THE PENNSYLVANIA STATE UNIVERSITY
SCHREYER HONORS COLLEGE

DEPARTMENT OF ECONOMICS

FERTILITY TRANSITION AND STALLING IN THE FACE OF SOCIOECONOMIC PROGRESS AND HIV/AIDS IN SUB-SAHARAN AFRICA

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Spring 2010

A thesis
submitted in partial fulfillment
of the requirements
for baccalaureate degrees
in International Politics and Economics
with honors in Economics

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ABSTRACT

Fertility transition, a phenomenon of lowering fertility rates after significant socioeconomic progress, is of great concern to sub-Saharan Africa as a means of curbing dramatic increases in population in the region. Many sub-Saharan African countries are experiencing fertility stalling, however, meaning the total fertility rate (TFR) in these countries is failing to decrease and may be increasing once again. This paper addresses the stalling exclusive to sub-Saharan Africa and attempts to find key socioeconomic, economic, and cultural explanations that may lead to solutions for reinitiating fertility decline in sub-Saharan Africa.

Past literature has motivated three approaches to research in this field. First, the paper will examine fertility transition and stalling based on socioeconomic development indicators using data from the Demographic and Health Surveys (DHS). Through the use of multivariate regression analyses at the national, urban/rural, and regional levels, this section will determine socioeconomic factors that influence changes in fertility decline between consecutive DHS surveys in order to better understand how to reinitiate fertility decline in stalling areas.

The second approach will address a specific issue to sub-Saharan Africa that may explain its unique fertility trends—the HIV/AIDS pandemic. Although the exact impact of HIV/AIDS on fertility and fertility decisions is yet unknown in the current literature, this section uses a multivariate regression analysis to link adult HIV prevalence to changes in fertility.

The third approach will use a recent 2008 Ghana DHS survey to conduct a case study of fertility at the individual level in this country. Ghana used to be experiencing stalling fertility, but as of the 2008 DHS survey, fertility decline has resumed in this region. This section will explore women's age, education level, ethnicity, and type of residence to find possible influences on the number of children ever born per woman.

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ACKNOWLEDGEMENTS

This thesis was a monumental task and one that could not have been completed without the support and guidance of several key individuals.

First and foremost, I owe the vast majority of my success to my teacher, advisor, and mentor, Dr. David Shapiro, who has both guided and inspired me over the past four years. He is the one who first sparked my interest in the subject matter as well as empirical work in general. His support has taken me further than I ever thought was possible for an undergraduate (to Morocco, and even back!), and without him, I would not be the diligent researcher I am today.

Many thanks are also due to Bee-Yan Roberts for her comments as my second faculty reader. She is the professor who initiated my love for economics and my interest in the growth and development field. I am also grateful to my colleagues in the Economics Department honors program for adding a dozen other pairs of eyes to the tedious review process. Finally, thanks to my family for seeing me through this momentous stage in my academic journey. If it were not for them, I would have never had the drive to accomplish such a great task.

I.

Fertility transition is a demographic trend describing the way in which a country experiences significant declines in fertility, often accompanied by socioeconomic growth and development. Between the early 1960s and the late 1980s, the total fertility rate (TFR) of the developing world declined by an estimated 36 percent—from 6.0 to 3.8 births per woman (United Nations, 1995). By the late 1980s and early 1990s, a vast majority of developing countries were experiencing fertility transition, sometimes bringing fertility rates at or close to replacement level of two children born per woman (usually around 2.1 children per woman to account for mortality). There was great variation in fertility decline across the subregions of the developing world, however. While some sub-Saharan African countries have reported the same fertility transition as other subregions of the developing world, most observed a delayed start to fertility transition. Researchers have also concluded that countries in sub-Saharan Africa also tend to experience lower rates of fertility decline relative to the rest of the developing world (Bongaarts, 2008; Kreider et al., 2009). Also, a handful of sub-Saharan African countries are currently seeing fertility stalling, meaning that their fertility rates fail to decrease whatsoever and may begin to increase. This phenomenon in fertility is currently unique to sub-Saharan Africa. Although there have been instances of fertility stalling elsewhere in the developing world, fertility decline has eventually resumed in all of these cases.

According to the medium variant of the most recent United Nations Population Division projections, almost all of the subregions of the developing world will complete

fertility transition by the years 2025-30, reaching TFRs at or below 2.2 (United Nations, 2007). Sub-Saharan Africa is one of two subregions that are excluded from this optimistic projection. Based on UN projections, TFRs in sub-Saharan Africa will still be around 3.5 children born per woman in the time period from 2025-30. Many demographers attribute this future divide to the generally slower rates of socioeconomic progress in sub-Saharan Africa as compared to other subregions of the developing world. Simultaneous low development and relatively high incidence of stalling fertility beg the question—Does socioeconomic progress[1] affect the fertility experiences of developing countries? And if so, could improvements in socioeconomic factors effectively lower the TFR of sub-Saharan Africa to the same replacement level projections as the rest of the developing world?

