

(a)

Mean	Std dev	sample size
Age at the time of the survey	17.44	1.73	5797
age if born on or after 1989	17.21	1.63	3086
Age if birth year<1989	17.72	1.81	2711
Years of schooling	6.92	3.80	5797
Completed Basic school	0 .36	0.48	5797
Completed ten or more year	0.15	0.35	5797
Age at first sex up to 20years	15.82	1.83	2685
Age at first union up to 20years	16.12	1.85	1031
Age at first birth up to 20yrs	17.13	1.58	940

(b)

	Total sample		control cohort		treated cohort	
	Percentage	N	percentage	N	percentage	N
Religion						
Christian	50.41	2922	61.38	1664	40.76	1258
Muslim	14.00	812	8.48	230	18.86	582
Others religion	35.59	2063	30.15	817	40.38	1246
total	**100**	**5797**	**100**	**2711**	**100**	**3086**
Ethnicity						
Akan	59.00	3420	59.28	1607	58.75	1813
Mole Dagbani	20.20	1171	14.02	380	25.63	791
Other ethnicity	20.80	1206	26.72	724	15.62	482
total	**100**	**5797**	**100**	**2711**	**100**	**3086**
Wealth index						
Poor	42.87	2485	37.07	1005	47.96	1480
Rich	57.13	3312	62.93	1706	52.04	1606
total	**100**	**5797**	**100**	**2711**	**100**	**3086**
Community of Resident						
Urban	43.16	2502	41.98	1138	44.20	1364
Rural	56.84	3295	58.02	1573	55.80	1722
total	**100**	**5797**	**100**	**2711**	**100**	**3086**

Note: Age at first sex, marriage and birth are calculated from only women who have had sexual intercourse, married and have had live birth respectively.

Table 4.2: summary statistics on Mechanisms

Outcome	Control Group			Treated Group		
	Mean	S.D	N	Mean	S.D	N
Knowledge						
1(able to read)	0.29	0.45	887	0.33	0.47	1761
1(male condom source known)	0.58	0.49	891	0.63	048	1765
1(know modern pregnancy preventive method)	0.96	0.20	1512	0.98	0.14	1780
Incarceration						
1(1^{st} sexual intercourse by 15years)	0.26	0.44	1392	0.25	0.44	1664
1(1^{st} sexual intercourse by 20)	0.88	0.32	1392	0.85	0.36	1664
1(1^{st} sexual intercourse by 25years)	0.98	0.14	1392	0.98	0.14	1664
Autonomy						
1(Working)	0.91	0.28	1512	0.98	0.27	1777
1(work for someone & receive payment)	0.41	0.49	843	0.36	0.48	1623
1(part in large household purchases decision)	0.55	0.50	760	0.55	0.50	1417
1(part in what to cook in the household everyday)	0.68	0.47	555	0.64	0.48	731
1(beating justified if wife goes out w/t telling husband)	0.35	0.48	886	0.28	0.45	1759
1(beating justified if wife neglects children)	0.39	0.49	885	0.34	0.47	1757
1(beating justified if wife refuse husband sex)	0.23	0.42	884	0.19	0.39	1749
Assortative mating and fertility preferences						
Husband years of schooling	7.41	5.81	1303	7.26	5.51	1541
Husband age	38.85	8.18	1244	38.8	8.05	1469
1(husband is a farmer)	0.44	0.5	1408	0.43	0.5	1637
1(husband prefers same number of children)	0.71	0.46	936	0.68	0.47	1142
Fertility preference for wife	4.65	2.07	1459	4.7	2.15	1754

Notes: The data are from 1998, 2003, 2008 and 2014 DHS dataset, however the following variables are not available in the 1998 DHS wave(male source of condom known, able to read, work for someone and receive payment, part of household decision in large purchases, beating justified if wife goes out without informing husband, beating justified if wife neglects children and beating justified if wife refuses to have sexual with husband).

Table 4.3 Comparison between data and full population

Variable	Census Report (%)	Data (%)
Proportion of Ghanaians	97.6	97.58
Sex(Females)	51.2	51.19
Economic active	54.2	54.19
Literate(16years or older)	74.1	74.17
Urban	50.9	50.87
Education(3 years or older		
Never attended school	23.4	23.40
Currently attending School	39.5	39.44
Attended School	37.1	37.16
Occupation(15 years and above)		
Skilled agriculture, Forestry and Fishing	41.2	43.82
Service and sales workers	21.0	20.39
Craft and related workers	15.2	14.58
Others	22.6	21.21
Employment Status		
Self employed	64.8	61.05
Family worker	11.5	16.79
employee	18.2	17.63
others	5.5	4.53
Ethnicity		
Akan	47.5	46.95
Mole-Dagbani	16.6	17.12
Ewe	13.9	13.44
others	-22.0	22.49
Religion		
Christian	71.2	71.13
Islam	17.6	17.04
others	11.2	11.83

Note: Figures in column (2) are author's own calculation from the 10% sample. Figures in column (1) are taken from 2010 Ghana PHC report.

Table 4.4: Descriptive statistics for the population data

	(a)								
	Control			Treated			Total Sample		
	Mean	S.D	N	Mean	S. D	N	Mean	S.D	N.
Years of education	6.559	5.86	417234	7.028	5.17	413406	6.792	5.53	830,640
1(if secondary)	0.096	0.29	417234	0.162	0.37	413406	0.129	0.34	830,640
1(if tertiary)	0.073	0.26	417234	0.101	0.30	413406	0.087	0.28	830,640
1 (if craft)	0.114	0 .32	417234	0.155	0.36	413406	0.134	0.34	830,640
1(if manufacturing)	0.084	0.28	417234	0.106	0.31	413406	0.095	0.29	830,640
1(if construction)	0.025	0.16	417234	0.034	0.18	413406	0.030	0.17	830,640
1(if agriculture)	0.389	0.49	417234	0.275	0.45	413406	0.332	0.47	830,640
1(if service)	0.184	0.39	417234	0.198	0.40	413406	0.191	0.39	830,640
1(if labour force)	0.902	0.30	417234	0.881	0.32	413406	0.891	0.31	830,640
1(if informal)	0.705	0.46	417234	0.665	0.47	413406	0.684	0.46	830,640

	(b)					
	Pre-reform		Post-reform		Full sample	
	Percentage	N	percentage	N	percentage	N
Education level						
No education	36.02	150,283	27.22	112,515	31.64	262,798
Primary	9.96	41,561	11.02	45,544	10.49	87105
JSS/Middle	37.07	154,673	35.43	146,482	36.26	301,155
Secondary or Higher	16.95	70717	26.33	108,865	21.62	179, 582
Total	100	417,234	100	413,406	100	830,640
Religion						
Christian	70.72	295,070	71.55	295,800	71.13	590,870
Muslim	15.19	63,391	17.51	72,371	16.34	135,762
Other religion	14.08	58,773	10.95	45,235	12.52	104,008
total	100	417,234	100	413,406	100	830,640
Sex						
Male	47.81	199,488	46.98	194,210	47.40	393,698
Female	52.19	217,746	53.02	219,196	42.60	436,942
Total	100	417,234	100	413,406	100	830,640
Ethnicity						
Akan	48.52	202,450	46.49	192,195	47.51	394,645
Ewe	14.33	59,771	14.12	58,383	14.22	118,154
Mole Dagbani	13.61	56,783	14.89	61,554	14.25	118,337
Other ethnicity	23.54	98,230	24.50	101,274	24.02	199,504
total	100	417,234	100	413,406	100	830,640

Notes: S.D represent standard deviation and N represent sample size.

Table 5.1: Impact of birthyear instrument on years of education

Outcome variable: Total schooling years	(1)	(2)	(3)	(4)
comparable mean=6.02				
1[Birthyear>1989]	0.89***	0.98***	0.85***	0.93***
	(0.292)	(0.272)	(0.293)	(0.272)
Controls	No	Yes	No	Yes
Spline	Linear	Linear	Quadratic	Quadratic
Total observation	2152	2152	2152	2152
R-squared	0.05	0.18	0.05	0.19

Notes: Standard errors, clustered in the survey cluster are in parentheses. * denotes significance at the 10%level, ** at the 5% level, and *** at the 1% level. Years of birth has been re-centered at the discontinuity (1989). The total observations are from 1998, 2003, 2008 and 2014 DHS dataset. Estimates based on bandwidth of 4 years

Table 5.2: Impact of years of education on birth, sexual intercourse and marriage

FCUBE IMPACT	(1) OLS	(2) 2SLS	(3) IVtobit
Fertility	-0.03***	-0.11**	-0.13***
	(0.002)	(0.046)	(0.041)
	{0.13}	{0.13}	{0.13}
1(ever given birth)	-0.01***	-0.08***	-0.09***
	(0.001)	(0.027)	(0.032)
	{0.12}	{0.12}	{0.12}
1(if married)	-0.04***	-0.14***	-0.17***
	(0.003)	(0.050)	(0.047)
	{0.16}	{0.16}	{0.016}
1 (if have had sexual intercourse)	-0.03***	-0.02	-0.2**
	(0.003)	(0.045)	(0.084)
	{0.41}	{0.41}	{0.41}

Notes: Robust standard errors clustered in survey cluster are in parenthesis. * represent significance at 10% level. ** at 5% level and *** at 1% level. Years of birth have been re-centered at the discontinuity (1989). FCUBE is used as an instrument for education. Standard errors are in brackets and mean of comparison groups are in braces. Total observations are from 1998,2003, 2008 and 2014 DHS dataset. Estimates are based on bandwidth of 4 years.

Figure 5.3: Impact of years of education on Knowledge

Knowledge	OLS	2sls
Ovulation	0.02***	0.03
	(0.004)	(0.04)
Family planning method	0.01***	0.04**
	(0.002)	(0.021)
TV and radio	0.03***	0.08**
	(0.003)	(0.043)

Notes: Standard errors, clustered in the survey cluster are in parentheses. * denotes significance at the 10%level, ** at the 5% level, and *** at the 1% level. FCUBE is used as an instrument to years of education.

Table 5.4: Heterogeneity effects of years of education on fertility

Outcome	OLS			2SLS		
	(1)	(2)	(3)	(4)	(5)	(6)
By economic status		test of		By economic Status		test of
Fertility	Rich	Poor	equality	Rich	Poor	equality
	-0.02***	-0.02***	p=0.37	-0.09***	-0.12**	P=0.10
	(0.002)	(0.003)		(0.037)	(0.047)	
	{0.10}	{0.20}		{0.10}	{0.20}	
	[817]	[1335]		[817]	[1335]	
By Urbanity		By Urbanity				
	Urban	Rural		Urban	Rural	
	-0.02***	-0.02***	p=0.08	-0.10**	-0.12**	p=0.09
	(0.002)	(0.003)		(0.041)	(0.050)	
	{0.07}	{0.19}		{0.07}	{0.19}	
	[997]	[1155]		[997]	[1155]	
By geographical sub-region		By geographical sub-region				
	North-Sav.	Coast-forest		North-Sav.	Coast-forest	
	-0.03***	-0.02***	p=0.3	-0.11**	-0.11**	p=0.6
	(0.003)	(0.003)		(0.045)	(0.046)	
	{0.17}	{0.12}		{0.17}	{0.12}	
	[550]	[1602]		[550]	[1602]	
By level of education		By level of education				
	9 or less	more than 9		9 or less	more than 9	
	-0.03***	-0.02***	p=0.11	-0.13**	-0.08***	p=0.07
	(0.004)	(0.002)		(0.054)	(0.029)	
	{0.15}	{0.04}		{0.15}	{0.04}	
	[1832]	[320]		[1832]	[320]	
By Religion			By Religion			
	Christian	Muslim	other	Christian	Moslem	Other
	-0.02***	-0.03***	-0.03*** p=0.03	-0.1**	-0.02	-0.14** p=0.39
	(003)	(0.006)	(0.004)(0.05)	(0.059)	(0.063)	
	{0.09}	{0.19}	{0.12}	{0.09}	{0.19}	{0.12}
	[1016]	[235]	[941]	[1016]	[235]	[941]

Notes: Standard errors, clustered in the survey cluster are in parentheses. * denotes significance at the 10%level, ** at the 5% level, and *** at the 1% level. FCUBE is used as an instrument for years of education.Mean of control group in braces and Sample size below mean. Column 3(6) represents p-value on the restriction that discontinuity effect is equal for the different subpopulation. Estimates based on bandwidth of 4 years. The total observations are from 1998, 2003, 2008 and 2014 DHS dataset.

