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What Explains Rwanda's Drop in Fertility between 2005 and 2010?

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Abstract

Following a decade-and-a-half stall, fertility in Rwanda dropped sharply between 2005 and 2010. Using a hierarchical age-period-cohort model, this paper finds that the drop in fertility is largely driven by cohort effects, with younger cohorts having substantially fewer children than older cohorts observed at the same age. An Oaxaca-Blinder decomposition is applied on two successive rounds of the Demographic and Health Survey. The findings show that improved female education levels account for the largest part of the fertility decline, with improving household living standards and the progressive move toward non-agricultural employment being important secondary drivers. The drop in fertility has been particularly salient for the younger cohorts, for whom the fertility decline can be fully explained by changes in underlying determinants, most notably the large increase in educational attainment between 2005 and 2010.

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What Explains Rwanda's Drop in Fertility between 2005 and 2010?

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1. Introduction

Rwanda was among the first countries in Sub-Saharan Africa to start the demographic transition, with total fertility rates dropping from 8.25 in the early 1980s to 6.3 in the early 1990s (Cohen, 1998; United Nations, 2011). Rwanda was however also among the first countries where the transition stalled (Bongaerts, 2008; Shapiro and Gebreselassie, 2008; Machiyama, 2010). After dropping substantially in the 1980s, the total fertility rate remained virtually stable between the 1992 Demographic and Health Survey (TFR of 6.2) and the 2005 DHS (TFR of 6.1).[2] Since 2005 however fertility rates have fallen rapidly, from 6.1 in 2005 to 4.6 in 2010, a 25 percent decline.[3] This drop is one of the fastest in the history of the Demographic and Health Surveys and comes during a period of rapid social and economic transitions.[4] Between 2005 and 2010, Rwanda's economy grew at more than 8 percent per annum, poverty headcount fell by 12 percentage points, net enrollment in primary school attained near universal status (99 percent in 2010) and gross secondary school enrollment doubled from 15.9 percent in 2005 to over 32 percent in 2010.[5] Health indicators also improved, witnessed by a drop in the under-five mortality rate from 108 (per 1,000 live births) in 2005 to 60.4 in 2010. At the same time significant shifts were observed in the labor market: Labor force participation increased, particularly among women, and there was a marked increase in wage employment and employment in the nonfarm sector as opposed to traditional farming (World Bank, 2013).

Sharp drops in fertility are important as they usually bode well for economic development. During the transition from a high fertility high mortality society to a low fertility low mortality one, there is a particular period where there is an exceptional bulge of working-age adults. Because fertility is

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[2] Studying the fertility impacts of the genocide, Bruck and Schindler (2011) find a strong positive impact on fertility of having lost children during the genocide. This replacement effect may help explain why fertility remained virtually unchanged between the early 1990s and 2005 despite the dramatic increase in the number of widowed women, which in itself would predict a fall in fertility.

[3] When a more current estimate of fertility is used, based on the last 12 months instead of the last 36 months for the standard TFR, fertility dropped even more – 27 percent (Westoff, 2012).

[4] Using the STATCOMPILER tool on the "measureDHS" website, we found that no other country with more than one DHS survey experienced such a large drop in the total fertility rate over a five-year period.

[5] Data from World Development Indicators, 2012.

falling there are relatively few children. And because mortality rates for the older generations are still high, there are relatively few elders to take care of. The result is a boom in working-age adults and a dramatic decline in the youth dependency ratio, what is called the "demographic dividend" (Bloom et al., 2001). While countries with a high youth dependency ratio are likely to devote substantial resources to children, depressing the pace of economic growth, countries with a boom generation of working-age adults can take advantage of an exceptionally large labor force to dramatically raise output levels. Lower youth dependency ratios are also linked to higher national savings rates, thereby enabling productive investment (Robalino et al., 2013).

Research shows that the economic impacts of the demographic dividend can be substantial: Estimates indicate that population dynamics related to the demographic dividend accounted for up to one-third of the "East Asian Miracle"[6] (Bloom and Willamson, 1998) and explain to a large extent Ireland's economic success in the 1990s (Bloom and Canning, 2003). Focusing on India, Aiyar and Mody (2011) find that falling fertility has spurred the growth acceleration in India since the 1980s and estimate that the demographic dividend will add two percentage points per annum to India's per capita GDP growth over the next two decades. Lower fertility does not only promote economic growth through changes in the age structure of the population. As women have fewer children they are more likely to enter the labor market, adding to the already increased labor supply resulting from the shifts in age structure and spurring income growth (Bloom et al, 2009). Since the opportunity cost of having extra children is higher when women participate in the labor market, employed women typically choose to have fewer children, leading to a virtuous circle of falling fertility and wealth creation. When families have fewer children, they also tend to invest more in the education their children (Becker, Murphy et al., 1990; Galor, 2006) and save more, pushing up the savings rate and facilitating productive investment (Bloom et al., 2003).

[6] The "East Asian Miracle" refers to the extraordinary growth experienced by many East Asian countries between 1965 and 1990-see World Bank (1993).

Lower fertility also produces benefits at the household level. Joshi and Schultz (2007) and Schultz (2009) study the effects of a long-run randomized family planning intervention in Bangladesh and find that the reduced fertility caused by the intervention (which amounted to approximately one child per woman) had significant and persistent positive impacts on women's health, earnings and their households' assets. In addition, children born in the treatment areas completed on average more years of schooling and were less likely to die before age five. Examining the expansion of a family planning organization in Colombia, Miller (2010) finds that family planning allowed women to postpone their first birth and reduce lifetime fertility, and that the ability to postpone the first birth enabled women to obtain more education and be independent later in life.

Given the potentially large economic payoffs from falling fertility, it is important to know what causes fertility to fall in the first place. This paper examines the sharp drop in fertility in Rwanda between 2005 and 2010 using data from two successive DHS cross sections. In a first step, we examine whether the drop in fertility is more related to the evolution of social and economic conditions simultaneously affecting women of all ages (so-called period effects) or to the shared socializing experiences of different cohorts (cohort effects). Using the hierarchical age-period-cohort (HAPC) method developed by Yang and Land (2006), we find that the decline in fertility has mainly been driven by cohort effects, with younger cohorts of women having significantly fewer children after controlling for the effects of age and period. These cohort effects are important as they represent the essence of social change and hint at further fertility reductions in the decade to come. In a second step, we decompose the change in fertility between 2005 and 2010 into a part that can be explained by changes in exogenous covariates and an unexplained part. We find that the drop in fertility for young women can to a large extent be explained by changes in covariates, most notably the sharp increase in educational attainment observed since 2005 and improving living standards at the household level. For older women the drop in fertility remains largely unexplained, though the explained part is in large part due to rising education levels. As a purely correlational finding, the analysis shows that the transition from farm to non-farm employment currently underway in Rwanda has been associated with falling fertility.

This paper proceeds as follows: The next section summarizes the determinants of fertility while Section 3 explains the data and presents the estimation methods. Section 4 summarizes the descriptive statistics. The main analysis is presented in Section 5. As usual, the final section concludes.

2. Determinants of Fertility

The determinants of fertility in Sub-Saharan Africa have been extensively studied. Although the data and methods used in many studies do not always allow causal attribution, a number of factors are robustly associated with fertility. In the economic theory of fertility, female education is a key determinant of fertility by raising the opportunity value of women's time and hence the opportunity cost of children (Mincer, 1963; Becker, 1981). This hypothesized negative relation between female education and fertility has been empirically confirmed by many studies and is one of the most robust associations in demography (see, for instance, Ainsworth et al, 1996; Schultz, 1998; Benefo and Schulz, 1996; Osili and Long, 2008; Cochrane, 1979). By itself, changes in women's schooling account for the largest share of the drop in total fertility rates in Africa since the 1980s (Schultz, 1994). Female education influences fertility not only through greater opportunity cost of child rearing but also through several other channels (Schultz, 2001). Educated women have better knowledge of contraception and its effective use, which reduces the risk of unwanted pregnancies. Child mortality rates also tend to be lower for educated mothers, reducing the need to produce more children to end up with a desired number of surviving children. Educated women are also more likely to enter the labor market, further increasing the opportunity value of their time.