Along with low growth and development relative to the rest of the developing world, sub-Saharan Africa faces a unique issue pertaining to its fertility discussion—HIV/AIDS. The United Nations (2007) reported that life expectancy in sub-Saharan Africa has declined specifically due to the spreading AIDS pandemic, while the rest of the developing world has recently been enjoying rapid improvements in longevity. The impact of HIV/AIDS on fertility includes effects among the infected (biological and behavioral mechanisms), among the uninfected (behavioral mechanisms), and at the population level (compositional effects). Do lower life expectancy and an increased need for eldercare due to the AIDS pandemic prompt a higher demand for fertility in sub-

[1] Socioeconomic progress, as used here, is defined as social and economic development in a society. This is generally measured using indicators such as GDP, life expectancy, mortality, and education (to name a few).

Saharan Africa relative to the rest of the developing world? Given that fertility stalling is currently unique to sub-Saharan Africa, could HIV/AIDS play a crucial role in fertility stalling?

The answers to these questions are essential when considering future trends in population growth and size in sub-Saharan Africa as well as the region's future wellbeing. Even after accounting for the large negative impact of the AIDS pandemic on future population size, the UN's medium variant projects that the population of sub-Saharan Africa will more than double in size between 2005 and 2050, from 769 million to 1.76 billion. The high variant predicts an even higher population of 2.02 billion by the year 2050 (assuming a slightly higher ultimate TFR of 3.0 instead of the 2.5 births per woman of the medium variant) (United Nations, 2007). If these projections are realized, there will likely be serious adverse effects on the region's social and economic development, food security, and the sustainability of natural resources (Alexandratos, 2005).

While the situation may seem dire, it could yet be reversible. This thesis will expand upon the research of demographers and economists alike who have studied the possible linkages between fertility and socioeconomic progress in the past. It will also integrate HIV/AIDS into the fertility discussion of sub-Saharan Africa, a connection that has been referenced in a general sense in others' research but has rarely been analyzed empirically before. By finding specific socioeconomic indicators that may affect the fertility decisions of sub-Saharan African people, even in the face of HIV/AIDS, it is

possible that improvements in socioeconomic progress may guide sub-Saharan Africa's fertility transition to replacement levels.

This paper will address these questions about the future of fertility transition in sub-Saharan Africa in a variety of ways. The first section will give a brief summary of the past literature reviewing fertility transition by examining the roles that socioeconomic development and HIV/AIDS have played in explaining fertility transition in the past. This background provides the inspiration for the data analysis conducted in the second section, which aims to explain changes in fertility based on socioeconomic indicators at national, urban/rural, and regional levels of analysis. The third section highlights the unique impact that HIV/AIDS may have on fertility decisions in sub-Saharan Africa and discusses the implications of such an impact on the future of fertility transition in the region. The final substantive section examines a case study of Ghana, the only sub-Saharan country to have resumed fertility decline after experiencing stalling. This study uses individual data from a recent 2008 Ghana DHS survey to regress children ever born per woman dependent upon ethnicity, women's age, women's level of schooling, and type of residence to examine what factors may be necessary in order for fertility decline to resume in sub-Saharan Africa after a stall. These three areas of analysis will help to ultimately determine the cause of prolonged fertility stalling in sub-Saharan Africa, as well as the measures needed for fertility transition to continue in the future.

II.
Background

A Review of Socioeconomic Development's Impact on Fertility

Since the study of fertility transition began, there has been much controversy as to the role that socioeconomic development plays in fertility decisions. Researchers debate as to how social and economic changes affect reproductive behavior and what conditions are necessary for a causal relationship linking socioeconomic progress to fertility decline. The following is an overview of the varying theories in regards to socioeconomic development's possible impact on fertility in the developing world.

The first of the theories is the classical demographic transition theory, formulated by Notestein (1953). According to Notestein, fertility is initially high in traditional agricultural societies in order to compensate for high mortality rates. As a society improves through socioeconomic development methods such as industrialization, urbanization, education and advancements in health, mortality rates begin to decline and fertility decisions change accordingly. Higher child survival rates, along with rising cost and declining economic value of children, are the fundamental motivation for fertility transition. Families, in turn, begin to demand birth control to reduce fertility to a lower desired family size.