Table 5.5: Heterogeneity effects of years of education on marriage

Outcome	OLS			2SLS		
	(1)	(2)	(3)	(4)	(5)	(6)
	By economic status		test of	By economic Status		test of
	Rich	Poor	equality	Rich	Poor	equality
	-0.03***	-0.03***	p=0.46	-0.12***	-0.15***	p=0.08
	(0.003)	(0.004)		(0.039)	(0.05)	
	{0.11}	{0.25}		{0.11}	{0.25}	
	[817]	[1335]		[817]	[1335]	
	By Urbanity			By Urbanity		
	Urban	Rural		Urban	Rural	
	-0.03***	-0.03***	p=0.08	-0.13***	-0.15***	p=0.08
	(0.003)	(0.003)		(0.044)	(0.054)	
	{0.08}	{0.23}		{0.08}	{0.23}	
	[997]	[1155]		[997]	[1155]	
	By geographical sub-region			By geographical sub-region		
	North-Sav.	Coast-forest		North-Sav.	Coast-forest	
	-0.04***	-0.03***	p=0.2	-0.14***	-0.14***	p=0.62
	(0.004)	(0.003)		(0.050)	(0.050)	
	{0.25}	{0.13}		{0.25}	{0.13}	
	[550]	[1602]		[550]	[1602]	
	By level of education			By level of education		
	9 or less	more than 9		9 or less	more than 9	
	-0.04***	-0.03***	p<0.01	-0.16***	-0.1***	p=0.02
	(0.004)	(0.003)		(0.057)	(0.03)	
	{0.18}	(0.02)		{0.18}	{0.02}	
	[1832]	[320]		[4918]	[879]	
By Religion				By Religion		
Christian	Muslim	other		Christian	Moslem	Other	
-0.03***	-0.04***	-0.03***	p<0.01	-0.12**	-0.03	-0.18**	p=0.3
(0.004)	(0.008)	(0.004)		(0.055)	(0.054)	(0.07)	
{0.1}	{0.23}	{0.14}		{0.1}	{0.23}	{0.14}	
[1016]	[235]	[941]		[1016]	[235]	[941]	

Notes: Standard errors, clustered in the survey cluster are in parentheses. * denotes significance at the 10%level, ** at the 5% level, and *** at the 1% level. FCUBE is used as an instrument for years of education. Mean of control group in braces and Sample size below mean. Column 3(6) represents p-value on the restriction that discontinuity effect is equal for the different subpopulation. Estimates based on bandwidth of 4 years. The total observations are from 1998, 2003, 2008 and 2014 DHS dataset.

Table 6.1: Impact of birthyear instrument on education

Outcome variable: Years of education	(1)	(2)	(3)	(4)
Comparable mean=5.3				
1[Birthyear≥1973]	-1.23 (0.361)***	- 1.15 (0.318)***	-1.23 (0.345)***	-1.14 (0.303)***
Controls	No	Yes	No	Yes
Spline	Linear	Linear	Quadratic	Quadratic
Total observation	3292	3292	3292	3292
R-squared	0.01	0.21	0.01	0.21

Notes: X represents the running variable (year of birth). Standard errors, clustered in the survey cluster are in parentheses. * denotes significance at the 10%level, ** at the 5% level, and *** at the 1% level. Years of birth has been re-centered at the discontinuity (1973). The total observations are from 1998, 2003, 2008 and 2014 DHS dataset. Estimates based on bandwidth of 4 years.

Table 6.2: Impact of years of education on ever married, ever given birth and fertility

Outcome	OLS	2sls
1(Ever married)	-0.013 (0.001)*** {0.94}	-0.02 (0.014) {0.94}
1(Ever given birth)	-0.017 (0.002)*** {0.90}	-0.035 (0.0165)** {0.90}
Fertility	-0.15 (0.007)*** {3.01}	-0.25 (0.101)** {3.01}

Notes: Standard errors, clustered in the survey cluster are in parentheses. * denotes significance at the 10%level, ** at the 5% level, and *** at the 1% level. Years of birth has been re-centered at the discontinuity (1973).NERP is used as an instrument for years of education. The total observations are from1998, 2003, 2008 and 2014 DHS dataset. Estimates based on bandwidth of 4 years. Regression estimates are based on only women with age less than 37years. Standard errors in brackets and mean in curly brackets. All specification allows the RD slopes to differ across the threshold.

Table 6.3: Discontinuity in husband years of schooling

Outcome variable: Husband years of schooling	(1)	(2)
1[X>1973]	1.79	0.73
	(1.82)	(3.59)
Spline	Linear	Quadratic
Total observation	3072	3072
R-squared	0.02	0.02

Notes: Standard errors, clustered in the survey cluster are in parentheses. * denotes significance at the 10%level, ** at the 5% level, and *** at the 1% level. Years of birth has been re-centered at the discontinuity (1973). The total observations are from 1998, 2003, 2008 and 2014 DHS dataset. Estimates based on bandwidth of 4 years

Table 6.4: Impact of years of education on fertility at different ages

Outcome: Fertility	by 15 years	by 20 years	by 25years	present no. of children
	(1)	(2)	(3)	(4)
Fertility	-0.04	-0.077	-0.172	-0.25
	(0.019)**	(0.052)	(0.072)**	(0.101)**
	{0.07}	{0.73}	{1.79}	{3.01}

Notes: Standard errors, clustered in the survey cluster are in parentheses. * denotes significance at the 10%level, ** at the 5% level, and *** at the 1% level. Years of birth has been re-centered at the discontinuity (1973). NERP is used as an instrument for years of education. The total observations are from1998, 2003, 2008 and 2014 DHS dataset. Estimates based on bandwidth of 4 years. Standard errors in brackets and mean in curly brackets. All specification allows the RD slopes to differ across the threshold.

Table 6.5: Mechanisms through which education affect fertility and the timing of birth.

Outcome	OLS	2SLS	Comparison means
	(1) (2)		
Knowledge effect			
1(able to read)	0.07 ***	0.08***	0.29
1(male condom source known)	0.04***	0.07**	0.60
1(know pregnancy preventive method)	0.004***	-0.006	0.96
Opportunity Cost			
1(Working)	- 0.001	0.009	0.92
1(work for someone & receive payment)	-0.01***	0.09*	0.13
Household bargaining power and Autonomy effect			
1(part in large household purchases decision)	-0.013***	0.11**	0.58
1(part in what to cook in the household everyday)	0.001	0.01	0.70
1(beating justified if wife goes out without telling husband)	-0.015***	-0.05	0.35
1(beating justified if wife neglects children)	-0.018***	-0.04	0.39
1(beating justified if wife refuses to have sex with husband)	-0.014***	-0.05*	0.23
Incarceration effect			
Fertility from 19yrs-22yrs	-0.04***	-0.22***	1.89
1(1^{st}sexual intercourse from 19yrs-22yrs)	0.004	0.02	0.24
Assortative mating and fertility preferences			
Husband years of schooling	0.61***	0.82***	7.41
Husband age	-0.13***	-0.44	39.4
1(husband is a farmer)	-0.04***	-0.09***	0.33
1(husband prefers same/less number of children)	0.008***	0.01	0.49
Fertility preference for wife	-0.139***	-0.3**	4.65

Notes: Standard errors, clustered in the survey cluster are in parentheses. * denotes significance at the 10%level, ** at the 5% level, and *** at the 1% level. Years of birth has been re-centered at the discontinuity (1973). NERP is used as an instrument for years of education.The total observations are from1998, 2003, 2008 and 2014 DHS dataset. Estimates based on bandwidth of 4 years. The following variables are not in the 1998 wave(male source of condom known, able to read, work for someone and receive payment, part of household decision in large purchases, beating justified if wife goes out without informing husband, beating justified if wife neglects children and beating justified if wife refuses to have sexual intercourse with husband). All specification allows the RD slopes to differ across the threshold.

Table 7.1: Impact of birthyear instrument on exposure to NERP and years of education

	(1)	(2)	(3)	(4)
Full Sample		Full Sample	Bandwidth of 7	Bandwidth of 7
1(IF EXPOSED TO NERP)				
1[birthyear≥1973]	0.312***	0.309***	0.326***	0.319***
	(0.003)	(0.003)	(0.013)	(0.013)
YEARS OF EDUCATION				
1[birthyear≥1973]	-0.543***	-0.541***	-0.368***	-0.373***
	(0.0286)	(0.0282)	(0.029)	(0.040)
Observations	830,640	830,640	429,118	429,118
Covariates	No	Yes	No	Yes
Spline	Quadratic	Quadratic	Linear	Linear

Notes: Exposure to NERP is defined as individuals who attended post primary education in 1987 or later. Robust standard errors are clustered at the district level (270 clusters) are in parentheses. All the estimation includes regional fixed effects. Predetermined Covariates included are gender, ethnicity, and religion. All the estimations include regional fixed effect (10 regions). * denotes significance at the 10%level, ** at the 5% level, and *** at the 1% level. Years of birth has been re-centered at the discontinuity (1973). The total observations are from 2010 population census in Ghana.

Table 7.2.Impact of exposure to new secondary education system on careers related to vocational training received.

	(1)	(2)
Outcomes	Full sample	Bandwidth of 7
CRAFT	-0.0165*	0.000989
	(0.00935)	(0.00765)
CONSTRUCTION	-0.00386	0.00401
	(0.00320)	(0.00314)
MANUFACTTURING	-0.00837	-0.00269
	(0.00631)	(0.00671)
Observations	830,640	429,118
Spline	Quadratic	Linear
Covariates	Yes	Yes
Fixed Effects	Yes	Yes
	(1)	(2)

Notes: Robust standard errors are clustered at the district level (170 clusters) are in parenthesis. All the estimations include regional fixed effects. Predetermine covariates included are gender, ethnicity and religion. NERP is used as an instrument to exposure of the reform. * represent significance at 10% level. ** at 5% level and *** at 1% level. Years of birth have been re-centered at the discontinuity (1973). Outcome variable Employee is a dummy defined as 1 (if a person is employed by somebody), the rest of the variables are also dummies and similarly defined as employee. Total observations are from 2010 population and housing census in Ghana.

Table 7.3: Impact of exposure to new secondary education system on higher education

	(1)	(2)
Outcomes	Full Sample	Bandwidth of 7
SECONDARY	0.179***	0.155***
	(0.0108)	(0.0101)
TERTIARY	0.0621***	0.051***
	(0.00703)	(0.007)
Observations	830,640	429,118
Spline	Quadratic	Linear
Control	Yes	Yes
Fixed Effects	Yes	Yes

Notes: Robust standard errors are clustered at the district level (270 clusters) are in parentheses. All the estimation includes regional fixed effects. Predetermined Covariates included are gender, ethnicity, and religion. All the estimations include regional fixed effect (10 regions).NERP is used as an instrument to exposure of the reform. * denotes significance at the 10%level, ** at the 5% level, and *** at the 1% level. Years of birth has been re-centered at the discontinuity (1973). The total observations are from 2010 population census in Ghana.

Table 7.4: Impact of exposure to new secondary education system on occupational distribution

Outcomes	(1) Full Sample	(2) Bandwidth of 7
Skilled agriculture, Forestry and Fisheries	-0.062***	-0.108***
	(0.013)	(0.018)
Service and sales workers	0.0174**	0.043***
	(0.008)	(0.009)
Professionals	0.054***	0.04***
	(0.006)	(0.005)
Elementary Occupations	0.012**	0.016***
	(0.005)	(0.005)
Craft and Related Workers	-0.0165*	0.001
	(0.009)	(0.008)
Others	0.022***	0.024***
	(0.006)	(0.007)
Observations	830,640	429,118
Covariates	Yes	Yes
Spline	Quadratic	Linear
Fixed Effect	Yes	Yes

Notes: Robust standard errors are clustered at the district level (170 clusters) are in parenthesis. All the estimations include regional fixed effects. Predetermine covariates included are gender, ethnicity and religion. NERP is used as an instrument to exposure of the reform. * represent significance at 10% level. ** at 5% level and *** at 1% level. Outcome variable skilled agriculture, Forestry and Fisheries is a dummy defined as 1(if a person occupation is under skilled agriculture, forestry and fisheries), the rest of the variables are also dummies and similarly defined as skilled agriculture, forestry and Fisheries. Years of birth have been re-centered at the discontinuity (1973). Total observations are from 2010 population and housing census in Ghana.

Table 7.5: Impact of exposure to new secondary education system on employment status

Outcomes	Full Sample	Bandwidth of 7
Employee	0.098***	0.055***
	(0.01)	(0.007)
Self-employed without employees	-0.089***	-0.039***
	(0.013)	(0.008)
Self-employed with employees	0.008*	0.01***
	(0.004)	(0.003)
Family worker	0.002	-0.011
	(0.005)	(0.006)
Others	0.009**	-0.002
	(0.004)	(0.004)
Observations	830,640	429,118
Covariates	Yes	Yes
Spline	Quadratic	Linear
Fixed Effect	Yes	Yes

Notes: Robust standard errors are clustered at the district level (170 clusters) are in parenthesis. All the estimations include regional fixed effects. Predetermine covariates included are gender, ethnicity and religion. NERP is used as an instrument to exposure of the reform. * represent significance at 10% level. ** at 5% level and *** at 1% level. Years of birth have been re-centered at the discontinuity (1973). Outcome variable Employee is a dummy defined as 1 (if a person is employed by somebody), the rest of the variables are also dummies and similarly defined as employee. Total observations are from 2010 population and housing census in Ghana.

Table 7.6: Impact of exposure to new secondary education system on sector of employment

Outcomes	(1) Full Sample	(2) Bandwidth of 7
Government worker	0.083***	0.061***
	(0.006)	(0.006)
Formal private sector worker	0.0183***	0.021***
	(0.004)	(0.003)
Informal sector worker	-0.0738***	-0.063***
	(0.009)	(0.006)
Observations	830,640	429,118
Covariates	Yes	Yes
Spline	Quadratic	Linear
Fixed Effect	Yes	Yes

Notes: Robust standard errors are clustered at the district level (170 clusters) are in parenthesis. All the estimations include regional fixed effects. Predetermine covariates included are gender, ethnicity and religion. NERP is used as an instrument to exposure of the reform. * represent significance at 10% level. ** at 5% level and *** at 1% level. Years of birth have been re-centered at the discontinuity (1973). Outcome variable Government worker is a dummy defined as 1 (if a person is employed by the government), the rest of the variables are also dummies and similarly defined as employee. Total observations are from 2010 population and housing census in Ghana.