Women's economic conditions are also expected to affect their demand for children. In theory, the impact can go both ways: According to Becker (1960), as long as children are non-inferior goods, an increase in income should increase both the quantity and quality of children, with the quantity elasticity however being small. However, since the price of children is time, children are more expensive for women with higher incomes who have a higher opportunity value of time, which would result in a negative relation between income and fertility. Empirically, the relationship between income and fertility is negative for most countries at most times (Jones at al., 2008). Given that income is largely a function of labor market participation, and labor market participation is jointly determined with fertility, income is endogenous in the study of fertility. As a result, women's economic conditions should be measured by variables that are not a function of women's labor force participation, such as inherited nonhuman capital assets or exogenous transfers (Benefo and Schultz, 1996).

The availability of family planning services may also affect fertility levels. In the US, introduction of family planning programs have been shown to drive down fertility rates (see for instance Anderson and Cope, 1987; Mellor, 1998). In the developing world, declines in fertility rates have also been linked to the roll-out of family planning programs (Bongaerts et al., 1990; Angeles et al., 2005). Family planning can however not be treated as exogenous, as women who wish to limit their fertility are more likely to actively seek family planning services, introducing a spurious negative relationship between demand for family planning services and fertility. In Canning and Schultz's (2012) study of the Matlab experiment however, random introduction of family planning programs did significantly lower fertility.

A main hypothesis in the demographic literature is that high child mortality induces parents to have many children in order to be left with the desired number of children. In this fashion, a decrease in child mortality would contribute to parents wanting fewer children, driving down fertility, and vice versa. The empirical specification of the relationship between child mortality and fertility is however complicated by the two-way causality: While high child mortality may increase fertility due to parents' anticipation of child deaths, high levels of fertility may increase child mortality due to the strain on household resources and the biological capacity of the woman to bear healthy children (Benefo and

Schultz, 1996). Empirical studies have consistently shown that lower child mortality is associated with lower fertility but have not been uniformly successful in addressing the endogeneity challenge. Convincingly addressing the joint determination of child mortality and fertility typically requires longitudinal data (see for instance Hossain et al., 2007). Since the goal of this paper is to examine to what extent reasonably exogenous transitions have affected fertility decline in Rwanda, we will not focus on the role of child mortality. We acknowledge that part of the impact of the exogenous factors on fertility runs through their effect on child mortality (in particular better female education and improved household living standards). The data at hand however do not allow for convincing identification of the exogenous effects of child mortality.

3. Data and Estimation Methods

3.1 Data

We use data from the 2005 and 2010 Rwanda Demographic and Health Survey (RDHS). Both surveys used a two-stage sampling design, first selecting enumeration areas (clusters) with probability proportional to size and then systematically selecting households within each cluster. The 2005 RDHS selected 462 clusters and 10,644 households, 10,272 of which were effectively interviewed. All women aged 15 to 49 years in the 10,272 interviewed households were eligible for the woman questionnaire. Of the 11,539 eligible women 11,321 women completed the survey. These 11,321 women form our 2005 sample. The 2010 RDHS sampled 492 clusters in the first stage and 12,792 households in the second stage. 12,540 households were effectively interviewed, resulting in a total of 13,790 eligible women. 13,691 women completed the survey and form our 2010 sample. In both the 2005 and 2010 RDHS every second household was eligible for the male interview. Overall, 4,820 men were surveyed in the 2005 RDHS and 6,329 in the 2010 RDHS.

3.2 Estimation Methods

To examine whether the drop in fertility is driven by period or cohort effects we apply the Age Period Cohort (APC) model. APC models have been widely used in sociological and demographic research to identify the net effect of each of the three time-related factors (age, period and cohort) on a certain time-specific phenomenon of interest (see, for instance, Ryder, 1965; Feinberg and Mason, 1985). APC models allow to distinguish three types of time-related variation in fertility (Yang and Land, 2006): age effects, or the natural age-variation in fertility (older women have more children), period effects, or variation over time that affects all age groups simultaneously (such as general social and economic development or shifts in cultural attitudes) and cohort-effects, associated with changes across groups of individuals who experienced birth during the same time-interval. Cohort effects may arise from successive cohorts having different formative experiences in successive time periods (Robertson, Gandini and Boyle, 1999). Cohort effects are particularly important as they are considered the essence of social change (Ryder, 1965): the effects of exposure in early life to social, economic and behavioral factors and environments that persist over the lifetime to produce differences in outcomes between successive cohorts.

The identification problem in the estimation of APC models, resulting from the exact linear dependency between age, period and birth cohort (*period=age + cohort*), has traditionally been overcome by using the constrained generalized linear model (CGLIM) estimator or, more recently, the intrinsic estimator (for overviews, consult Fienberg and Mason (1978; 1985) and Fu (2000)). When repeated cross sections are available and the exact age of respondents is known, rather than the age in five-year intervals, the linear dependency is broken. For those cases, Yang and Land (2006) propose a mixed models approach to APC analysis, which they label the cross-classified random effects APC model (or hierarchical APC model). This model takes account of the multi-level structure of the data, in which respondents (women) are members simultaneously in cohorts and periods (that is, they are cross-classified).[7] For the APC analysis we specify following model:

Level 1 Within-Cell model:

$$Fertility_{ijk} = \beta_{0jk} + \beta_1 Age_{ijk} + e_{ijk} \quad (1)$$

Level 2 Between-Cell model:

$$\beta_{0jk} = \propto_0 + u_{0j} + v_{0k} \quad (2)$$

Combined Model

$$Fertility_{ijk} = \propto_0 + \beta_1 Age_{ijk} + u_{0j} + v_{0k} + e_{ijk} \quad (3)$$

where *i* denotes woman *i* within cohort *j* and period *k*, *j* denotes cohort (*j*=8) and *k* denotes period (*k*=2). In our model, within each birth cohort and period, woman i's fertility is modeled as a function of only her age.[8] $\propto_0$ is the grand mean, or mean cumulative fertility for all women in all cohorts during both periods, u_{0j} is the cohort random effect, or the contribution cohort *j* to fertility averaged over both periods, and v_{0k} is the period random effect or the contribution of period *k* to fertility averaged over all cohorts.

In a second step of the analysis, we will decompose the change in fertility between 2005 and 2010 using the Oaxaca-Blinder decomposition, a technique well-known in labor economics. The Oaxaca-Blinder decomposition decomposes changes in the mean of a variable into a part that can be explained by changes in the means of explanatory variables and a part that is left unexplained (or explained by changes in coefficients). In our case, we will decompose the change in mean cumulative fertility between 2005 and 2010 in a part explained by changes in the means of underlying exogenous drivers of fertility and an unexplained part. In technical terms:

[7] Failing to account for the multi-level structure of the data and estimating fixed effects on the pooled sample would violate the independence of errors assumption due to the likely correlation between error terms within cohorts and time periods, leading to deflated standard errors.

[8] The model could include other fixed effects that influence fertility, such as education and economic status. The goal however is the conduct a pure APC analysis. The impact of other covariates will be assessed in the next step of the analysis.

$$Fertility_{2010} - Fertility_{2005} = (X_{2010} - X_{2005})\beta_{pooled} + X_{2010}(\beta_{2010} - \beta_{pooled}) + X_{2005}(\beta_{pooled} - \beta_{2005}) \quad (4)$$

Where $(X_{2010} - X_{2005})\beta_{pooled}$ is the explained part, the part of the change in fertility that can be explained by the change in underlying explanatory variables between 2005 and 2010 ($(X_{2010} - X_{2005})$), and $X_{2010}(\beta_{2010} - \beta_{pooled}) + X_{2005}(\beta_{pooled} - \beta_{2005})$ is the unexplained part, the part of the fertility change due to the change in coefficients β. X_{2010} is a vector of explanatory variables in 2010, X_{2005} is the same in 2005, β_{2010} are the 2010 coefficients, β_{2005} the 2005 coefficients and β_{pooled} the coefficient of the pooled sample.[9] The explained part of the fertility change can further be decomposed in the contribution of each single covariate. This detailed decomposition will be carried out in the analysis.