Easterlin then advanced the classical demographic transition theory into his economic supply-demand analysis of fertility. According to Easterlin (1975), fertility decisions are controlled by the conventional economic concept of consumer behavior in

which couples weigh the costs and benefits of each additional child and choose their optimal family size accordingly. The cost analysis includes the marginal benefit of each additional child, the financial demands of raising said child, as well as the cost of limiting fertility instead. Changes in fertility are then based upon determinants working through three categories: the demand for children (the number of surviving children that couples would have if fertility regulation were costless), the potential output of children (the number of surviving children that parents would have if they did not limit fertility), and the costs of fertility regulation (both the psychic costs caused by displeasure in the use of fertility control and the market costs describing the time and money necessary to learn about and use specific techniques). Through these three outlets, it is easy to see how socioeconomic progress could impact changes in fertility. Increases in income, prices, and tastes would influence demand, whereas natural fertility and infant/children mortality would affect the potential output of children. Cultural views of fertility regulation and access to family planning programs would change the costs of fertility regulation.

Upon testing the classical demographic transition theory, Coale and Watkins (1986) and Watkins (1987) both discovered that socioeconomic conditions only partially explained fertility declines and transitions began at varying levels of development. They also observed that once a particular region of a country had begun a decline, neighboring regions with common language or cultural elements followed after short delays, regardless of their level of development. According to these studies, diffusion and social interaction are key factors needed in order for socioeconomic development to impact fertility rates. These processes dictate that a necessary condition for fertility transition is

the spreading of fertility regulation acceptance through common language and cultural values. Social interaction refers to how a community's collective attitudes towards fertility regulation affect the fertility decisions of an individual, while diffusion spreads new ideas about fertility regulation among individuals and societies. According to the theory of diffusion and social interactions, socioeconomic development will not affect fertility until it becomes socially acceptable for couples to seek family planning measures.

Finally, a combination of these theories is revolutionized by Bongaarts (2002), who says that perhaps both classical demographic transition and diffusion/social interaction processes play a role in fertility decisions in the face of socioeconomic progress. He concludes that diffusion and social interaction are crucial in the initial stages of fertility transition in order to overcome traditional resistance to regulation methods. Once fertility transition approaches later phases, however, changes in fertility seem to be more affected by improvements in socioeconomic development. Bongaarts and Watkins (1996) expand upon this theory by stating that not only does improved socioeconomic development affect fertility decline but that the initial level of socioeconomic development determines the extent to which increased development will lower fertility. Their study combines the initial level of socioeconomic development with the years since the beginning of transition in the region and finds that this pair of variables is highly predictive of transition status. The pattern of onsets of transitions they find suggests a moving threshold model, in which "the first countries to begin sustained fertility decline within a region do so only after relatively high level of development have

been attained" (Bongaarts and Watkins, 1996, 652). The initial level of socioeconomic development for fertility transition to take place in subsequent countries in the region gradually falls and the probability of entering transition rises over time. Despite the success of this intuition, Bongaarts and Watkins (1996) fail to confirm the same type of moving threshold in sub-Saharan Africa, presumably due to the small number of transitions that have occurred in the region. It may be too early in sub-Saharan Africa's fertility transition history to determine a socioeconomic development threshold and a declining trend in this threshold over time.

Additional factors may also play a partial role in explaining fertility patterns in sub-Saharan Africa. One of these is the possible existence of a time trend in which the influence of socioeconomic development on fertility changes over time. Bongaarts and Watkins (1996) find that the effect a country's level of development had on fertility decline was much greater in 1985-90 than in 1960-65. A country with a human development index (HDI) of 0.7 would tend to have a TFR of below 4 births per woman in the late 1980s, while this same level of development would be associated with a TFR of over 6 births per woman in the early 1960s. This trend in fertility patterns over time could also indicate an increase in the availability of organized family planning programs over time.

Another important aspect of sub-Saharan Africa that could explain why its fertility experiences have been so different from the rest of the developing world is the HIV/AIDS pandemic, which will be analyzed further in the following section.

The Role of the AIDS Pandemic in Fertility Decisions

Although HIV/AIDS affects many different facets of fertility in sub-Saharan Africa, causation could run in either direction—HIV/AIDS could affect fertility intentions and outcomes, and fertility could increase the risk of HIV/AIDS. The following is a discussion of the effects of HIV/AIDS on desired fertility and natural fertility with possible linkages between the AIDS pandemic and the stalling of fertility.