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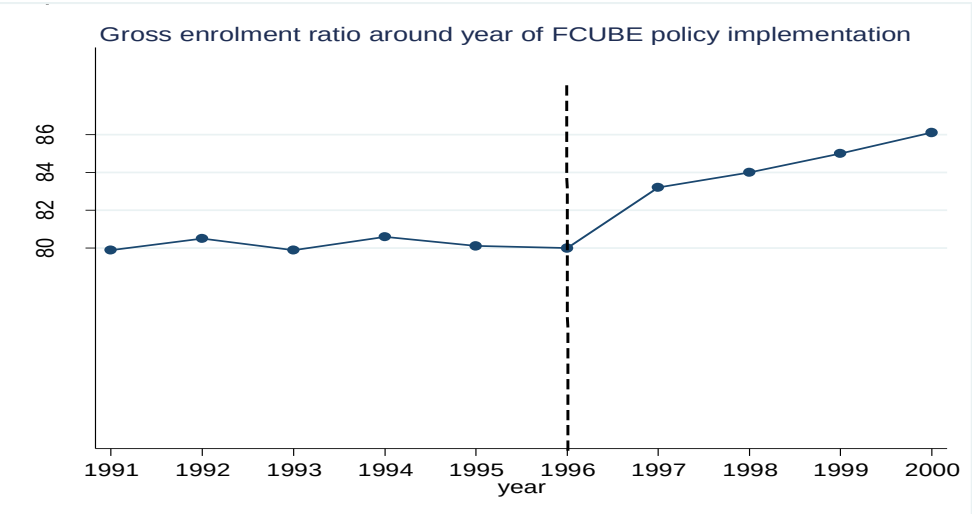
Fig. 3.1: Years of Pre-tertiary education before and after 1987 reform.

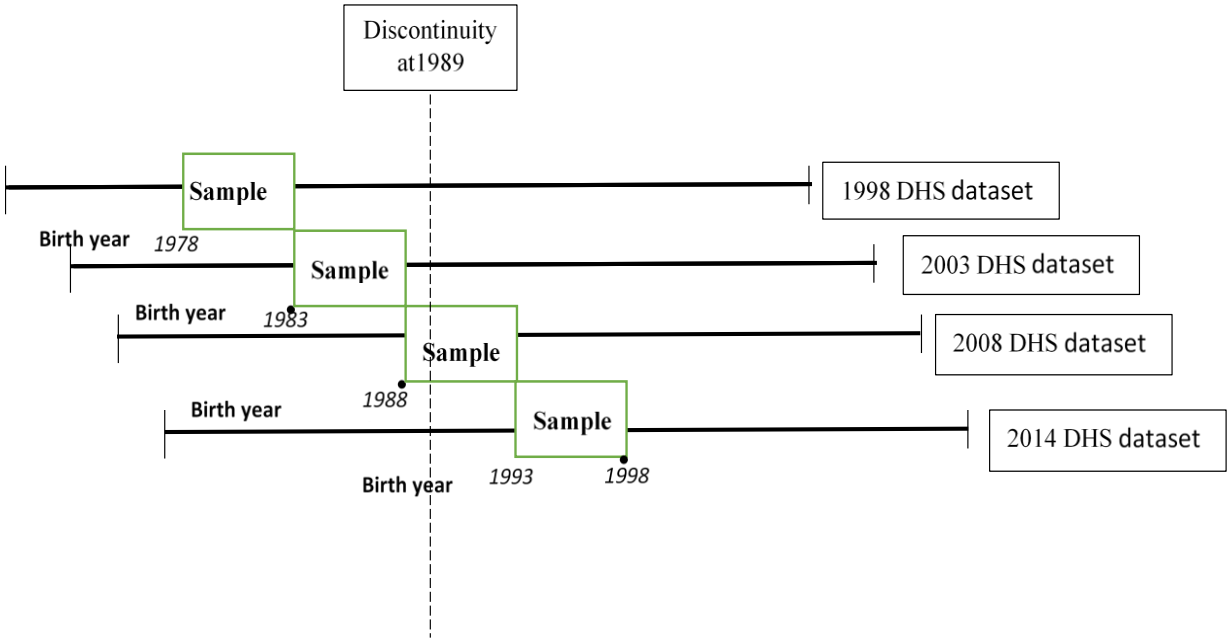
Years of Education	Prior to 1987	1987 and Beyond
1 2 3 4 5 6	**PRIMARY**	**PRIMARY**
7 8 9	**MIDDLE SCHOOL**	**MIDDLE SCHOOL (Name change to JSS)**
10		**SECONDARY**
11 12	**SECONDARY**	
13 14 15 16 17		

Fig. 3.2. Gross enrolment ratio from 1991 to 2000



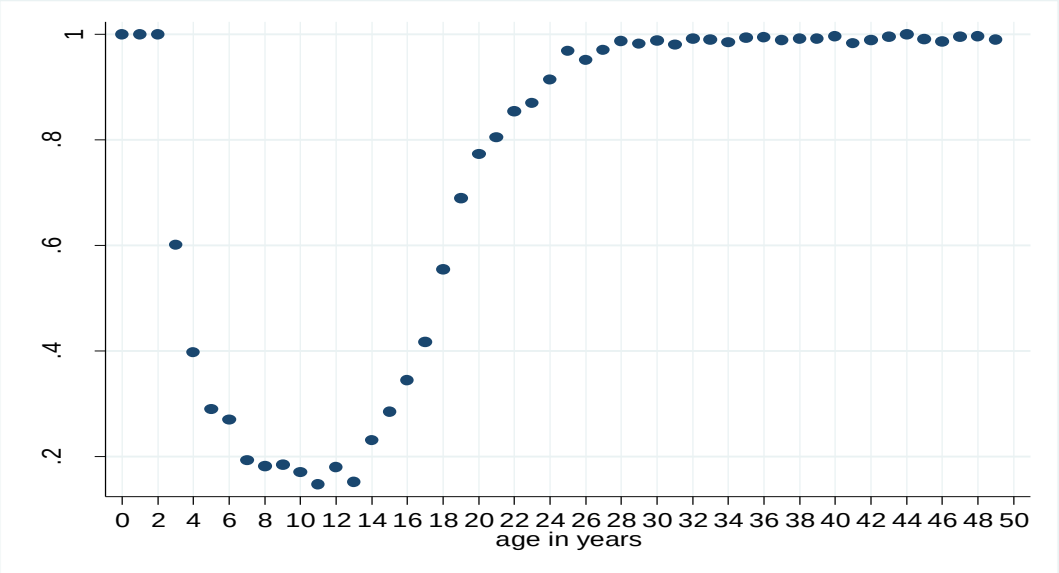
Source: World Databank

Fig. 4.1. Sample Frame for FCUBE policy analysis



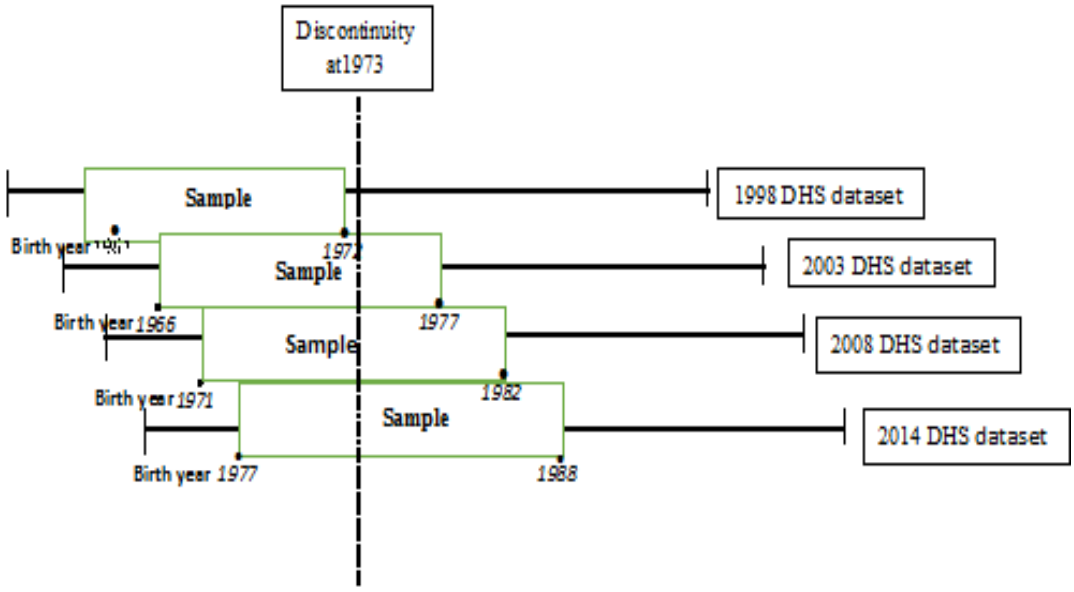
Note: Author's own calculation from 1998, 2003, 2008, and 2014 dataset

Figure 4.2: Proportion of individual out of school for each age group of the population



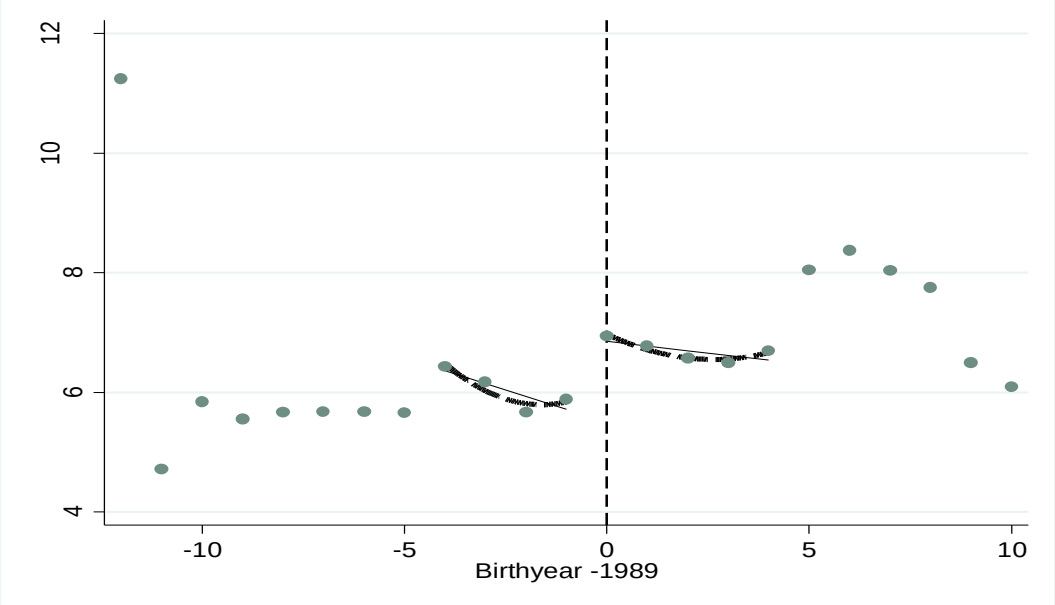
Note: Data are from GLSS5, 2005.

Fig. 4.3: Sample Frame for NERP reform



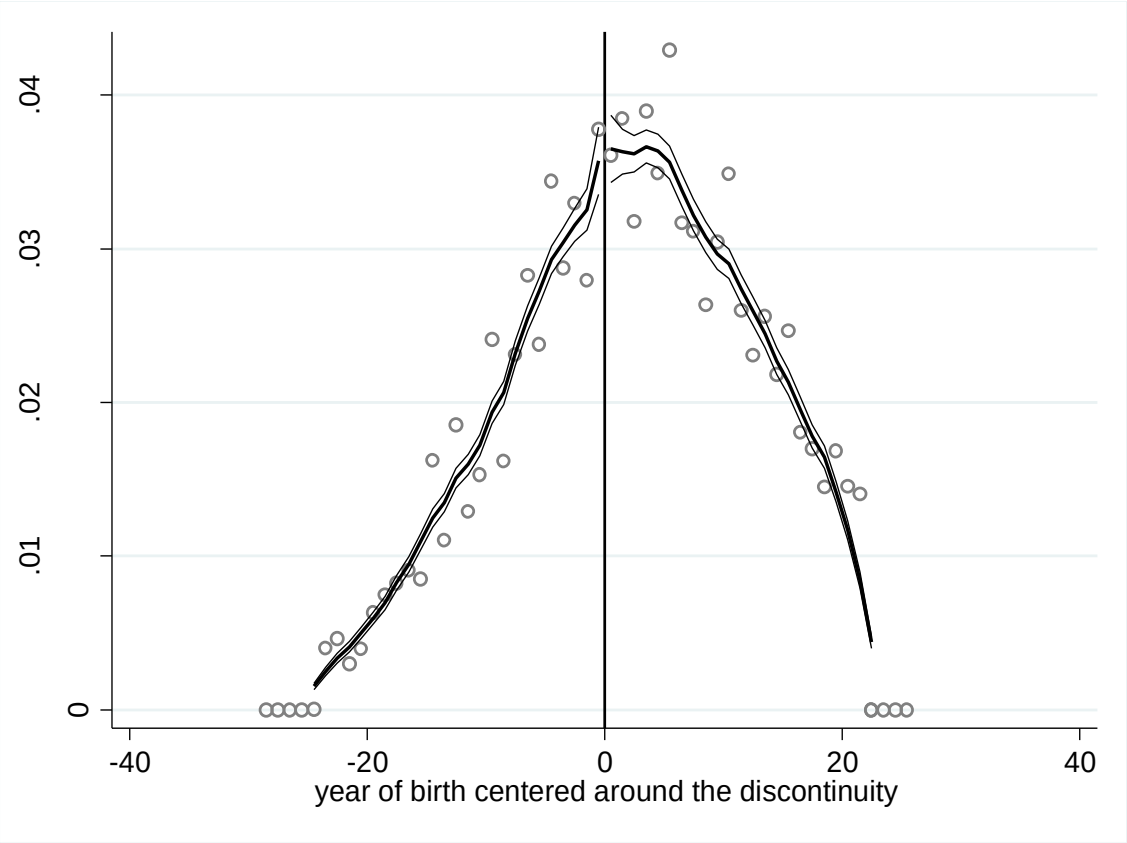
Note: Author's own calculation from 1998, 2003, 2008, and 2014 dataset