In the decomposition analysis we will only include explanatory variables that can reasonably be considered exogenous. Proximate determinants of fertility such as marital status, use of contraception, age at first marriage and age at first birth are jointly determined with fertility and are not included in the analysis (for a similar approach, see for instance Ainsworth et al., 1996).[10] Child mortality has consistently been shown to be related to fertility but is not included in the analysis due to the obvious two-way causality.[11] In addition, a substantial part of the impact of child mortality on fertility operates through the effects of female education and household living standards on lowering child mortality (Schultz, 1994). As female education and household living standards will be included in the analysis, these variables will partly control for the impact of decreased child mortality. Next to female

[9] Performing the decomposition using the estimated coefficients from the pooled sample (β_{pooled}) risks inappropriately transferring some of the unexplained part of the difference to the explained part. To avoid this, we will include a group indicator (dummy for survey period) in the pooled model (Jann, 2008).
[10] Westoff (2012) focuses on the role of increased contraception use in Rwanda's recent fertility transition.
[11] In their study on the determinants of fertility in Cote d'Ivoire and Ghana, Benefo and Schultz (1996) fail to reject the null hypothesis of exogeneity of child mortality. Their identifying instruments (community health infrastructure and disease problems) are however relatively weak in explaining variation in child mortality and are likely to be correlated with fertility itself.

education and household living standards, other explanatory variables included in the decomposition are age of the women, exposure to mass media (to control for the potential exposure to family planning messages), and age and education of the household head (in most cases this is the husband of the respondent). Although women's participation in the labor market is endogenous to fertility, we will nevertheless include it in some specifications to explore the extent to which increased labor force participation among women (especially in nonfarm activities) has been associated with the fertility decline.

4. Descriptive Statistics

Table 1 shows the evolution of cumulative fertility, the number of children born per woman at the time of the surveys, by age defined in five-year intervals. Overall the average number of children born per woman dropped from 2.68 in 2005 to 2.42 in 2010, a 10 percent decrease significant at the 1 percent level. Except for the youngest women (women of 15 to 19 years old) where there was a small (0.01 children) though statistically significant increase in cumulative fertility, fertility dropped in each age-group between 2005 and 2010. Women in each age-group thus had fewer children in 2010 than women of the same age-group in 2005. In relative terms, the drop in fertility between 2005 and 2010 was higher for the younger women (decrease of 19 percent for the 20-24 age-group and 20 percent for the 25-29 age-group) than for the older women (decrease of 6 percent in the 30-34 age group and 5 percent in the 35-39 age-group). The cohort effects in the fertility decline are reflected in Figure 1. Each line in Figure 1 follows one specific cohort between 2005 and 2010. Observed at the same age (the "break" between two consecutive lines), women from younger cohorts consistently have fewer children than women from the next cohort (the endpoint of each line is lower than the beginning point of the next line). Next to the cohort-effects, we observe large age effects, with older women having more children.

Table 2 summarizes the evolution of possible determinants and correlates of fertility between 2005 and 2010. We also include proximate determinants, although they will not be included in the actual analysis for reasons of endogeneity. The first important thing to note in Table 2 is that there is no difference in average age of sampled women between 2005 (28.3 years) and 2010 (28.4 years). This is important because of the life-cycle effect of cumulative fertility: If women sampled in 2010 would have been significantly younger than the women sampled in 2005, then the lower cumulative fertility observed in 2010 could just be due to this age-effect instead of a genuine secular drop in fertility. This is however not the case (if any, women are somewhat older in 2010 than in 2005). The figures in Table 2 show an improvement in female education, one of the main determinants of fertility, between 2005 and 2010: The number of years of education completed increased by 0.8 years, the proportion of women that completed primary school (8 years of education in Rwanda) increased by almost 50 percent, 15.4 percent of women were still in school during the 2010 survey compared to nine percent in 2005 and the proportion of women that never went to school dropped from 23.4 percent in 2005 to 15.5 percent in 2010. Female literacy increased to 68.4 percent in 2010 in line with the improved education outcomes. All changes are statistically significant at the 1 percent level. We also observe an increase in educational attainment of household heads between 2005 and 2010: The average number of years of education completed by household heads increased by 0.4 years.

In the standard Mincer-Becker framework, women's participation in the labor market influences fertility decisions by increasing the opportunity cost of having children (Mincer, 1963; Becker, 1981). Women's participation in the labor market increased considerably between 2005 (73.1 percent) and 2010 (83.7 percent). The bulk of working women are engaged in agriculture (83.4 percent in 2005 and 75.9 percent in 2010), but non-agricultural employment is growing fast: the fraction of women with a non-agricultural occupation almost doubled between 2005 (10.6 percent) and 2010 (19 percent), reflecting the more than 500,000 nonfarm jobs that have been created during this period (NISR, 2012).

Since child-rearing is time-consuming and affects women's allocation of time, fertility is considered inversely related to labor force participation, leading to the joint determination of both variables. While labor force participation is clearly endogenous to fertility in modern societies where women actively manage fertility jointly with labor market decisions, it is less convincing for poor agricultural economies where female labor market participation is high as family responsibilities and agricultural work are usually combined (Mammen and Paxson, 2000). In Rwanda, as in many parts of rural Africa, women tend to their daily occupations, which mainly consist of cultivating the family farm or self-employment in small-scale family businesses, while simultaneously taking care of children. In the data used for this paper, women with an above average number of children are not less likely to participate in the labor market than women with a below-average number of children. To the contrary, labor force participation is higher for the former women in both surveys. Similarly, women who gave birth in the year preceding the surveys were not less likely to work than women without birth in the year preceding the surveys. This holds true even within cohorts (women in a certain age-group who gave birth in the year preceding the survey were not less likely to work than women in the same age-group without birth). As a consequence, we will include labor force participation as a determinant of fertility in a certain number of specifications. We will however also present results excluding women's labor force participation to see how estimated coefficients change.

Between 2005 and 2010 Rwanda experienced rapid economic growth and poverty reduction. To explore whether the rapid increase in living standards was associated with the drop in fertility, we construct a household wealth index along the lines proposed by Filmer and Pritchett (2001). The wealth index consists of 22 binary asset indicators containing information about the quality of housing of the household, sources of water and energy, asset holdings, etc.[12] To be able to compare the wealth index over time (the wealth index is standardized), the principal component analysis underlying the

[12] Information about construction of the index available on request.

construction of the index was estimated on the pooled sample. The DHS data reflect the increase in household living standards between 2005 and 2010: The average score on the wealth index increased from -*0.143* in 2005 to *0.219* in 2010 (Table 2).

The remainder of Table 2 shows the proximate determinants of fertility. All proximate determinants moved as to lower fertility. The percentage of women ever in union (which includes marriage and informal forms of cohabitation) decreased by one percentage point, the age at first union increased by half a year and the age at first birth with one-third of a year. Given the importance of marriage (de jure or de facto) for fertility in Rwanda (see for instance Bruck and Schindler, 2011) this has likely been associated with lower fertility through delayed child bearing. The proportion of women without any exposure to mass media (defined as women who have not listened to the radio, watched television or read a newspaper in the week preceding the survey) dropped from 43.6 percent in 2005 to 30.5 percent in 2010. The exposure to mass media is important as it potentially affects fertility through the exposure to education campaigns, information or family planning messages disseminated through mass media. Similarly, exposure to family planning messages increased considerably: In 2005, almost 60 percent of women were not exposed to family planning messages of any kind (media, billboards, brochures, posters,…) in the few months preceding the survey, compared to one third in 2010. Finally, use of modern contraception increased exponentially (but remains low): In 2010, 25 percent of women reported using modern contraception, up from 5.6 percent in 2005.

Table A1 in the Appendix replicates Table 2 but disaggregates by age. We consider three age-groups: Young women (15 to 24 years-old), “middle” women (25 to 34-years-old) and older women (35 to 49-years old). These groups are not chosen at random. All women in the youngest age-group entered their reproductive period after the 1994 genocide during a period of unprecedented social and economic change in Rwanda. The younger women in this group have no active recollection of the genocide and attended primary school after the events when enrolment and completion rates increased rapidly. These developments in the post 1994 era may have affected their fertility. The “middle” group consists of women who were of primary and secondary school age or slightly older during the genocide. For many women in this age-group, schooling was brutally interrupted by the 1994 events. Although schools in Rwanda reopened in late 1994, many parents and children did not want to go back to schools, which had been main scenes of mass slaughter during the genocide. For many of those women education was prematurely and permanently cut short, which may have influenced future economic and fertility outcomes. Finally, the upper age-group consists of women who grew up in the 1970s and 1980s and had completed their education before the genocide.