The easiest effect of HIV/AIDS to measure empirically is the biological impact of persons infected with HIV on collective fertility rates. Zaba and Gregson (1998) compile evidence from six African studies ranging from the early to mid-1990s and conclude that overall fertility among HIV-positive women is biologically 25-40 percent lower than that of HIV-negative women. Research literature tends to agree that HIV-positive status does not lead to noticeable behavioral changes in fertility, largely due to the fact that only a minority of seropositive people in developing countries know that they are infected.

Behavioral effects seem more common among the uninfected segment of the population (including those who perceive themselves as uninfected). While these effects may play a substantial role in fertility transition, they tend to be much more difficult to study empirically. Caldwell et al. (1999) speculate that behavioral adjustment due to the risk of HIV/AIDS may be a key component in the beginning of fertility transition in many sub-Saharan African countries, although more recent reports by Caldwell (1999, 2000) seem far less confident of this. In fact, in some cases such as Nigeria, Caldwell et al. (1999) fear that the AIDS pandemic may actually contribute to stalling fertility by

slowing mortality decline and reinforcing perceptions that mortality risks are high. On the other hand, some believe that fertility decisions may be fairly robust to HIV/AIDS altogether due to existing cultural norms that dictate decision-making power based on generation and gender (Rutenberg et al., 2000).

Along with possible behavioral effects due to the fear of the pandemic itself, there may be changes in fertility in an attempt to cope with the aftermath of HIV/AIDS. For example, the increased number of orphans due to the pandemic has caused some adults to intentionally lower their own fertility as they assume the role of guardian to near kin or neighboring children (Rutenberg et al., 2000).

The effect of the AIDS pandemic on fertility decisions can also affect future fertility in a cyclical manner. Changes in sexual behavior and increases in contraceptive use to guard against HIV/AIDS today can slow the spread of the pandemic. This will gradually lower the proportion of seropositive women in the population thereby lessening the impact of their biological response to AIDS on aggregate fertility. With the future of fertility transition resting upon the effects of HIV/AIDS on fertility decisions today, it is important to try to integrate this component into empirical analyses despite its difficulty to measure.

III.
Methodology

Multivariate Regressions and Selection of Variables

The data analysis section will approach the question of fertility transition and stalling as many experts in the field have in the past—through the use of multivariate regressions of TFR. These regressions were conducted using data from the Demographic and Health Surveys (DHS).[2] The MEASURE DHS project is funded by the U.S. Agency for International Development (USAID) in order to provide technical assistance in over 85 countries and has conducted more than 240 surveys in order to advance "global understanding of health and population trends in developing countries" (*About DHS,* 2007).

In the multivariate regressions estimated here, decline in the TFR was dependent variable regressed with several socioeconomic and economic indicators as the explanatory variables: increases in the percentage of women with no schooling, increases in the percentage of women with at least secondary education, growth in the percentage of women using modern contraception, increases in the infant and child mortality rate, and percentage growth in GDP per capita over five years. These changes were observed between all consecutive DHS surveys for every sub-Saharan African country for which there are two or more surveys. This equation was estimated at the national, urban/rural, and regional levels.

[2] Data for growth in GDP per capita gathered from the Penn World Table 6.2, found at http://pwt.econ.upenn.edu/php_site/pwt62/pwt62_form.php.

For each level of analysis, three different equations were estimated. The first equation incorporates the socioeconomic and economic variables listed above as well as the time trend variable. The second equation adds a variable that measures the initial level of the TFR at the time of the earlier survey year. Although at the national level, there is little difference between the two equations, the addition of the initial level of the TFR affects the regressions at the urban/rural and regional levels, hence its inclusion at each level. The third equation uses the same variables as the first two equations, but also includes variables measuring the initial level of the socioeconomic indicators.[3] This method reflects the theory proposed by Bongaarts and Watkins (1996) that the level of socioeconomic development affects the extent to which socioeconomic improvement lowers fertility.[4]

The first two explanatory variables, increases in the percentage of women with no schooling and in the percentage of women with secondary or higher education, consider a possible link between changes in fertility and the educational attainment of women of reproductive age (denoted here as women ages 15-49). An extensive body of research supports the concept that fertility is inversely related to women's education (see Jejeebhoy, 1995; Rutstein, 2002; Shapiro and Gebreselassie, 2008; Kreider et al., 2009).

[3] A variable measuring the initial level of GDP per capita is omitted here. The use of such a variable measuring GDP per capita at the first year of the five year span was explored, but never yielded statistically significant results and often drastically decreased the significance of the other variables. This may be due to the method used to measure GDP per capita being from a different source than the DHS survey data or the three-year lag may not capture the relevant initial level of GDP per capita. For the sake of reaching explainable conclusions for the other variables, the initial level of GDP per capita is not included.