Fig 5.1: Impact of being born after 1989 on education



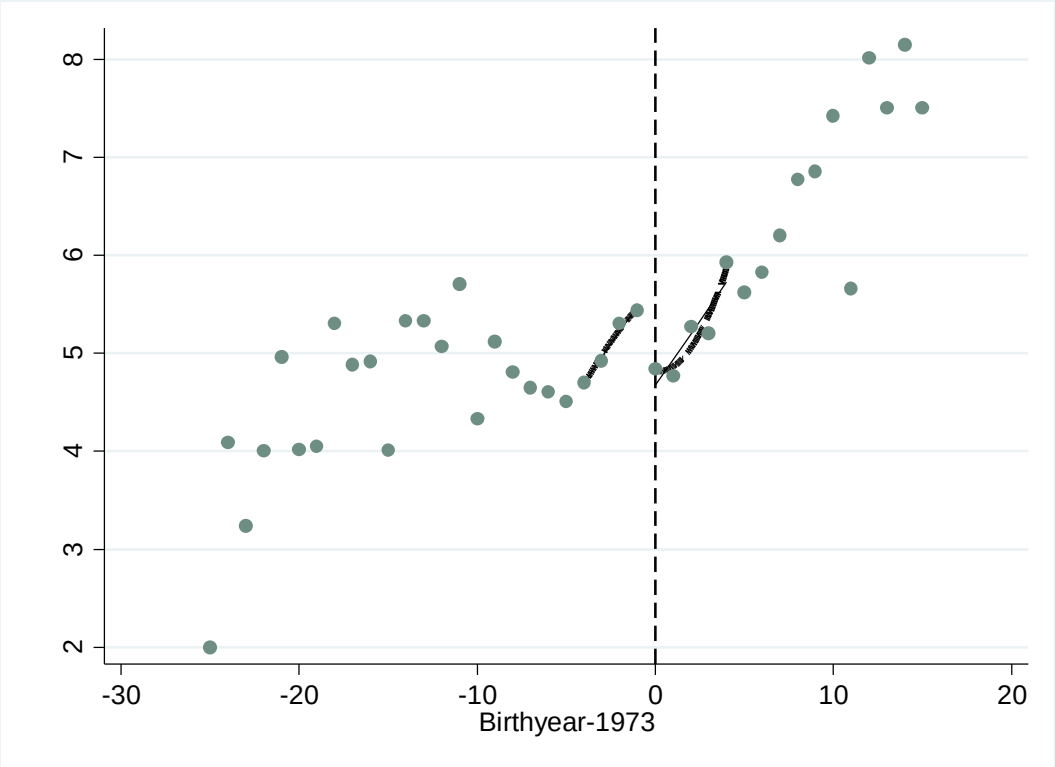
Note: Using 1998, 2003, 2008 and 2014 waves of Ghana DHS dataset. Reduced form graph of the effect of FCUBE on education

Figure 6.1: Density function for the running variable



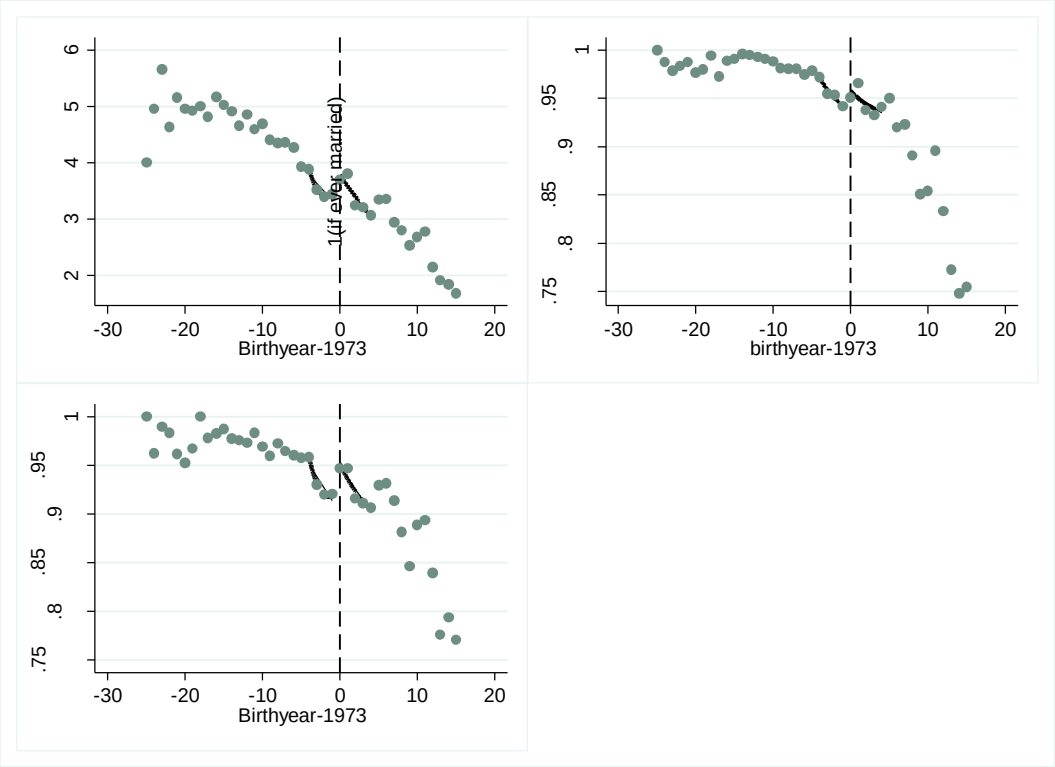
Source: Using 1998, 2003, 2008 and 2014 waves of Ghana DHS dataset

Figure 6.2: Impact of being born after 1973 on years of education



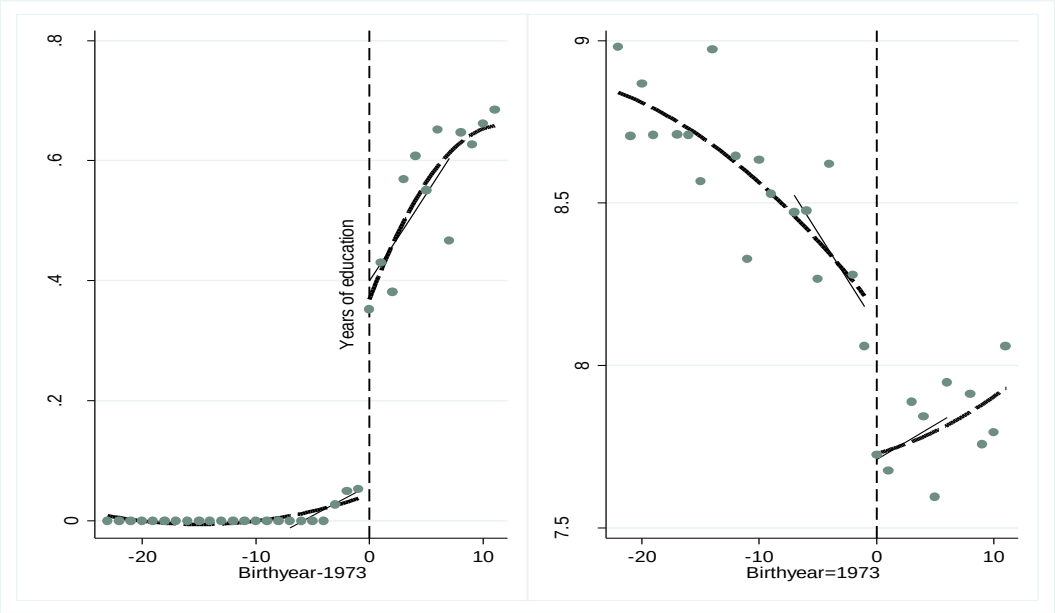
Note: Using 1998, 2003, 2008 and 2014 waves of Ghana DHS dataset. Reduced form graph of the effect of NERP on education

Figure 6.3: Impact of being born after 1973 on fertility, ever given birth, and ever married



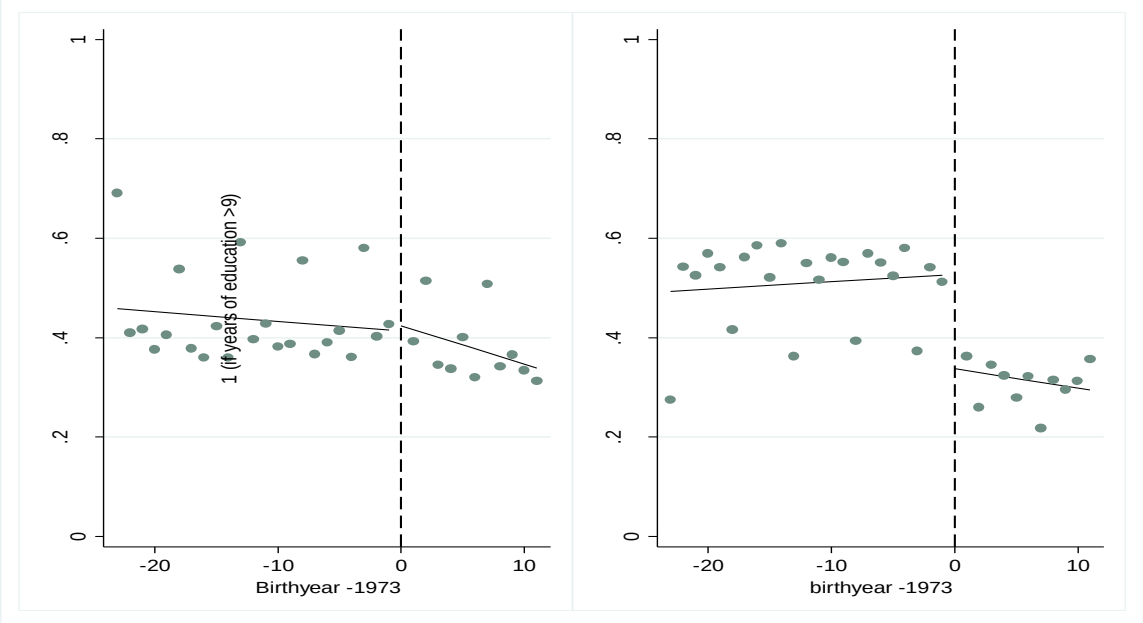
Note Using 1998, 2003, 2008 and 2014 waves of Ghana DHS dataset. Reduced form graphs of the effect of NERP on fertility, ever given birth and ever married

Figure 7.1: Impact of being born after 1973 on years of education and exposure to NERP