The first thing to note in Table A1 is that although fertility dropped in each age-group between 2005 and 2010, the drop was relatively stronger for the younger groups: Age-specific cumulative fertility decreased by 16 percent for the youngest age-group, 14 percent for the middle-age group and 9 percent for the oldest age-group. The increase in average educational attainment between 2005 and 2010 is particularly important for the young women and for the older women. In 2005, the average number of years of education completed amounted to 3.9 for young women and 3.1 for older women. In 2010 this had increased to 5.3 and 4.1, respectively. Young women are also staying in school longer: Over 37 percent of young women were still in school during the 2010 survey, up from 20.6 percent during the 2005 survey. The effect of the genocide is reflected in the evolution of education outcomes of the middle age-group: While the average educational attainment of women between the ages of 25 and 34 amounted to 4.7 in 2005 it dropped to 4.5 in 2010. Women who were in this age-bracket during the 2010 survey were born between 1976 and 1985 and had started schooling before the genocide cut it short: Women from this cohort were more likely to have ever been enrolled in school compared to women born five years earlier (witnessed by the lower percentage of women who never went to school in Table A1), but were less likely to have completed primary school and completed on average 0.2 fewer years of education.

The increase in women's labor market participation is also in large part driven by younger cohorts: The proportion of women working increased by 13 percentage points in the youngest age-group, 10 percentage points in the middle group and 7 percentage points in the older group. Young women increasingly engage in non-agricultural activities: The proportion of young women with a non-agricultural occupation more than doubled between 2005 and 2010. Non-agricultural employment increased for other age-groups as well, albeit more modestly. Reflecting the rapid growth and poverty reduction between 2005 and 2010, household living standards, measured by the score on the asset index, increased for all age-groups. The increase in the asset index is fairly uniform across age-groups, though somewhat bigger for the older and middle age-group (0.38 standard deviations) than for the youngest age-group (0.34 standard deviations).

To summarize, cumulative fertility has dropped in each five-year age-group but the youngest between 2005 and 2010. While in absolute terms the decrease in age-specific cumulative fertility was highest for the women in the 40-49 age group, in relative terms the decrease was strongest in the 20-29 age group. The evolution in determinants and proxy determinants of fertility between 2005 and 2010 suggests there are many potential drivers of the observed decline in fertility: Female education levels and labor market participation increased significantly, more women are engaging in non-agricultural income-generating activities and household wealth is increasing. The preliminary descriptives suggest that the drop in fertility is the result of dynamics at both ends of the age distribution. At the young end of the age-distribution, increased levels of education and school continuation and increased participation in especially the non-agricultural labor market are pushing back the age at first union and age at first birth (see Table A1), leading to a decline in cumulative fertility. At the other end, the passing of time from 2005 to 2010 has shed the cohort born in 1956-1960 (oldest cohort in 2005), a cohort characterized by low levels of education (2.2 years on average and median of zero) and high fertility (cumulative fertility of 7), and replaced it with the next one (1961-1965, the oldest cohort in 2010), a cohort with significantly higher levels of education (2.9 years on average and median of 2) and lower levels of fertility (6.37).

5. Empirical Results

The Hierarchical APC Model

Table 3 shows the results of estimating the hierarchical age-period-cohort model specified in equation (3). To allow for diminishing increases in fertility at older age we add a quadratic age term as fixed effect. Needless to say, the coefficient of age is large and strongly statistically significant: Older women have on average given birth to more children. The age-effect on cumulative fertility is only weakly concave: the coefficient on age squared is negative but insignificant in both substantial and statistical terms. There does not seem to be a significant deceleration in fertility as women approach the end of the reproductive period.

Turning to the variance components at the end of Table 3, we find that most of the variation in cumulative fertility is accounted for by the individual-level regressors (age). However, after controlling for age and time-period of the survey, the residual variation between cohorts is still significant and estimated to be *0.461* (standard deviation). This means that net of age and period, there are cohort-specific effects that are systematically related to higher or lower fertility. Figure 2 plots the best linear unbiased predictions of the cohort random effects on the left-hand-side axis. In line with the descriptives presented earlier we find almost monotonically decreasing cohort effects, with more recent cohorts having lower fertility, net of age and period. The estimated coefficients are particularly negative for the cohorts born in 1981 or later. These cohorts entered their reproductive period after the 1994 genocide when Rwanda experienced rapid social and economic development and marked improvements in health, education and living standards. To illustrate, the right-hand-side axis in Figure 2 plots the proportion of women within each cohort who never went to school. The cohort effects broadly follow the evolution in the proportion of women without any schooling: As successive cohorts of women become more educated, the cohort-specific random effect drops and turns negative (though insignificant) at the 1976 cohort. The youngest cohort is an exception, as despite the strong reduction in women who never went to school the cohort-effect on fertility is smaller than for the two previous cohorts (though it stays strongly significant and negative). From Figure 2, it seems obvious that the rising levels of education have contributed to the drop in fertility in Rwanda.

Residual variation in fertility by period is statistically significant but small in comparison to cohort variation (standard deviation of *0.116* for period compared to *0.461* for cohorts). This suggests that the social and economic changes observed between 2005 and 2010 did contribute to driving down fertility but were substantially less important than the cohort effects.[13] In sum, the results presented in Table 3 suggest that the decline in fertility is predominantly due to cohort effects, with younger cohorts systematically having fewer children than the cohorts before, controlling for age of women and time period of the surveys.[14]

Statistical Decompositions

Table 4 examines the drivers of the fertility decline between 2005 and 2010 using the Oaxaca-Blinder decomposition specified in equation (4). The decompositions are based on cross sectional regressions for both the 2005 and the 2010 survey. For reasons of space the regressions are not presented but are available on request. The conditional correlations estimated by both regressions are qualitatively similar: women's education and participation in the labor force, household wealth scores, and women's exposure to mass media are negatively related to fertility, and education of the household head (most often the husband) and age of the woman are positively associated with fertility. Women without exposure to mass media have on average lower fertility, though this is likely due to selection effects.

[13] Using longer (10-year) or shorter (3-year) cohorts instead of the standard 5-year cohorts does not change the results.

[14] In contrast, the fertility declines in the US, Europe and South Korea can largely be explained by period effects (Pullum, 1985; Foster, 1990; Kye, 2012). These studies however span a far greater time period than the five years examined in this paper.

The first column in Table 4 performs the decomposition on the full sample (11,321 women in the 2005 survey and 13,671 women in the 2010 survey) and includes female labor market participation. Overall, about one-third (0.084 of 0.26) of the change in cumulative fertility between 2005 and 2010 can be explained by the changes in covariates. The remainder is left unexplained (or “explained” by changes in coefficients between 2005 and 2010). This mirrors Canning’s (2011) argument that while changes in household-level characteristics do affect fertility, changes in fertility behavior are more like changes in social norms than changes in individual decision-making characteristics. The decomposition results show that the single biggest part of the drop in fertility is due to increased female education levels. The increase in the average number of years of schooling completed accounts for 70 percent of the explained portion of the fertility drop and 22.7 percent of the overall fertility drop. This is in line with Schultz’ (1994) argument that the largest part of the fertility decline in African countries since the 1980s can be explained by changes in women’s schooling. The increase in household living standards, measured by the score on the asset index, emerges as the second main contributor to the fertility decline, accounting for slightly over 15 percent of the fertility decline.

The increased participation of women in the labor market has also been significantly associated with the decrease in average cumulative fertility. The magnitude of the association is however rather modest: The increased proportion of women working explains only 5.4 percent of the overall decline in fertility. This can likely in part be explained by the types of work most women in Rwanda are engaged in (agricultural work on the family farm and employment in household businesses), which are more compatible with family responsibilities than modern non-farm wage employment (Mammen and Paxson, 2000). Contrary to intuition, the decrease in the percentage of women not exposed to mass media is associated with an increase in fertility. This is probably the result of endogeneity. As shown in Table A1, the increase in exposure to mass media was highest among the older women, who also have the highest cumulative fertility. In addition, it is likely that women with a comparatively high number of children actively seek information about family planning and birth control (to minimize the likelihood of having more children) and hence are more likely to be exposed to mass media, driving the spurious correlation between exposure to mass media and fertility. Finally, we find that the increase in educational attainment of household heads (who are mostly men) has been significantly associated with increased fertility, a widely found pattern in empirical studies on fertility in Africa (Schultz, 1997). The size of the association is however small (*0.005*).

The second column of Table 4 disaggregates women's work in two types: agricultural and non-agricultural work. We expect that non-agricultural employment is related more strongly to fertility than traditional farm work through a higher opportunity value of time for women engaged in nonfarm work. This is confirmed empirically: the increased incidence of non-agricultural work has been a lot more important for the fertility decline than agricultural work. While the increased engagement in non-agricultural activities explains over 8 percent of the total drop in fertility, increased agricultural employment explains less than one percent. Even though this does not represent a causal relationship, the progressive shift to non-agricultural employment in Rwanda over the past decade has been strongly associated with the decline in fertility. Improved female education remains the main contributor, accounting for over one-fifth of the total decline in fertility. The increase in household living standards remains the second main contributor, accounting for an additional 12.5 percent.