[4] There were no attempts made here to estimate the time since the beginning of regional transition because of the previous difficulty that Bongaarts and Watkins (1996) encountered in doing so. Perhaps in a few years, more precise estimations of a moving threshold for sub-Saharan Africa will be possible.

The current trend in development is towards greater educational attainment of women (Schultz, 1993) by increasing the percentage of women with secondary or higher education and reducing the percentage of women with no schooling, both of which should contribute in lowering fertility.

Another socioeconomic factor pertaining to fertility behavior is mortality. According to Easterlin (1975), views on changes in mortality can influence observed fertility because of the perceived supply of children and its impact on fertility control. For this analysis, the infant and child mortality rate (designated as $5q_0$ in the DHS data) was selected because of its past success in previous works (see Shapiro and Gebreselassie, 2008; Kreider et al., 2009). Out of the 25 countries in this analysis, 10 have experienced increases in the infant and child mortality rate, including the two mid-transition stall countries, two of the five early-transition stall countries, and six of the 16 countries in which fertility has been declining. While increases in mortality are fairly common, their incidence seems to be relatively greater among stalling countries. This would indicate that declines in mortality could be associated with declining fertility.

Like previous research, this paper uses a lagged measure of changes in infant and child mortality. Past literature has determined that a lag of 0-14 years in $5q_0$ yielded the equation with the greatest explanatory power (Shapiro and Gebrelassie, 2008; Kreider et al., 2009), so this is also the lag used in this paper[5]. The theory behind the use of a

[5] DHS surveys provide estimates of infant and child mortality by five-year periods dating back as far as 20-24 years prior to the survey. For the lag of 0-14 years used here, the values of $5q_0$ for 0-4, 5-9, and 10-14 years prior to the survey were averaged.

lagged variable is that it allows time for actual changes in infant and child mortality to be accurately perceived and acted upon by the general population in regards to fertility.

This paper also examines growth in GDP per capita in relation to fertility decline. In the past, fertility transition has generally been accompanied by sustained economic growth. Although, there is some literature suggesting that economic difficulties experienced by sub-Saharan African countries during the 1980s and 1990s may have caused crisis-led fertility declines in which drastic decreases in economic well-being would encourage decreased fertility (Lesthaeghe, 1989; National Research Council, 1993), this measure of economic growth is inversely related to the magnitude of fertility decline for the sample countries as a whole. Similar to the mortality variable, there is a lag assigned to the GDP per capita measurements used here. Earlier research done by Shapiro and Gebreselassie (2008) and Kreider et al. (2009) has found that a 3-8 year lag of GDP growth yielded the highest explanatory power of changes in fertility, so the same has been used here. Since fertility is measured for the three years preceding the survey, a 3-8 year lagged GDP per capita growth variable measures the change in GDP per capita for the five years preceding the period during which fertility is measured. Again, this gives some additional time for changes in economic growth to be realized by the general public and to affect fertility decisions.

As mentioned earlier, there is also a time trend variable to capture any systematic changes in the pace of fertility declines over time. This variable reflects past findings by Bongaarts and Watkins (1996) and Bongaarts (2002) that fertility transition originally required relatively high levels of socioeconomic development. Now, diffusion and social

interaction processes allow fertility decline to occur at progressively lower levels of socioeconomic development once neighboring countries or regions have begun transitioning. The time trend variable will also reveal any temporal changes in other variables that influence the pace of fertility decline.

Difficulties in Fertility Transition Analysis

Along with varying theories for the propellants of fertility transition, the term itself is a source of some debate. Throughout the research on the topic, different demographers and economists use different definitions of fertility transition for their analyses, which can have a significant impact on their reported results.

Bongaarts' original definition of fertility transition from his 2002 paper will be used throughout this analysis, which denotes a country as stalling if it fails to see a decline in fertility between the two most recent DHS surveys. This presents some key differences with his 2008 paper, which defines fertility stalling as a country that fails to see a significant decline in fertility. Using his 2008 definition, Bongaarts designates Cote d'Ivoire, Ethiopia, Nigeria, Zambia, and Zimbabwe as sub-Saharan African countries with stalling fertility, whereas his 2002 definition used here denotes all of these countries as declining. Due to the inclusion of two more recent surveys (Benin 2006 and Uganda 2006), this paper also designates Benin as stalling while Bongaarts does not and Uganda as declining while Bongaarts considers it to be stalling.