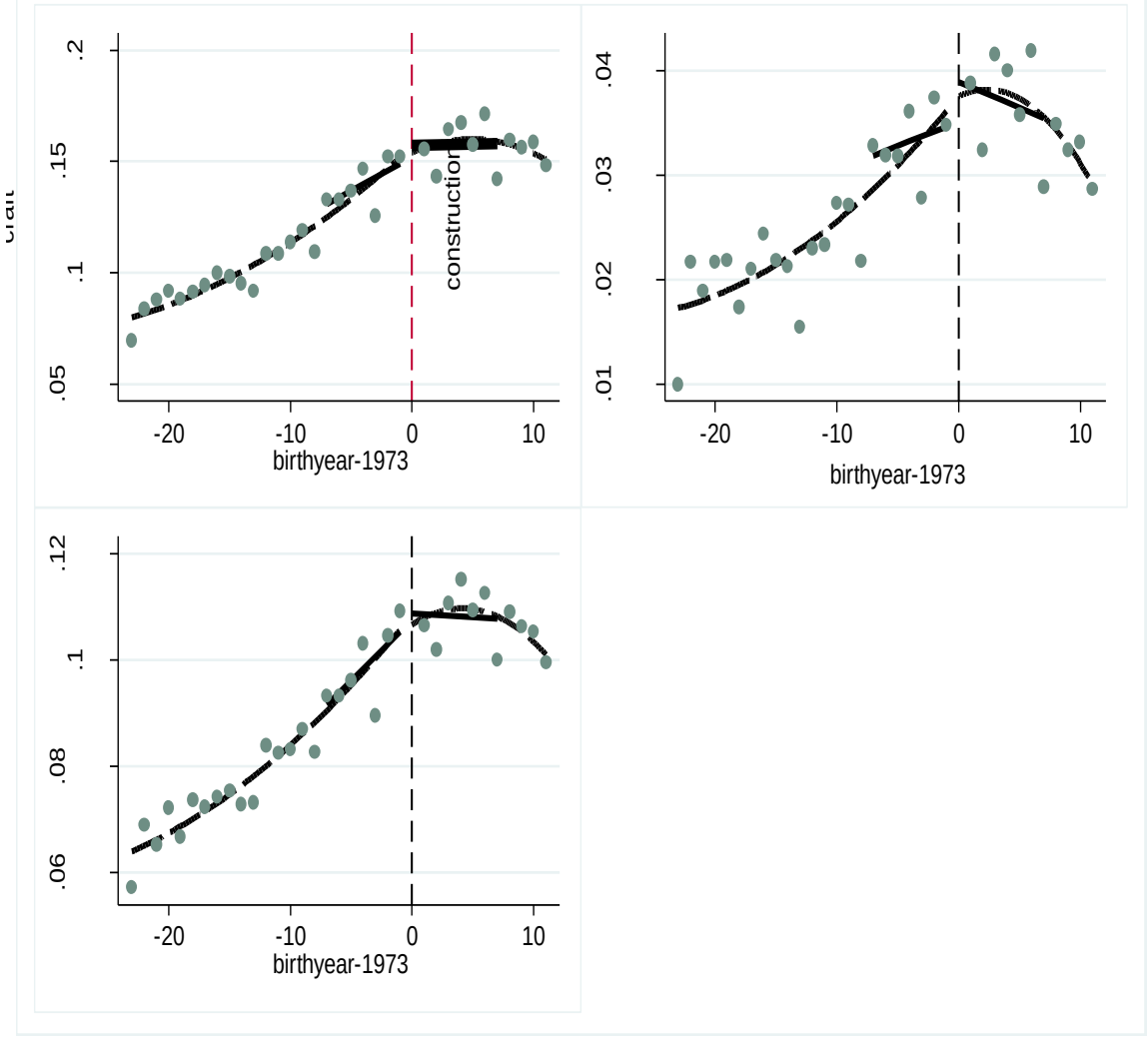
Source: 2010 Ghana Population and Housing Census.

Fig. 7.2: Impact of being born after 1973for persons with at most primary education and at least 10 years of schooling



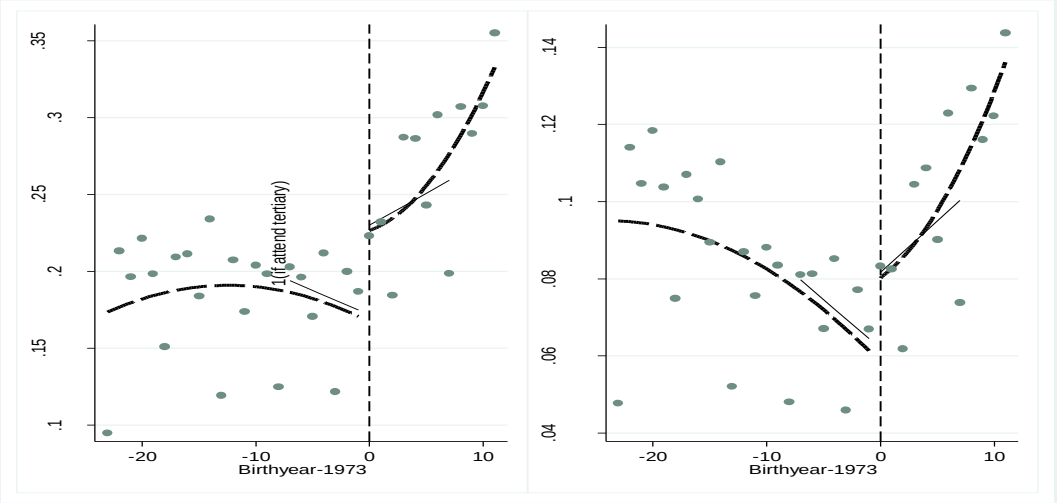
Note: 2010 Ghana Population and Housing Census

Fig. 7.3: Impact of being born after 1973 on the choice of vocational related career



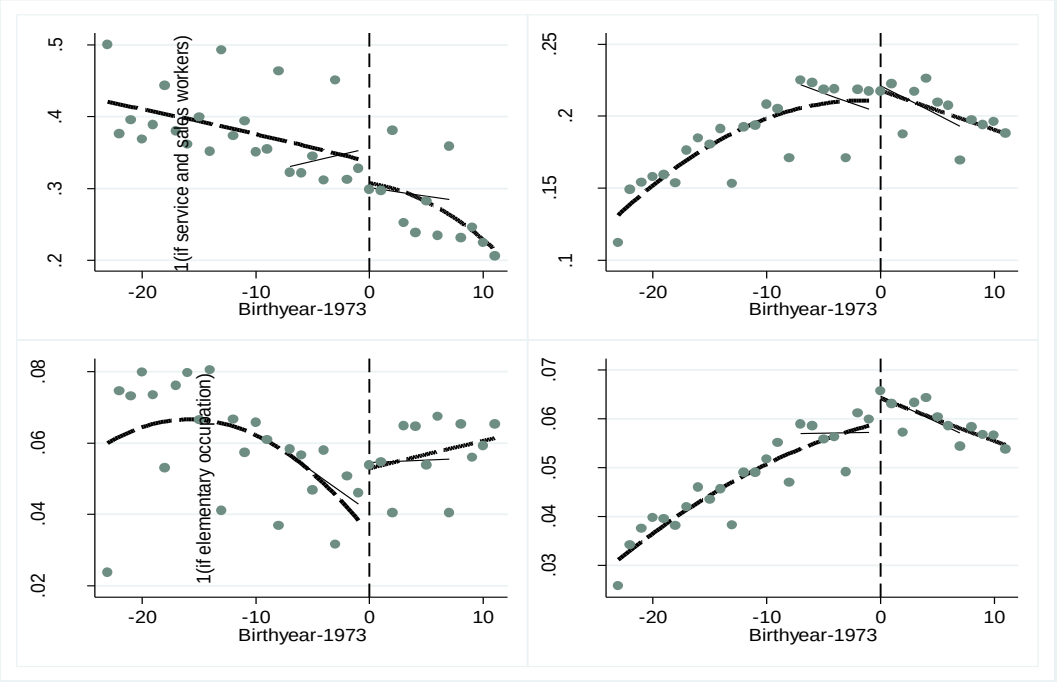
Note: 2010 Ghana Population and Housing Census. Reduced form graphs of the effect of NERP on construction, manufacturing and craft

Fig. 7.4Impact of being born after 1973 on higher education



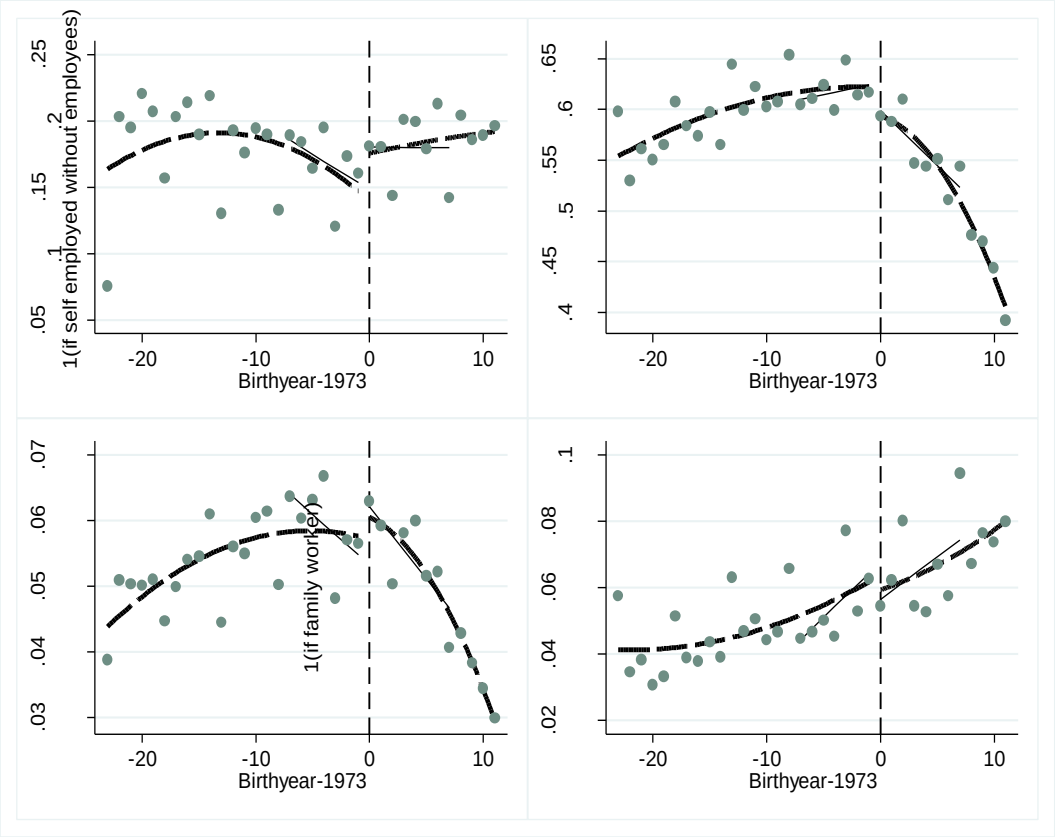
Note: 2010 Ghana Population and Housing Census. Reduced form graphs of the effect of NERP on access to secondary and tertiary education

Fig. 7.5: Impact of being born after 1973on occupational distribution



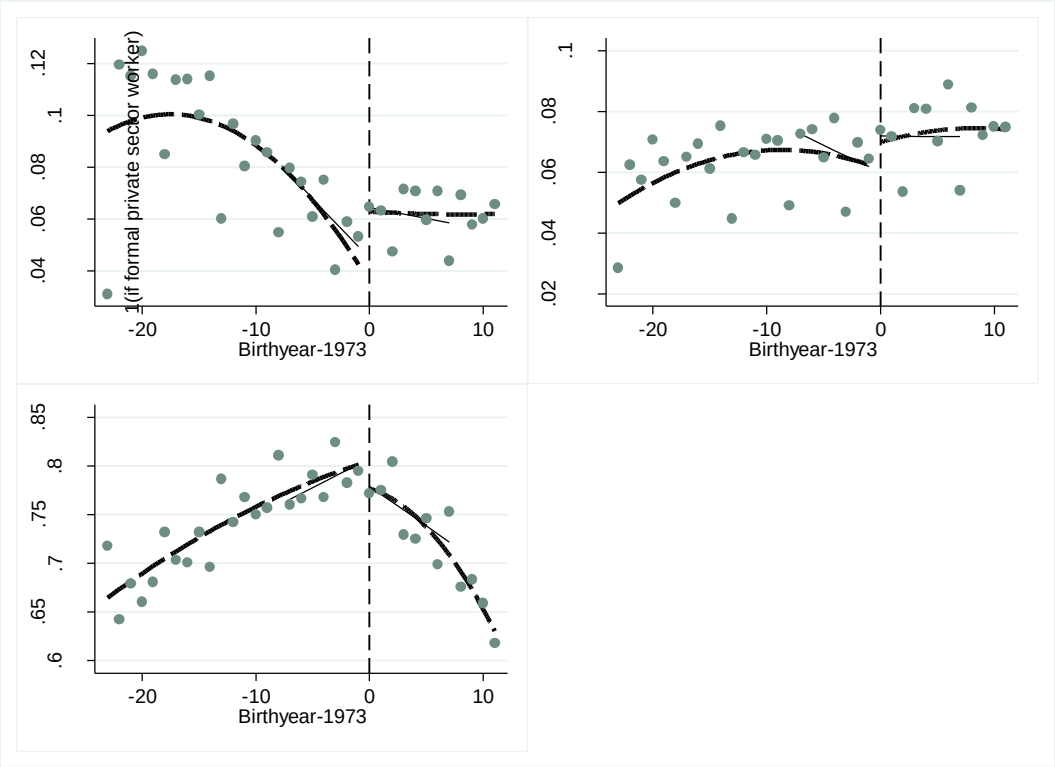
Note: 2010 Ghana Population and Housing Census.Reduced form graphs of the effect of NERP on agriculture, service, professionals and elementary occupation.

Fig 7.6: Impact of being born after 1973 on Employment status



Note: 2010 Ghana Population and Housing Survey. Reduced form graphs of the effect of NERP on employee, self-employment and family worker.

Fig 7.7: Impact of being born after 1973 on sector of employment



Note: 2010 Ghana Population and Housing Survey. Reduced form graphs of the effect of NERP on informal and formal employment

Appendix A

Outcome Schooling years	coefficient	sample size
1[X>1989] (maximum age to begin primary 1 is 7 years)	0.99 (0.2646)***	6318
1[X>1989] (maximum age to begin primary 1 is 8 years)	0.88 (0.2322)***	7494
1[X>1989] (maximum age to begin primary 1 is 9 years)	0.91 (0.2256)***	7979
1[X>1989] (No restriction on age to begin primary 1)	0.95 (0.2218)***	8650

Notes: X refer to years of birth, Standard errors, clustered in the survey cluster are in parentheses. * denotes significance at the 10% level, ** at the 5% level, and *** at the 1% level. Years of birth has been re-centered at the discontinuity (1989). The total observations are from Ghana Living Standard Survey 6. Estimates based on bandwidth of 4 years.