In the third column of Table 4 we drop the potential endogenous variables (women's labor force participation and exposure to mass media). Results on the key variables do not change much: Improvements in female education still account for slightly over one-fifth of the overall decline in fertility, while improved living standards at the household level explain an additional 14 percent. In this parsimonious model 28 percent of the total decline in fertility is explained by changes in covariates, while the remaining 72 percent is left unexplained.

To examine whether certain evolutions have been more important for particular age-groups than for others, Table 5 presents separate decompositions for the three age-groups used for Table A1 (15 to 24-years-olds, 25 to 34-year-olds and 35 to 49-year-olds). Overall, there is substantial variation across age-groups in the extent to which the change in fertility can be explained by changes in covariates. For the youngest age group (15 to 24), the change in fertility is overexplained by the change in covariates: actual fertility declined by less *(-0.063)* than what would be expected based on the change in covariates *(-0.077)* or, in other words, 122 percent of the change in fertility is explained by the covariates. In contrast, the unexplained part is small and statistically insignificant. This testifies to the rapid pace of social and economic changes between 2005 and 2010, changes that predominately affected the youth (see Table A1). For the middle (25 to 34) and older (35 to 49) age groups, the drop in fertility remains largely unexplained. Changes in covariates between 2005 and 2010 account for 16 percent of the change in fertility for the 25 to 34-year-olds and 20 percent for the 35 to 49-year-olds.

The improvements in female education explain the bulk of the fertility decrease among young women. The average number years of education in this age-group increased by 1.4 between 2005 and 2010, accounting for 65 percent of the overall decline in their fertility (*-0.041* divided by *-0.063*). The improvement in living standards of the households in which young women live accounts for another 20.6 percent of the drop in fertility. Together, the improvements in female education and household living standards explain over 85 percent of the decline in fertility among young women in Rwanda between 2005 and 2010. In contrast to the full-sample results (Table 4), increased exposure to mass media for young women has been associated with a decrease in cumulative fertility: The percentage of young women exposed to mass media on a weekly basis increased by 12.6 percentage points and has been associated with an 8 percent decrease in cumulative fertility. Finally, the increase in the proportion young women with a non-agricultural occupation accounted for 12.6 percent of the drop in fertility.

Although this is not a causal effect, it is clear that the increased availability of nonfarm jobs between 2005 and 2010 has been associated with lower fertility among young women in Rwanda.

The group of women aged 25 to 34 during any of the two surveys presents a special case, as their educational attainment (measured by number of years of schooling completed) actually decreased between 2005 and 2010 (see Table A1). The deterioration in education outcomes has limited the observed decrease in cumulative fertility by positively affecting the explained part of the fertility change (worsening of education outcomes for this age group was associated with higher fertility). The increase in household living standards in this group has driven down fertility, explaining 11 percent of the observed decline. The increase in the proportion of women in this age-group engaged in non-agricultural employment has been weakly associated with the fertility decline, accounting for a mere 1.5 percent of the drop. The increased proportion of women working in agriculture has had the opposite effect, being weakly associated with an increase in fertility. Note that more than 16 percent of the fertility change within this age group between 2005 and 2010 can be explained by the younger average age of the women in this age-group in 2010: While average age in this group amounted to 29.2 in 2005, it amounted to 29.0 in 2010. Since age is strongly related to fertility, this small difference nevertheless explains a considerable part of the lower fertility in 2010. Overall the bulk of the fertility decline for this age-group remains unexplained.

Better educational outcomes in 2010 for the women in the 35-49 age-group explain the largest part of the decline in fertility for this group (22.8 percent). The improvements in household living standards, although the largest of all age-groups, have not been statistically significantly associated with a decrease in fertility. The increased engagement in non-agricultural employment explains slightly over 4 percent of the drop in fertility between 2005 and 2010, while the increased employment in agriculture has been largely unrelated. The increased exposure to mass media for the women in this age group has, in contrary to the youngest age-group, been associated with an increase in cumulative fertility.

The decompositions by age-group presented in Table 5 do not necessarily compare different cohorts of women. Given that the age-intervals are longer than the time span between the two surveys, each of the three age group-specific comparisons in Table 5 contains both a “panel” and a “cross-section” element. For instance, the decomposition for the youngest age-group compares the 1986-1990 cohort in 2005 (at ages 15-19) with the same cohort in 2010 (at ages 20-24), which is the (pseudo) panel element, and compares the 1986-1990 cohort with the 1991-1995 cohort, the cross-section element. To explain the cohort effects observed in Figure 1 and Table 1, we repeat the decompositions for each of the 7 five-year age-groups, comparing each five-year cohort with the previous one. The results are summarized in Appendix Table A2. The first (15 to 19-years-old) and the third (25 to 29 years-old) age-group are the exceptional ones. For the youngest age-group, we would, based on the changes in the covariates, expect a 47.2 percent decrease in fertility between 2005 and 2010. Instead, we observe a 41.7 percent increase. This increase is left fully unexplained. While all key covariates changed in the direction to drive down fertility (more years of education, higher score on the asset index and a higher employment share outside agriculture) fertility increased nonetheless. Future DHS rounds will show whether this increase is genuine/structural or due to chance.[15] The third age-group is an exception in the opposite direction. While the evolution of covariates would predict a slight and statistically insignificant increase in fertility, observed fertility dropped by 20 percent. This age-group observed in 2010 (the 1981-1985 cohort) forms the core of the genocide-cohort for whom education was interrupted by the events. As such, the deterioration in education outcomes for this age group between 2005 and 2010 would predict higher fertility levels in contrast to the actually observed ones.

For the other age groups improvements in education and household living standards from one five-year cohort to the next emerge as the main drivers of the decrease in age-specific cumulative fertility. The increase in female educational attainment accounts for 25 percent of the decrease in

[15] Note however that in absolute terms the increase is small: 0.015 children per woman.

fertility in the 20-24 age-group, 36 percent in the 35-39 age-group, 21 percent in the 40-44 age-group and 19 percent in the 45-49 age-group. It accounts for only 2 percent of the decrease in the 30-34 age-group, not surprising given that the average number of years of education completed is almost the same for the 1976 cohort (4.72) and the 1971 cohort (4.68), most likely owing to the effect of the genocide on education levels of the former cohort. The increase in household living standards from one cohort to the next explains a sizable part of the decline in fertility for younger age-groups (11 percent for the 20-24 age group and 25 percent for the 30-34 age group) but explains only marginal parts of the decrease in older groups (2 percent for the 35-39 group, and between 4 and 5 percent for the 40-44 and 45-49 age-groups).

The increase in the proportion of women with a non-agricultural occupation has in general been associated with a decrease in fertility, though the association is small and not or only weakly statistically significant for most of the age-groups. Only for the 35-39 age-group has increased non-agricultural employment been significantly associated with lower fertility, accounting for 19 percent of the decline in age-specific fertility between 2005 and 2010. In contrast to the full sample results, the increase in the proportion of women working in agriculture has not been associated with lower fertility in any of the seven age-groups.

In sum, the decrease in cumulative fertility from one cohort to the next can largely be explained by increasing female education levels and household living standards. The rising share of women participating in the labor market has also been associated with the fall in fertility, though this effect is rather weak and only true for employment outside agriculture. It is this type of employment that increased substantially between 2005 and 2010 (from 11 percent to 19 percent of all women) while employment in agriculture increased only marginally (from 62 percent to 65 percent).

In the full sample and in most of the five-year age-groups more than half of the fertility decline between 2005 and 2010, and in some age-groups much more, remains unexplained by the change in covariates. In the logic of the Oaxaca-Blinder decomposition method this means that the "fertility returns" of certain characteristics have decreased between 2005 and 2010 (the magnitude of the regression coefficients has changed). Examining the detailed decomposition of the unexplained part of the fertility decline shows that the fertility returns to age have decreased significantly between 2005 and 2010: Observed at similar ages, women in 2010 had significantly fewer births than women in 2005 (coefficient of *-0.711* with z-ratio of *8.96*). As shown by Figure 3, which shows for each five-year age-group the change in fertility due to changing returns to age (the change in the regression coefficient on the age-variable in both cross-sectional regressions), this pattern is mainly driven by the 20-24 and 25-29 age-groups, who in 2010 had statistically significantly lower fertility returns to age than women of the same age observed five years before. This of course corresponds to the strong negative cohort effects for these cohorts observed in Figure 2 and Table 3.