There are also variations in defining the stages of fertility transition. This paper uses past fertility estimates provided by the United Nations Population Division (2007) in order to define a pre-transitional country as one for which the TFR has not declined at least 10 percent from some existing historical peak. In contrast, Bongaarts defines a pre-transitional country as one for which the "contraceptive prevalence among married women is 10 percent or less" (2008, 109). Such differences in definitions can, again, yield varying results. Using the former definition, Mail and Niger are considered to be pre-transitional here, whereas Bongaarts classifies Chad, Guinea, and Mali as pre-transitional.

While conclusions can still be made about major trends in fertility transition, it is important to note these key differences in definitions when doing cross-study analyses. Differing classifications of a handful of stalling v. non-stalling countries may contribute to major differences in results from one study to the next, including the results in this set of multivariate analyses. Although it may be cumbersome to navigate the variations in analysis framework, the field is making some important advances in empirical research that should still be acknowledged.

IV. Data Analysis

An Overview of Fertility in Sub-Saharan Africa

In previous work, Kreider et al. (2009) determined that the only stalling of fertility transition is currently concentrated in sub-Saharan Africa. Despite previously high fertility levels and some intermittent periods of stalling, other regions of the developing world (including Asia, North Africa, Latin America and the Caribbean) have experienced continued fertility transition over the past few decades, in some cases bringing fertility rates down to replacement level. This study will therefore focus on sub-Saharan Africa in an attempt to determine differences between countries within this region that may contribute to fertility transition and, more specifically, the stalling of fertility transition.

The following table shows TFRs at the national level as well as a distinction between urban and rural fertility rates for all of the sub-Saharan African countries for which there have been multiple Demographic and Health Surveys (DHS). The rightmost column shows the current fertility trend for each country, determined by changes in TFRs between the two most recent surveys for each country. Again, a country is classified as stalling if it experienced a non-decreasing or zero change in national TFR between the two most recent surveys. These specifications are identical to those made by Kreider et al. (2009).

Table 1. Total Fertility Rates, National, Urban, and Rural, and Trend: Countries with Multiple DHS Surveys

Country (Year of Survey)	TFR			Trend
	National	Urban	Rural	
Benin 1996	6	4.9	6.7	
Benin 2001	5.6	4.4	6.4	
Benin 2006	5.7	4.9	6.3	early-transition stall
Burkina Faso 1992/93	6.5	4.6	7	
Burkina Faso 1998/99	6.4	3.9	6.9	
Burkina Faso 2003	5.9	3.4	6.5	decline
Cameroon 1991	5.8	5.2	6.3	
Cameroon 1998	4.8	3.8	5.4	
Cameroon 2004	5	4	6.1	mid-transition stall
Chad 1996/97	6.4	5.9	6.5	
Chad 2004	6.3	5.7	6.5	decline
Cote d'Ivoire 1994	5.3	4.4	6	
Cote d'Ivoire 1998/99	5.2	4	6	decline
Eritrea 1995	6.1	4.2	7	
Eritrea 2002	4.8	3.5	5.7	decline
Ethiopia 2000	5.5	3	6	
Ethiopia 2005	5.4	2.4	6	decline
Ghana 1988	6.4	5.3	7	
Ghana 1993	5.2	3.7	6	
Ghana 1998	4.4	3	5.3	
Ghana 2003	4.4	3.1	5.6	
Ghana 2008	4.0	3.1	4.9	decline
Guinea 1992	5.67	5.18	5.89	
Guinea 1999	5.5	4.4	6.1	
Guinea 2005	5.7	4.4	6.3	early-transition stall
Kenya 1989	6.7	4.5	7.1	
Kenya 1993	5.4	3.4	5.8	
Kenya 1998	4.7	3.1	5.2	
Kenya 2003	4.9	3.3	5.4	mid-transition stall
Liberia 1986	6.7	6	7.1	
Liberia 2007	5.2	3.8	6.2	decline
Madagascar 1992	6.1	3.8	6.7	
Madagascar 1997	6	4.2	6.7	
Madagascar 2003/2004	5.2	3.7	5.7	decline
Malawi 1992	6.7	5.5	6.9	
Malawi 2000	6.3	4.5	6.7	
Malawi 2004	6	4.2	6.4	decline