Appendix 5A2: Impact of being born after 1989 on years of education for different bandwidth length

Outcome variable: Total schooling years	linear	quadratic	N
Bandwidth(2 years)			
1[Birthyear>1989]	0.83 (0.417)**	1.1 (0.406)**	1256
Bandwidth(3 years)			
1[Birthyear>1989]	0.96 (0.301)***	0.93 (0.354)***	1696
Bandwidth(4 years)			
1[Birthyear>1989]	0.92 (0.324)***	0.93 (0.291)**	2152
Bandwidth(5 years)			
1[Birthyear>1989]	0.73 (0.316)**	1.1 (0.313)***	2677
Quadratic	No	Yes	
R-squared	0.17	0.19	

Notes: Standard errors, clustered in the survey cluster are in parentheses. * denotes significance at the 10%level, ** at the 5% level, and *** at the 1% level. Years of birth has been re-centered at the discontinuity (1989).FCUBE is used as an instrument to years of education. The total observations are from 1998, 2003, 2008 and 2014 DHS dataset. Estimates based on bandwidth of 2,3,4 and 5 years

Appendix 5A3: Discontinuity in years of education of men likely to be husbands of women in the dataset

Outcome variable: Men years of schooling	(1)	(2)
1[Birthyear>1982]	-0.302	0.801
	(0.341)	(0.711)
Spline	Linear	Quadratic
Total observation	3730	3730
R-squared	0.29	0.29

Notes: Standard errors, clustered in the survey cluster are in parentheses. * denotes significance at the 10%level, ** at the 5% level, and *** at the 1% level. Years of birth has been re-centered at the discontinuity (1982). The total observations are from the sixth wave of Ghana Living Standard survey dataset surveyed in 2012. Estimates based on bandwidth of 4 years

Appendix 6A1: Impact of NERP on education given different bandwidth

Outcome variable: Total schooling years	linear (1)	quadratic (2)	cubic (3)	N
Bandwidth(4 years)				
1[X>1973]	- 1.15	-1.14	-0.65	3292
	(0.318)***	(0.303)***	(0.345)*	
Bandwidth(8 years)				
1[X>1973]	-0.77	-0.79	-1.08	5967
	(0.221)***	(0.219)***	(0.278)***	
Bandwidth(2 years)				
1[X>1973]	-0.91	-0.91	-1.62	1848
	(0.512)*	(0.447)**	(0.616)***	

Notes: X represents the running variable (year of birth). Standard errors, clustered in the survey cluster are in parentheses. * denotes significance at the 10%level, ** at the 5% level, and *** at the 1% level. Years of birth has been re-centered at the discontinuity (1973). Estimations for bandwidth of 4 and 8 years are from 1998, 2003, 2008 and 2014 DHS dataset. The estimate based on bandwidth of 2years is from 1998, 2003, and 2008 DHS dataset.

Appendix 6A2: Discontinuity estimate on men likely to be husbands of women in the dataset

Outcome variable: Men years of schooling	(1)	(2)
1[Birthyear>1965]	-0.005	-0.27
	(0.498)	(0.969)
Spline	Linear	Quadratic
Total observation	2311	2311
R-squared	0.29	0.29

Notes: Standard errors, clustered in the survey cluster are in parentheses. * denotes significance at the 10%level, ** at the 5% level, and *** at the 1% level. Years of birth has been re-centered at the discontinuity (1965). The total observations are from the sixth wave of Ghana Living Standard survey dataset surveyed in 2012. Estimates based on bandwidth of 4 years

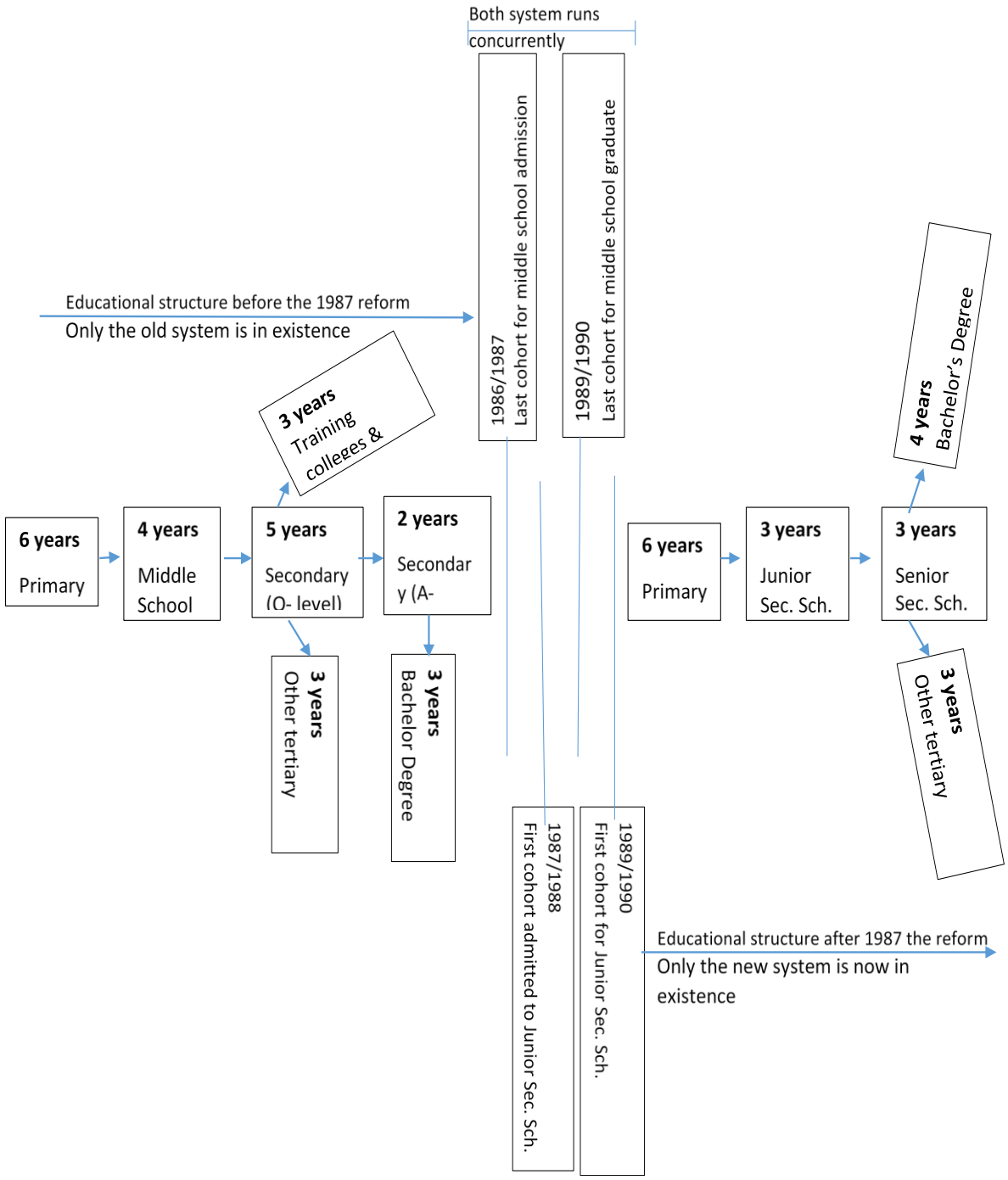
Appendix 6A3: Pupil teacher ratio and Government budget allocation

Year	pupil-teacher ratio in primary education (headcount basis)	pupil teacher ratio in secondary education (headcount basis)	Government expenditure on education (% of GDP)
1982	29.7	21.6	1.9
1983	29.5	20.8	1.6
1984	28.7	20.9	2.0
1985	27.6	21.5	2.0
1986	23.2	20.9	3.3
1987	23.8	17.2	3.6
1988	23.9	16.1	3.5
1989	25.9	17.5	3.4
1990	27.1	18.2	3.2
1991	29.1	18.9	3.1

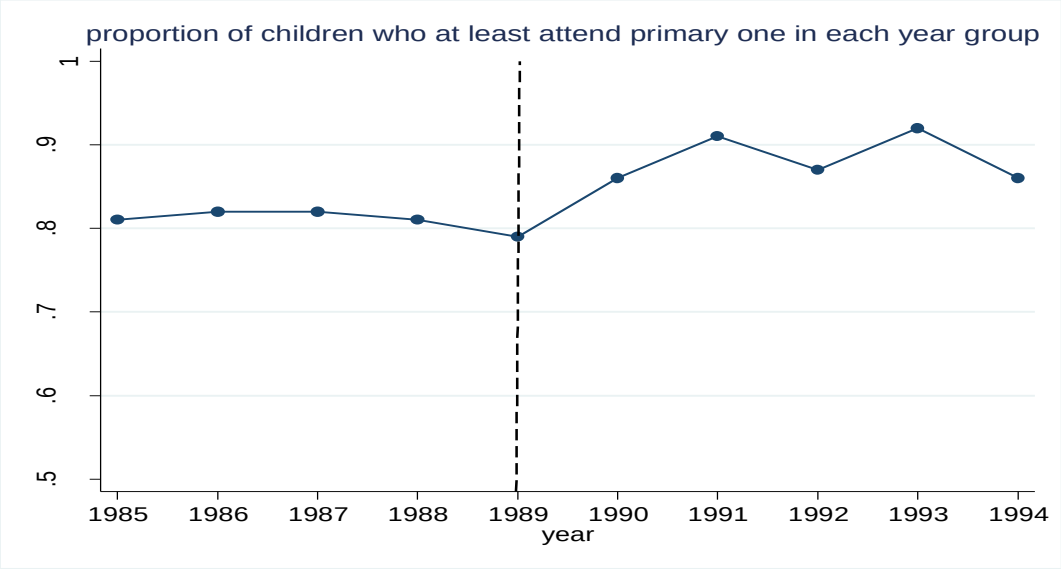
Source: data on pupil teacher ratio obtained from World DataBank and data on Government expenditure on education is obtained from Center for Economic Policy Analysis report(2000)

Appendix B

Appendix 3B1: Summary of the 1987 educational reform in Ghana

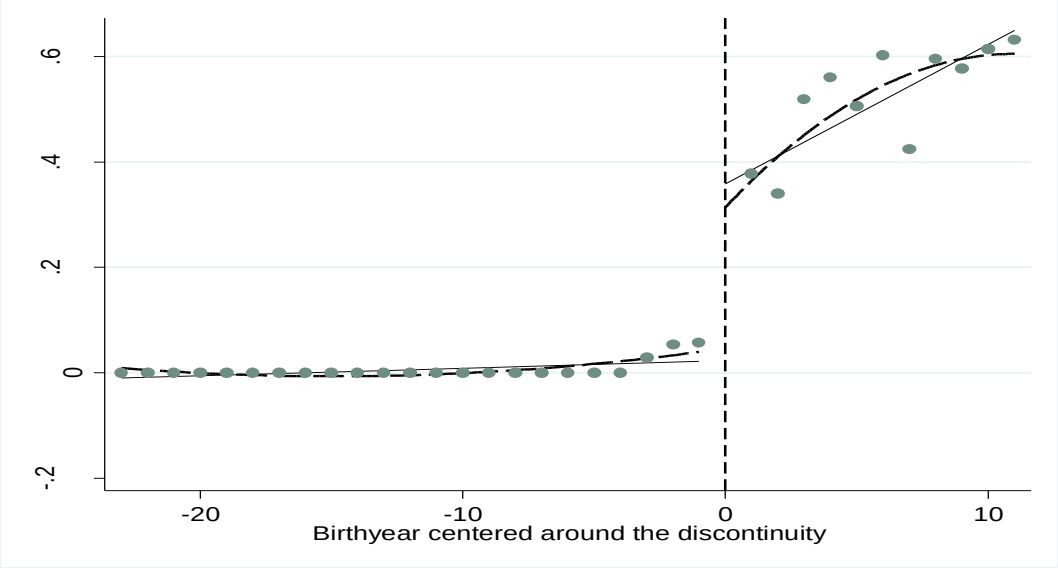


Appendix 3B2: Proportion of Ghanaian who at least enroll in primary one from 1985-1994