6. Conclusions

After a decade-and-a-half stall, fertility declined sharply in Rwanda between 2005 and 2010. While fertility dropped across all cohorts (except for the youngest cohort), the decline has in relative terms been most pronounced for younger cohorts. Between 2005 and 2010, cumulative fertility declined by 20 percent for the 20 to 29 age-group, compared to 9 percent for the 35 to 49 age-group. We find that conditional on age, cohort effects explain the majority of the decline in fertility, with younger cohorts having substantially fewer children than women of older cohorts observed at the same age. Period effects, while statistically significant, are small compared to cohort effects.

Increased levels of female education explain the largest part of the fertility decline in the full sample, accounting for slightly over one fifth of the drop. Improved household living standards emerge as a secondary driver of the fertility decline. The bulk of the fertility decline in the full sample remains however unexplained by the evolution of the exogenous covariates. Splitting the sample by age shows that while the drop in fertility remains largely unexplained for the older cohorts, it is overexplained for the younger women in the sample (15 to 25-years-old). For this age group, rapidly rising levels of education, improving household living standards and increased employment in nonfarm activities have substantially raised the opportunity value of time, driving down fertility. Improved female education explains two-thirds of the drop in fertility in this age group. At the other extreme of the age distribution, the passing of time between 2005 and 2010 has shed the 1956-1960 cohort, characterized by high fertility and almost no education. This natural phenomenon has lowered average cumulative fertility in the older cohorts.

The fertility decline in Rwanda seems unlikely to stall again. As noted by Schultz (2001), when historically high fertility levels have declined by 10 percent or more they are unlikely to rise again on a sustained basis. The progressive roll out of the 12 years of basic education program is expected to substantially increase the educational attainment of young cohorts, further raising the opportunity cost of children. Together with the progressive move off the farm, this suggests that further declines in fertility can be expected in the decade to come.

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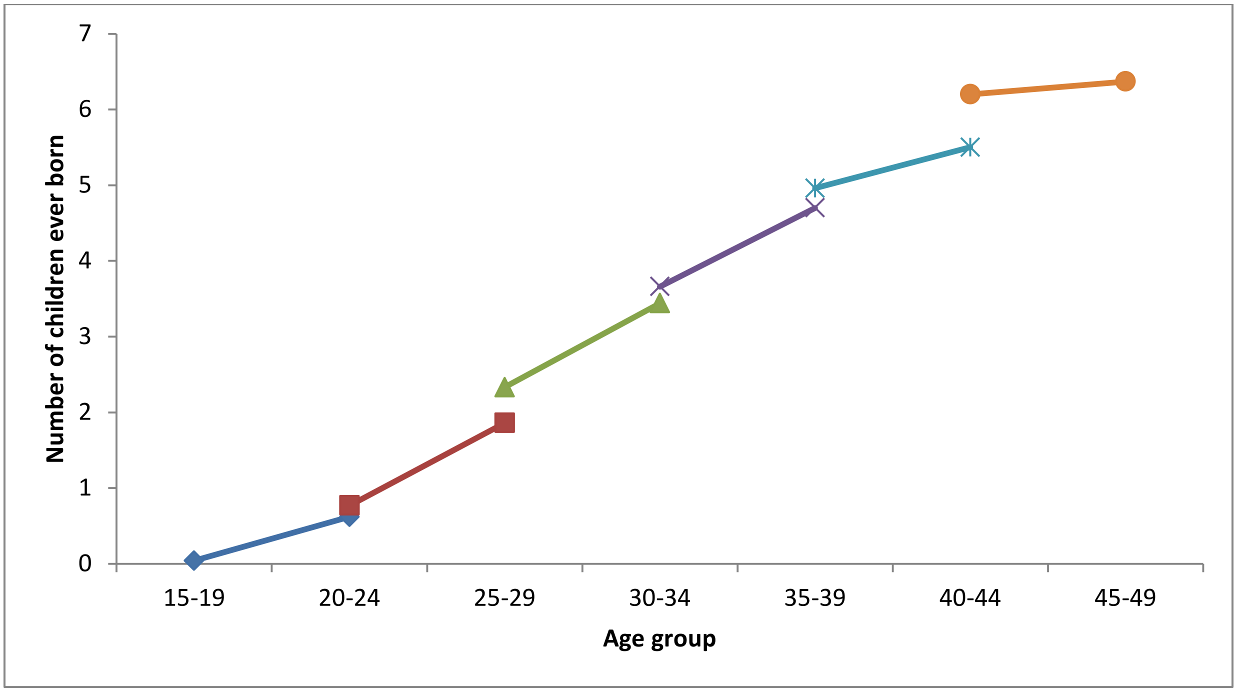
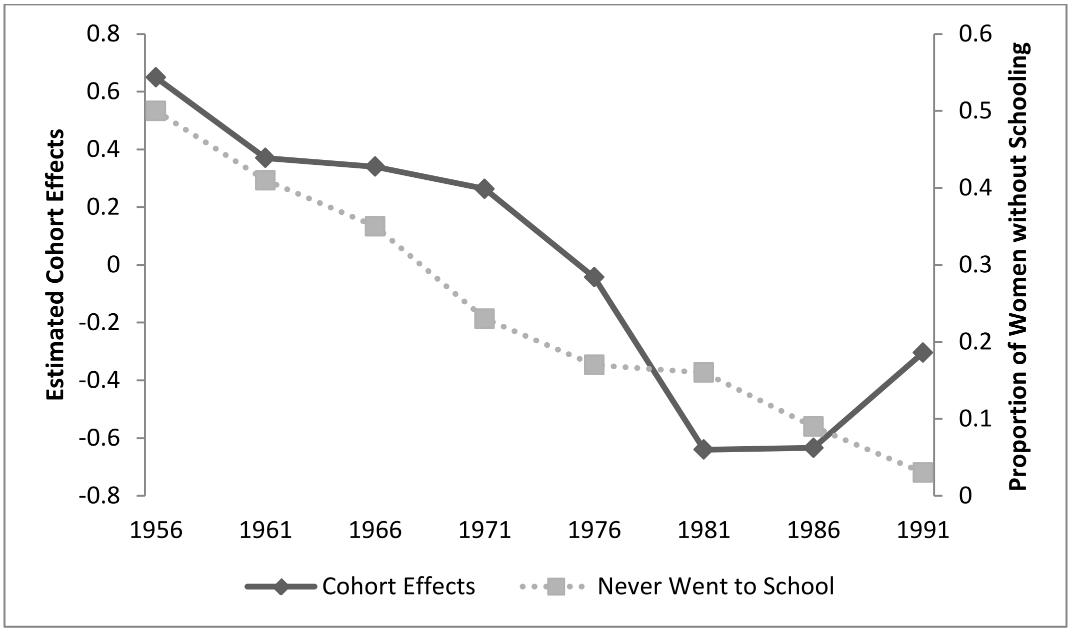
Figure 1: Cumulative Fertility by Cohort, 2005-2010



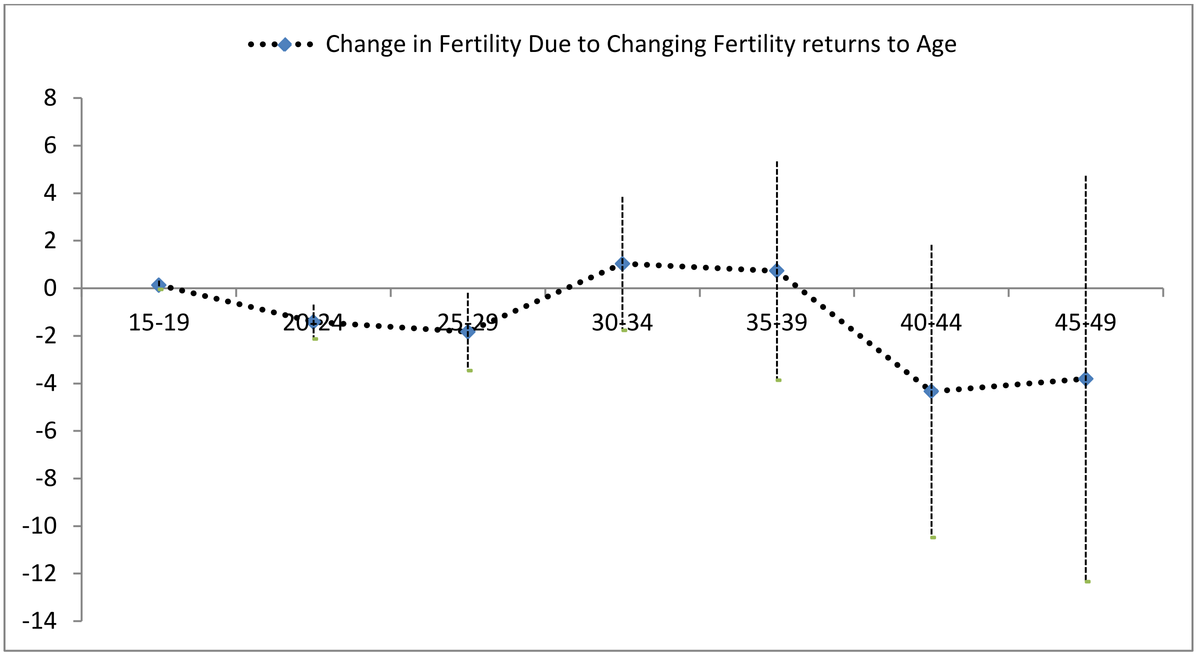
Source: DHS, 2005; 2010. The starting point of each line is the 2005 average for the cohort. The endpoint of each line is the 2010 average for the same cohort (when the women are five years older). Each line tracks a cohort from 2005 to 2010.