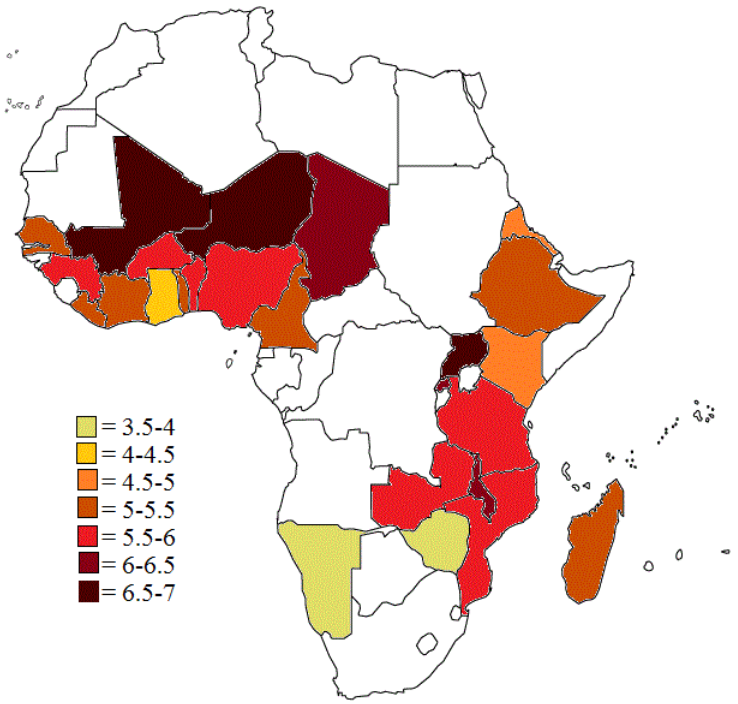
Mali 1987	7.1	6.3	7.4	
Mali 1995/96	6.7	5.4	7.3	
Mali 2001	6.8	5.5	7.3	
Mali 2006	6.6	5.4	7.2	pre-transition
Mozambique 1997	5.2	4.6	5.3	
Mozambique 2003	5.5	4.4	6.1	early-transition stall
Namibia 1992	5.4	4	6.3	
Namibia 2000	4.2	3.1	5.1	
Namibia 2006/2007	3.6	2.8	4.3	decline
Niger 1992	7	6.4	7.1	
Niger 1998	7.2	5.6	7.6	
Niger 2006	7	6.1	7.3	pre-transition
Nigeria 1990	6	5	6.3	
Nigeria 2003	5.7	4.9	6.1	Decline
Rwanda 1992	6.2	4.5	6.3	
Rwanda 2000	5.8	5.2	5.9	
Rwanda 2005	6.1	4.9	6.3	early-transition stall
Senegal 1986	6.4	5.4	7.1	
Senegal 1992/93	6	5.1	6.7	
Senegal 1997	5.7	4.3	6.7	
Senegal 2005	5.3	4.1	6.4	Decline
Tanzania 1992	6.2	5.1	6.6	
Tanzania 1996	5.8	4.1	6.3	
Tanzania 1999	5.6	3.2	6.5	
Tanzania 2004	5.7	3.6	6.5	early-transition stall
Togo 1988	6.4	4.9	7.3	
Togo 1998	5.2	3.2	6.3	Decline
Uganda 1988	7.4	5.7	7.6	
Uganda 1995	6.9	5	7.2	
Uganda 2000/01	6.9	4	7.4	
Uganda 2006	6.7	4.4	7.1	Decline
Zambia 1992	6.5	5.8	7.1	
Zambia 1996	6.1	5.1	6.9	
Zambia 2001/02	5.9	4.3	6.9	Decline
Zimbabwe 1988	5.4	3.8	6.2	
Zimbabwe 1994	4.3	3.1	4.9	
Zimbabwe 1999	4	3	4.6	
Zimbabwe 2005/06	3.8	2.6	4.6	Decline

According to these criteria, seven out of the 25 countries in this study are experiencing a stalling of fertility. Out of these seven, five countries are categorized as experiencing early-transition stalls, defined as a stall occurring before a country's TFR has fallen below five. These early-transition stall countries include Benin, Guinea, Mozambique, Rwanda, and Tanzania. Any other stalling activity occurring when a country's TFR is above replacement level is considered a mid-transition stall, meaning that Cameroon and Kenya are experiencing mid-transition stalls.[6] Two countries, Mali and Niger, are classified as pre-transitional due to high TFRs with no significant fertility decline.

The following map shows the 25 sub-Saharan African countries in this study, categorized by the TFR level of their most recent DHS surveys. Although it is difficult to compare national TFRs to one another (each country's most recent DHS survey is not from the same year), a bit of a pattern emerges in which adjacent countries tend to have similar TFR levels. This could contribute to the diffusion and social interaction theory that Coale and Watkins (1986) described in which fertility transition spreads throughout a region based on similar culture, language, and acceptance of fertility control.

[6] DHS is in the process of releasing a Kenya 2008/2009 survey that reports a national TFR of 4.6, down from 4.9 in 2003 (Starkey, Feb. 2010). While this may imply that its mid-transition stall is reversing, the results of this survey were not included due to the full survey not yet being available on the DHS website at the time of this paper.