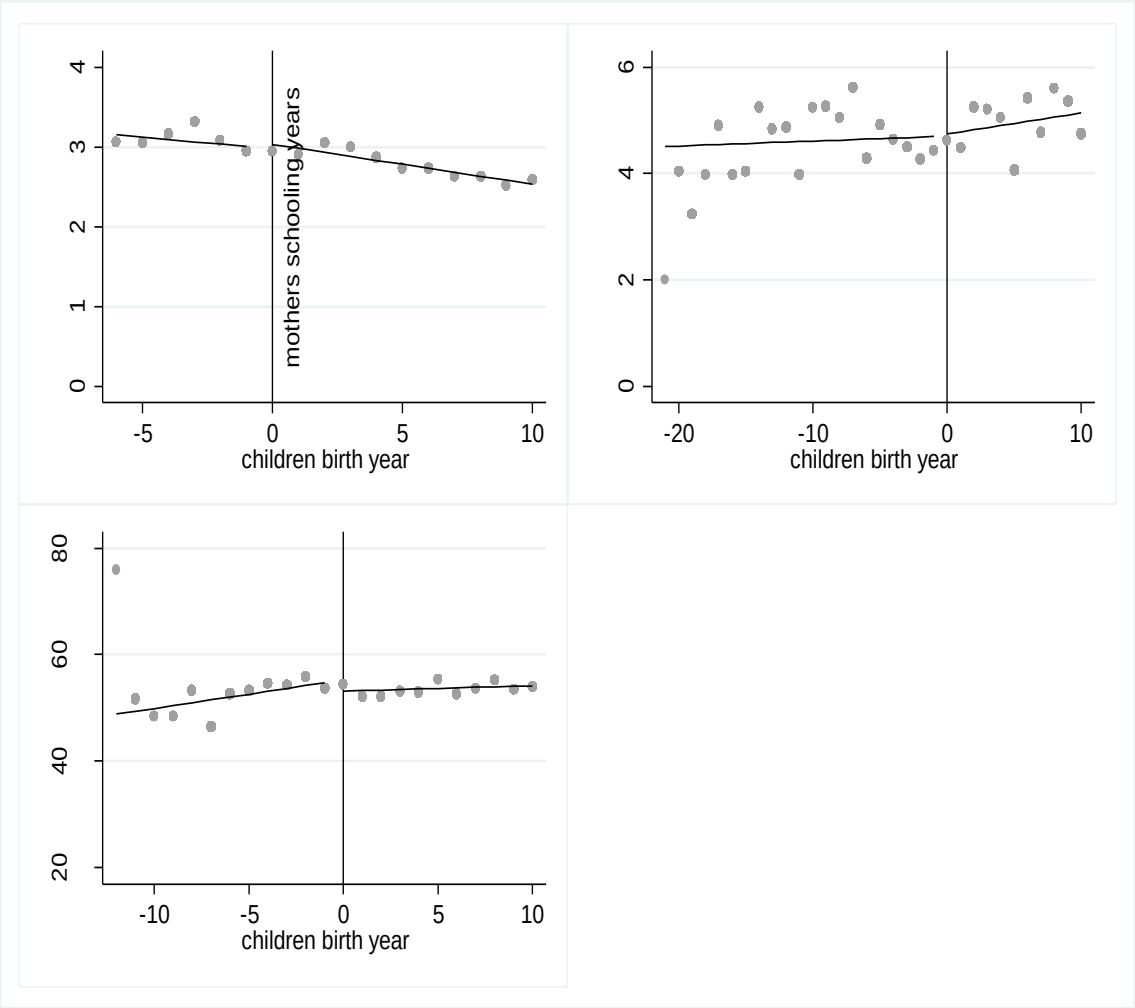
Source 2014: DHS household survey

Appendix 4B1: Impact of being born after 1973 on years of education for persons without tertiary education



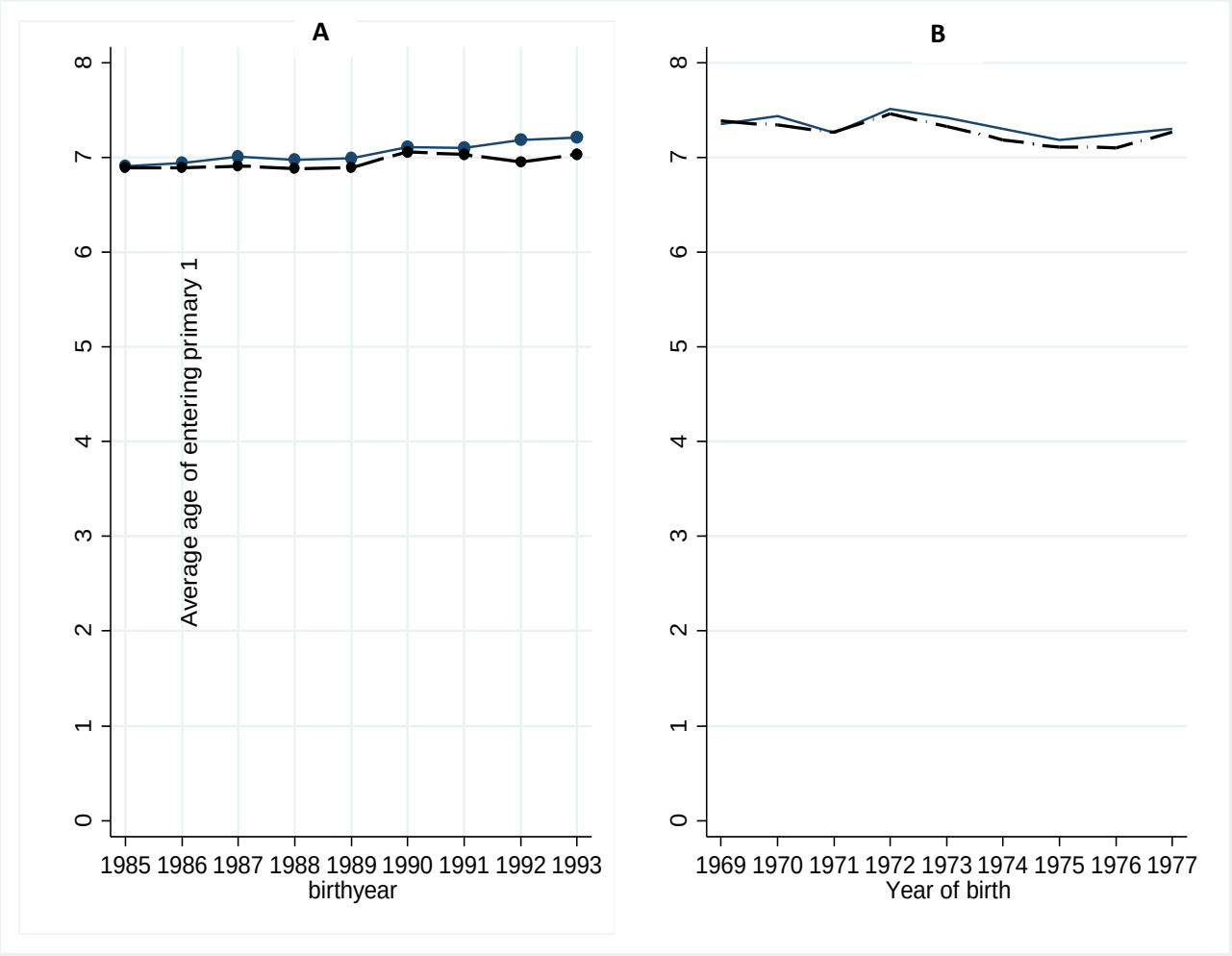
Source: 2010 Ghana Population and Housing Census

Appendix 5B1: Impact of being born after 1989 on wealth, mothers schooling years, and mothers education



Source: 1998, 2003, 2008, 2014 DHS dataset

Appendix 5B2: Average age in entering primary one for both men and women

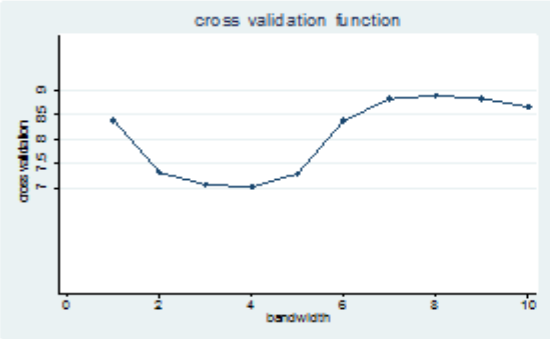


Source: GLSS6, 2012

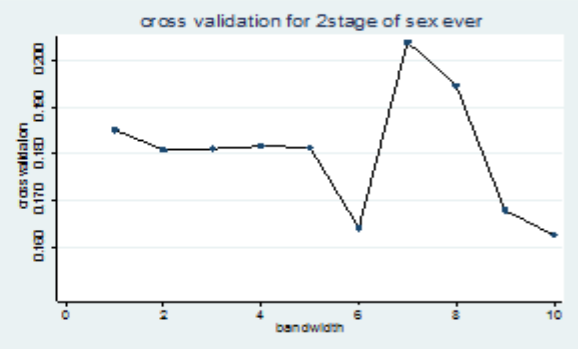
Note: Short dashes are for females and solid line is for males

Appendix 5B3: Selection of the optimal bandwidth

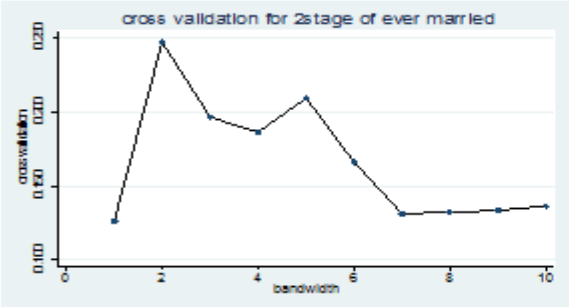
a



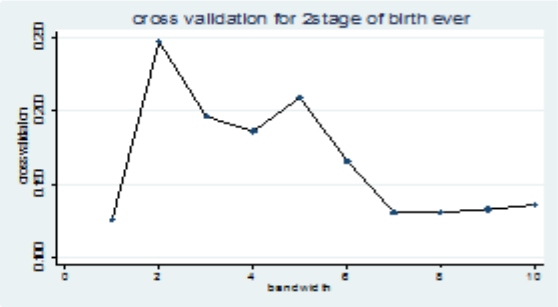
b



c

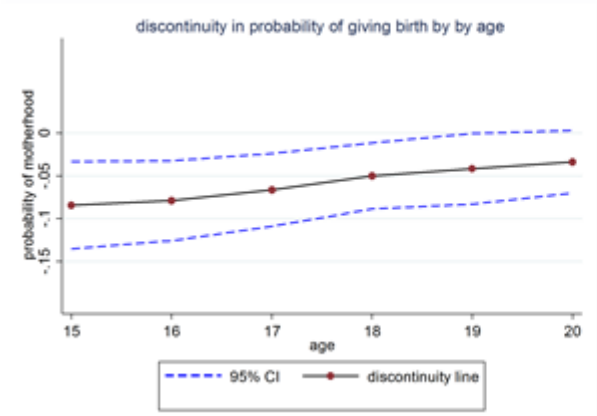


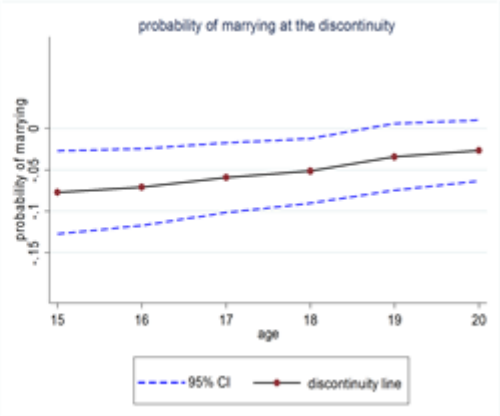
d



Source: 1998, 2003, 2008, 2014 Ghana DHS dataset

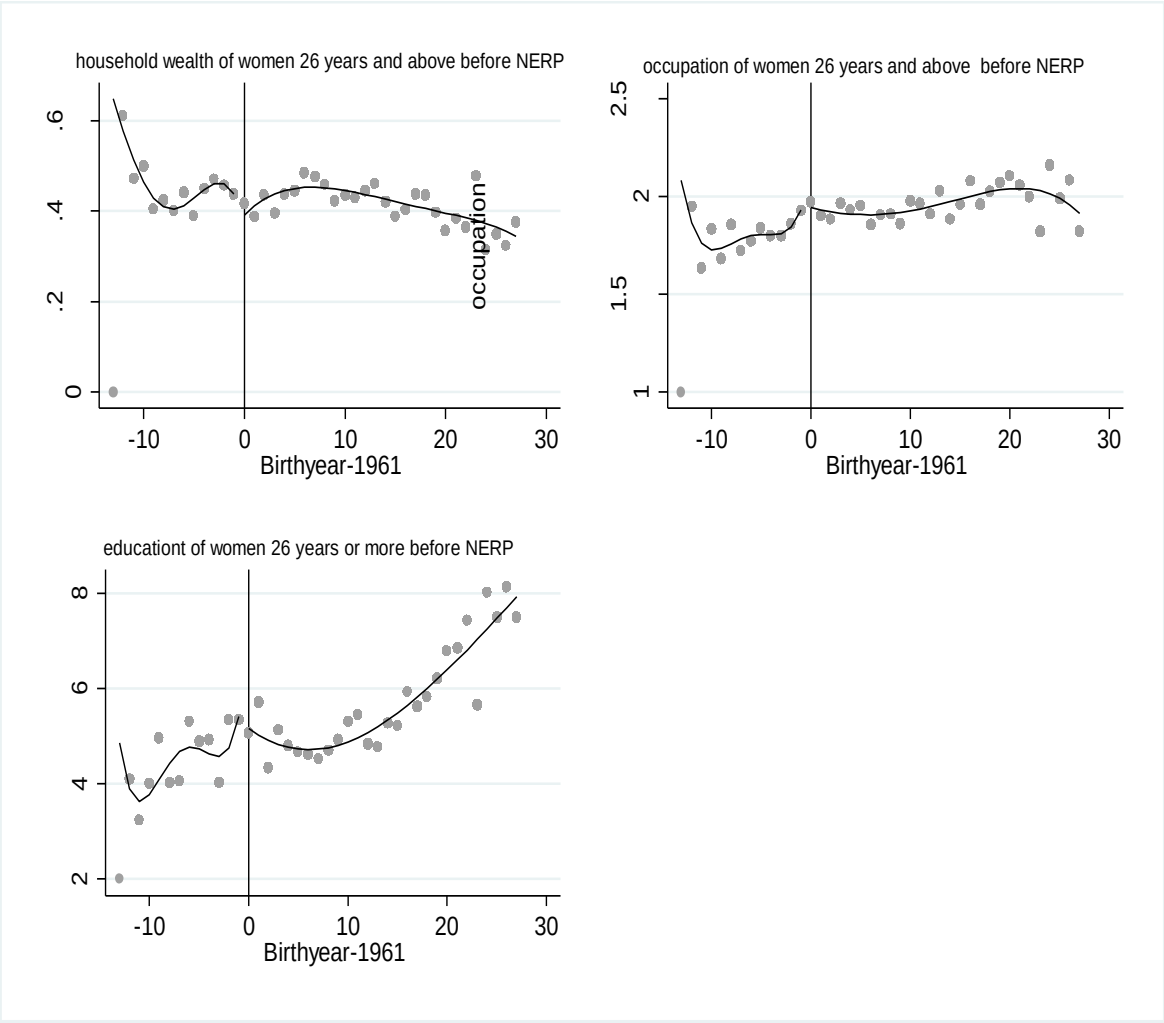
Appendix 5B4: Impact of being born after 1989 on probability of marrying and giving birh at specific ages