Figure 2: Estimated Cohort Effects on Fertility and Proportion of Women without Schooling



Notes: Left vertical axis shows the estimated cohort effects on fertility. Right vertical axis plots the proportion of women without any schooling. Data Source: DHS, 2005; 2010.

Figure 3: Changes in fertility Due to Changes in the Fertility Returns to Age, by Age-Group, 2005-2010



Notes: Whiskers represent the 95% confidence interval for the estimated coefficient. Coefficient is statistically significant for the 20-24 and 25-29 age-groups only. Data Source: DHS, 2005; 2010.

Table 1: Change in Cumulative Fertility by Age-Group, 2005-2010

Age Interval	Number of Children Ever Born		Mean Difference	N
	2005	2010		
15-19	0.04	0.05	0.01***	5,588
20-24	0.77	0.62	-0.15***	5,048
25-29	2.33	1.86	-0.47***	4,240
30-34	3.66	3.44	-0.22***	3,282
35-39	4.96	4.7	-0.26***	2,575
40-44	6.2	5.5	-0.7***	2,282
45-49	7.02	6.37	-0.65***	2,007
Total	**2.68**	**2.42**	**-0.26*** **	
N	11,321	13,671		24,992

Source: DHS, 2005; 2010. ***: Statistically significant at the 1% level.

Table 2: Determinants and Correlates of Fertility, 2005-2010

	2005	2010	Mean Difference
Cumulative Fertility	2.68	2.42	-0.26***
	[0.028]	[0.023]	[0.036]
Age	28.34	28.41	0.07
	[0.092]	[0.082]	[0.123]
Ever Given Birth (% Yes)	0.626	0.627	0.001
	[0.005]	[0.004]	[0.006]
Number of Years of Education	3.9	4.73	0.83***
	[0.033]	[0.032]	[0.047]
Completed Primary (% Yes)	0.131	0.19	0.059***
	[0.003]	[0.003]	[0.005]
Still In School (& Yes)	0.09	0.154	0.064***
	[0.003]	[0.003]	[0.004]
Never Went to School (% Yes)	0.234	0.155	-0.079***
	[0.004]	[0.003]	[0.005]
Literate (% Yes)	0.591	0.684	0.093***
	[0.005]	[0.004]	[0.006]
Number of Years of Education Household Head	3.57	3.95	0.38***
	[0.035]	[0.032]	[0.047]
Woman Works (% Yes)	0.731	0.837	0.106***
	[0.004]	[0.003]	[0.005]
Has Non-Agricultural Occupation (% Yes)	0.106	0.19	0.084***
	[0.003]	[0.003]	[0.005]
Has Agricultural Occupation (% Yes)	0.624	0.647	0.023***
	[0.005]	[0.004]	[0.006]
Household Wealth (Asset Index)	-0.143	0.219	0.362***
	[0.010]	[0.009]	[0.014]
Ever in Union (% Yes)	0.623	0.613	-0.01
	[0.005]	[0.004]	[0.006]
Age at First Union	19.99	20.5	0.51***
	[0.041]	[0.040]	[0.057]
Age at First Birth	21.13	21.45	0.32***
	[0.040]	[0.038]	[0.055]
No Exposure to Mass Media (%)	0.436	0.305	-0.131***
	[0.005]	[0.004]	[0.006]
No Exposure to Family Planning Messages (%)	0.589	0.334	-0.255***
	[0.005]	[0.004]	[0.006]
Currently Using Modern Contraception (% Yes)	0.056	0.252	0.196***
	[0.002]	[0.004]	[0.005]
N	11,321	13,671	

Notes: “No exposure to mass media” defined as not listening to the radio, not watching television and not reading newspapers at least once a week. “No exposure to family planning messages” defined as not having seen, heard or read any family planning information in the past few months (preceding the survey). Data source: DHS, 2005; 2010. ***: Statistically significant at the 1% level. All observations weighted by women’s individual sample weight.

Table 3: Hierarchical Age Period Cohort Model of Fertility

Fixed Effects	Coefficient	se	t-Ratio
Intercept	2.71***	0.186	14.58
Age	0.196***	0.006	30.66
Age Squared	-0.0001	0.0002	-0.57
Random Effects	Coefficient	se	t-Ratio
Cohort			
1956	0.649	0.090	7.21
1961	0.37	0.080	4.63
1966	0.34	0.080	4.25
1971	0.263	0.078	3.37
1976	-0.043	0.078	-0.55
1981	-0.64	0.076	-8.42
1986	-0.634	0.076	-8.34
1991	-0.304	0.079	-3.85
Period			
2005	0.089	0.074	1.20
2010	-0.089	0.074	-1.20
Variance Components	Std. Dev.	se	p value
Cohort	0.461***	0.143	0.00
Period	0.116***	0.074	0.00
Individual	1.623***	0.007	0.00

Notes: Cross-classified random effects estimation of fertility. P values for variance components are based on likelihood ratio tests. Data source: DHS, 2005; 2010. ***: Statistically significant at the 1% level. All observations weighted by women's individual sample weight.

Table 4: Oaxaca-Blinder Decomposition of the Difference in Fertility between 2005 and 2010

	(1)	(2)	(3)
Cumulative Fertility 2005 survey	2.68	2.68	2.68
Cumulative Fertility 2010 survey	2.42	2.42	2.42
Difference between 2010 and 2005	-0.26***	-0.26***	-0.26***
	[0.036]	[0.036]	[0.036]
Explained by Covariates	-0.084***	-0.084***	-0.073**
	[0.029]	[0.029]	[0.029]
Unexplained (changes in coefficients)	-0.183***	-0.182***	-0.193***
	[0.022]	[0.022]	[0.022]
Explained Part:			
Age of Woman	0.014	0.014	0.014
	[0.029]	[0.029]	[0.029]
Education (number of years)	-0.059***	-0.057***	-0.057***
	[0.004]	[0.004]	[0.004]
Woman Works (1 if Yes)	-0.014***		
	[0.003]		
Agricultural Employment (1 if Yes)		-0.002**	
		[0.001]	
Non-Agricultural Employment (1 if Yes)		-0.021***	
		[0.003]	
Household Asset Index	-0.040***	-0.033***	-0.037***
	[0.004]	[0.004]	[0.004]
Age of Household Head	0.002	0.002	0.002
	[0.002]	[0.002]	[0.002]
Education Household Head (number of years)	0.005***	0.005***	0.005***
	[0.001]	[0.001]	[0.001]
Woman Exposed to Mass Media (1 if Yes)	0.008***	0.008**	
	[0.003]	[0.003]	
N	24,992	24,992	24,992
N 2005	11,321	11,321	11,321
N 2010	13,671	13,671	13,671

Notes: Only explained part of the decomposition is shown. Robust standard errors in brackets. Data source: DHS, 2005; 2010. ***: Statistically significant at the 1% level. **: Statistically significant at the 5% level All observations weighted by women's individual sample weight.