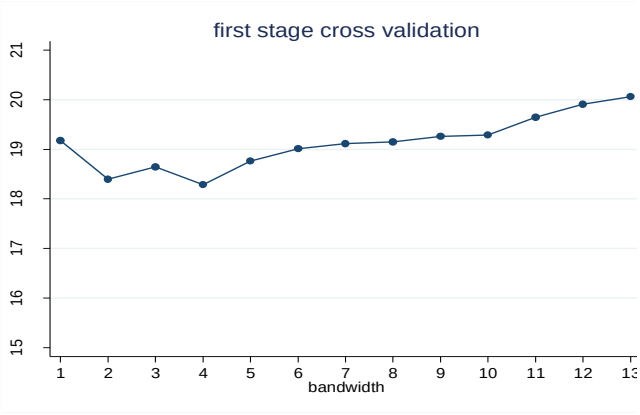
Source: 1998, 2003, 2008, 2014 Ghana DHS dataset

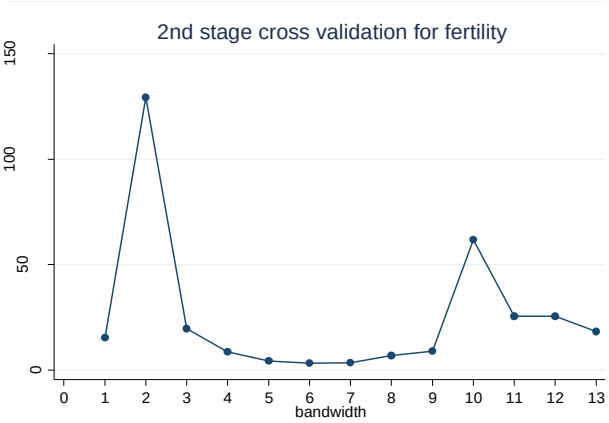
Appendix 6B1: Discontinuities in pretreatment covariates for NERP at the cutoff

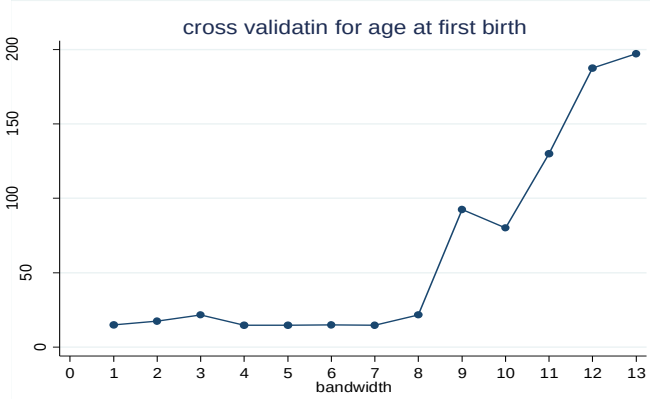


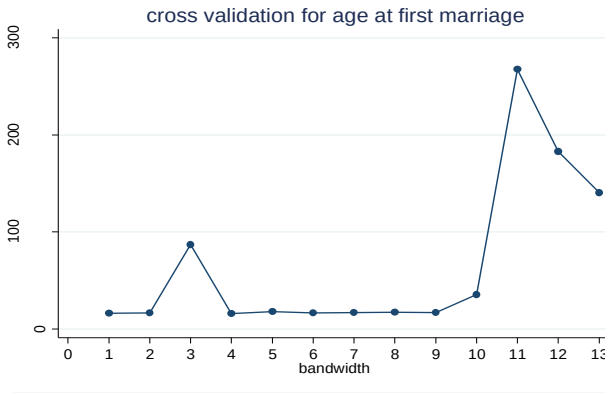
Source: 1998, 2003, 2008, 2014 Ghana DHS dataset

Appendix 6B2: Cross Validation of being born after 1973 for education, fertility, first birth and marriage

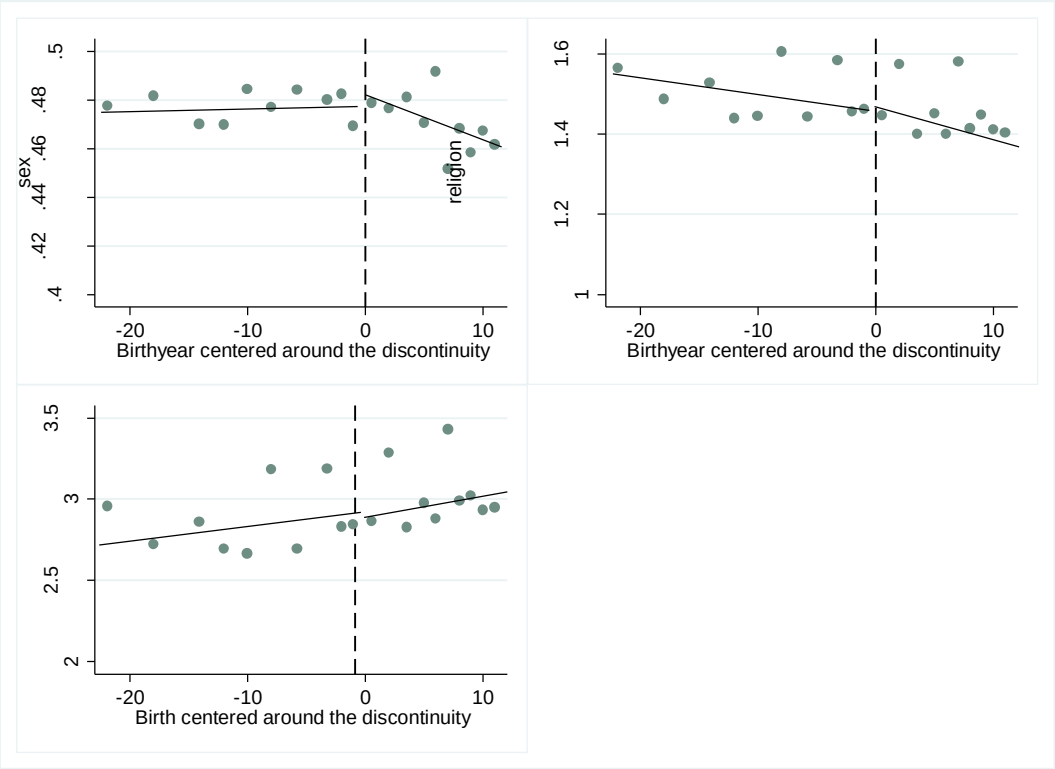






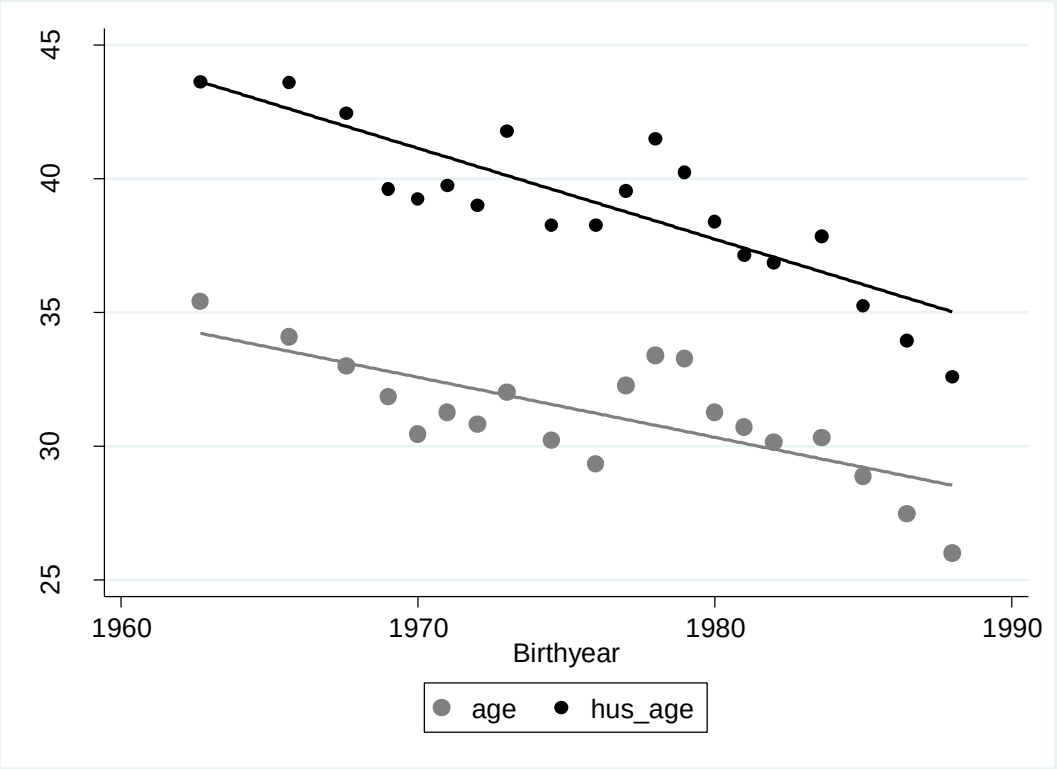


Appendix 6B3: Impact of being born after 1973 on sex, religion and ethnicity



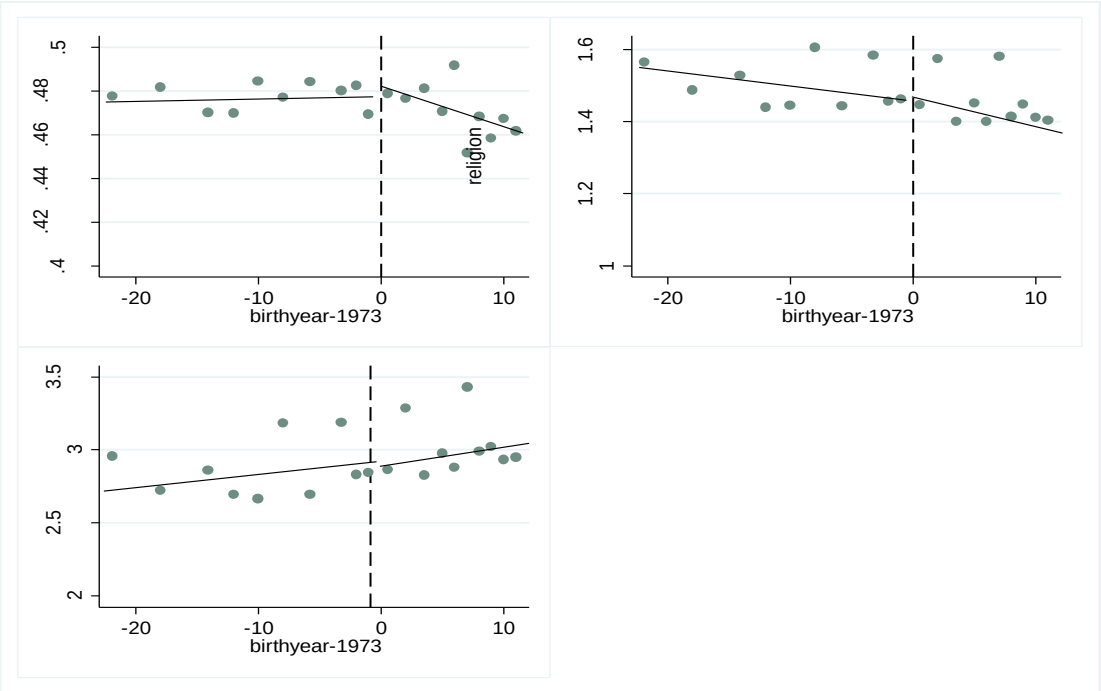
Source: 2010 Population and Housing Census

Appendix 6B4: Average age of husbands and wives by birthyear



Source: DHS 1998, DHS 2003, DHS 2008, DHS, 2014

Appendix 7B1: Impact of being born after 1973 on sex, religion and ethnicity



Source: 2010 Ghana population and Housing Census