Table 5: Oaxaca-Blinder Decomposition of the Difference in Fertility between 2005 and 2010 for Different Age-Groups

Age-Group	15-24	25-34	35-49
Cumulative Fertility 2005 survey	0.387	2.938	5.993
Cumulative Fertility 2010 survey	0.324	2.531	5.445
Difference in Fertility between 2010 and 2005	-0.063***	-0.407***	-0.548***
	[0.015]	[0.044]	[0.065]
Percentage Difference in Fertility	*-16.3*	*-13.8*	*-9.1*
Explained by Covariates	-0.077***	-0.065**	-0.11***
	[0.009]	[0.026]	[0.028]
Unexplained (changes in coefficients)	0.014	-0.342***	-0.438***
	[0.013]	[0.039]	[0.063]
Explained Part:			
Age of Woman	-0.002	-0.067***	-0.003
	[0.006]	[0.020]	[0.019]
Education (number of years)	-0.041***	0.016**	-0.125***
	[0.003]	[0.007]	[0.016]
Agricultural Employment (1 if Yes)	0	0.005	0.002
	[0]	[0.003]	[0.002]
Non-Agricultural Employment (1 if Yes)	-0.008***	-0.006*	-0.024***
	[0.002]	[0.004]	[0.008]
Household Asset Index	-0.013***	-0.044***	-0.021
	[0.002]	[0.009]	[0.016]
Age of Household Head	-0.008**	0.025***	-0.004
	[0.004]	[0.009]	[0.004]
Education Household Head (number of years)	0	0	0.027***
	[0.001]	[0.001]	[0.008]
Woman Exposed to Mass Media (1 if Yes)	-0.005***	0.005	0.038***
	[0.002]	[0.005]	[0.011]
N	10,606	7,522	6,864
N 2005	4,951	3,205	3,165
N 2010	5,655	4,317	3,699

Notes: Only explained part of the decomposition is shown. Robust standard errors in brackets. Data source: DHS, 2005; 2010.
***: Statistically significant at the 1% level. **: Statistically significant at the 5% level; *: Statistically significant at the 10% level
All observations weighted by women's individual sample weight.

Appendix

Table A1: Determinants and Correlates of Fertility by Age-Group, 2005-2010

	Women 15-24			Women 25-34			Women 35-49		
	2005	2010	Mean Difference	2005	2010	Mean Difference	2005	2010	Mean Difference
Cumulative Fertility	0.387	0.324	-0.063***	2.938	2.531	-0.407***	5.993	5.445	-0.548***
Age (Years)	19.32	19.3	-0.02	29.2	28.98	-0.22***	41.5	41.49	-0.01
Ever Given Birth (% Yes)	0.235	0.229	-0.006	0.884	0.854	-0.03***	0.972	0.964	-0.008*
Number of Years of Education	3.91	5.33	1.42***	4.72	4.51	-0.21**	3.06	4.06	1.00***
Completed Primary (% Yes)	0.089	0.233	0.144***	0.12	0.119	-0.001	0.127	0.209	0.082***
Still In School (& Yes)	0.206	0.374	0.168***	0	0	0	0	0	0
Never Went to School (% Yes)	0.128	0.061	-0.067***	0.209	0.15	-0.059***	0.422	0.303	-0.119***
Literate (% Yes)	0.65	0.775	0.125***	0.652	0.68	0.028**	0.438	0.552	0.114***
Number of Years of Education Household Head	3.43	3.82	0.39***	4.23	4.24	0.01	3.14	3.79	0.65***
Woman Works (% Yes)	0.608	0.734	0.126***	0.803	0.904	0.101***	0.848	0.916	0.068***
Woman Has Non-Agricultural Occupation (% Yes)	0.11	0.243	0.133***	0.123	0.173	0.05***	0.083	0.129	0.046***
Household Wealth (Asset Index)	-0.055	0.286	0.341***	-0.16	0.217	0.377***	-0.261	0.122	0.383***
Ever in Union (% Yes)	0.238	0.215	-0.023***	0.876	0.836	-0.04***	0.968	0.957	-0.011**
Age at First Union (Years)	18.63	19.19	0.56***	20.1	20.69	0.59***	20.42	20.76	0.34***
Age at First Birth (Years)	19.3	19.56	0.26***	21.13	21.55	0.42***	21.81	22.02	0.21**
No Exposure to Mass Media (%)	0.4	0.274	-0.126***	0.433	0.318	-0.115***	0.493	0.335	-0.158***
No Exposure to Family Planning Messages (%)	0.626	0.364	-0.262***	0.54	0.31	-0.23***	0.582	0.317	-0.265***
Currently Using Modern Contraception (% Yes)	0.021	0.098	0.077***	0.095	0.405	0.31***	0.073	0.307	0.234***
N	4,951	5,655		3,205	4,317		3,165	3,699	

Notes: "No exposure to mass media" defined as not listening to the radio, not watching television and not reading newspapers at least once a week. "No exposure to family planning messages" defined as not having seen, heard or read any family planning information in the past few months (preceding the survey). Data source: DHS, 2005; 2010. ***: Statistically significant at the 1% level; **: Statistically significant at the 5% level; *: Statistically significant at the 10% level. All observations weighted by women's individual sample weight.

Table A2: Oaxaca-Blinder Decomposition of the Difference in Fertility between 2005 and 2010 by Five-Year Age-Group

Age-Group	15-19	20-24	25-29	30-34	35-39	40-44	44-49
Cumulative Fertility 2005 survey	0.036	0.773	2.331	3.659	4.961	6.2	7.022
Cumulative Fertility 2010 survey	0.051	0.623	1.865	3.443	4.696	5.497	6.365
Difference between 2010 and 2005	0.015***	-0.15***	-0.466***	-0.216***	-0.265***	-0.703***	-0.657***
	[0.006]	[0.027]	[0.048]	[0.068]	[0.093]	[0.111]	[0.124]
Percentage Change in Fertility	*41.7*	*-19.4*	*-20*	*-5.9*	*-5.3*	*-11.3*	*-9.4*
Explained by Covariates	-0.017***	-0.081***	0.002	-0.037	-0.114***	-0.118***	-0.038
	[0.003]	[0.029]	[0.025]	[0.030]	[0.035]	[0.039]	[0.044]
Unexplained (changes in coefficients)	0.033***	-0.069***	-0.467***	-0.179***	-0.151*	-0.583***	-0.619***
	[0.007]	[0.024]	[0.046]	[0.066]	[0.091]	[0.114]	[0.126]
Explained Part:							
Age of Woman	-0.001	0.003	0.004	-0.035**	0.007	0	0.034**
	[0.001]	[0.008]	[0.013]	[0.015]	[0.012]	[0.013]	[0.014]
Education (number of years)	-0.010***	-0.037***	0.025***	-0.005	-0.095***	-0.151***	-0.122***
	[0.003]	[0.005]	[0.008]	[0.014]	[0.022]	[0.032]	[0.031]
Agricultural Employment (1 if Yes)	0	0	0.009**	0.002	-0.006	0.001	0.005
	[0]	[0.00]	[0.004]	[0.004]	[0.006]	[0.002]	[0.007]
Non-Agricultural Employment (1 if Yes)	-0.001	-0.007*	-0.005	-0.006	-0.051***	-0.017	0.002
	[0.001]	[0.004]	[0.004]	[0.006]	[0.016]	[0.010]	[0.015]
Household Asset Index	-0.001	-0.017***	-0.037***	-0.053***	-0.006	-0.033	-0.025
	[0.001]	[0.004]	[0.009]	[0.016]	[0.021]	[0.033]	[0.034]
Age of Household Head	-0.001*	-0.014***	0.012	0.037***	-0.003	-0.011	0
	[0.001]	[0.009]	[0.013]	[0.012]	[0.010]	[0.008]	[0.002]
Education Household Head (number of years)	-0.001*	0	-0.002	0.007	0.017	0.045**	0.017
	[0.001]	[0.001]	[0.002]	[0.004]	[0.012]	[0.019]	[0.011]
Woman Exposed to Mass Media (1 if Yes)	0	-0.009***	-0.004	0.018**	0.023*	0.048**	0.05**
	[0.001]	[0.004]	[0.005]	[0.008]	[0.013]	[0.021]	[0.024]
N	5,558	5,048	4,240	3,282	2,575	2,282	2,007
N 2005	2,595	2,356	1,745	1,460	1,133	1,127	905
N 2010	2,963	2,692	2,495	1,822	1,442	1,155	1,102

Notes: Only explained part of the decomposition is shown. Robust standard errors in brackets. Data source: DHS, 2005; 2010. ***: Statistically significant at the 1% level. **: Statistically significant at the 5% level; *: Statistically significant at the 10% level All observations weighted by women's individual sample weight.