Figure 1: TFR level at most recent DHS survey by country



Multivariate Regression Analyses of Fertility with Socioeconomic Development Indicators

Several multivariate regressions were estimated using the socioeconomic development indicators discussed in the previous section. Again, the dependent variable measures the decline in the TFR between surveys, meaning a negative number indicates stalling of fertility decline. All of the explanatory variables, aside from the time trend and the initial level of the total fertility rate, represent positive changes in the indicators measured.

Table 2-1. Regression Analysis of the Decline in the TFR Between Consecutive Surveys National Data

Variable	**1**	**2**	**3**
Increase in percentage of women with no schooling	-.019	-.018	-.0082
Increase in percentage of women with at least secondary education	.016*	.016*	.014*
Growth in the percentage of women using modern contraception	.0056	.0059	.0059
Increase in the infant and child mortality rate[a]	-.0079**	-.0079**	-.011**
Percentage growth in GDP per capita over 5 years (3-year lag)	-.0046	-.0036	-.0032
Time Trend	-.057**	-.056**	-.036**
Initial total fertility rate	--	.011	.34**
Initial percentage of women with no schooling	--	--	.0037
Initial percentage of women with at least secondary education	--	--	.0039
Initial percentage of women using modern contraception	--	--	-.00049
Initial infant and child mortality rate	--	--	-.0070**
Intercept	.72**	.64	-.54
R-squared	.641	.641	.841
Adjusted R-squared	.587	.576	.791
F-ratio	11.88**	9.94**	16.85**
N	47	47	47

a The infant and child mortality rate for the period 0-14 years prior to the survey was used.

** Significant at the .01 level.
* Significant at the .05 level.
+ Significant at the .10 level.

At the national level, an increase in the percentage of women with at least secondary education is significantly associated with fertility decline, as previous literature indicated. Although the coefficient for the growth in the percentage of women with no schooling is not significant at this level of analysis, it becomes significantly negative at the urban/rural and regional levels, which is consistent with the idea that improvements in women's education have a positive effect on fertility decline. Increases

in the infant and child mortality rate are strongly significantly associated with decreases in the magnitude of fertility decline, meaning that decreases in infant and child mortality contribute to fertility transition.

The coefficient for the time trend is negative and highly significant, indicating that as time passes, there is a tendency for declines in fertility to lessen in magnitude all else being equal. The percentage of women with no schooling, the growth in the percentage of women using modern contraception, and the percentage growth in GDP per capita over five years are not significant in these two equations. These national level equations account for just under sixty percent of the variance in fertility decline using the adjusted R-squared values and include 47 observations.

When the initial levels of socioeconomic development are added in the third equation, the coefficient for the initial level of the TFR becomes highly significantly and positively associated with the decline in TFR. Although most of the initial level variables are not significant, the initial level of the infant and child mortality rate is negatively and significantly associated with fertility decline, meaning that the higher the initial infant and child mortality rate, the smaller the fertility decline. The third equation also has higher explanatory power, capturing around 80 percent of the variance in fertility decline.

The following table depicts the regression results for the same equations at the urban/rural level.

Table 2-2. Regression Analysis of the Decline in the TFR Between Consecutive Surveys Urban/Rural Data

Variable	**1**	**2**	**3**
Increase in percentage of women with no schooling	-.029**	-.029**	-.022*
Increase in percentage of women with at least secondary education	.015*	.016*	.0091^{+}
Growth in the percentage of women using modern contraception	.019*	.019*	.022*
Increase in the infant and child mortality rate[a]	-.0047*	-.0033	-.0072**
Percentage growth in GDP per capita over 5 years (3-year lag)	-.0040^{+}	-.0036	-.0050*
Time Trend	-.053**	-.046**	-.032**
Initial total fertility rate	--	.11^{+}	.31**
Initial percentage of women with no schooling	--	--	.0028
Initial percentage of women with at least secondary education	--	--	-.0041
Initial percentage of women using modern contraception	--	--	.0067
Initial infant and child mortality rate	--	--	-.0064**
Urban dummy variable	--	.32*	.48**
Intercept	.65**	-.16	-.62
R-squared	.517	.546	.678
Adjusted R-squared	.483	.503	.631
F-ratio	15.50**	12.76**	14.24**
N	94	94	94

a The infant and child mortality rate for the period 0-14 years prior to the survey was used.

** Significant at the .01 level.
* Significant at the .05 level.
$^{+}$ Significant at the .10 level.

Table 2-2 shows the results for two multivariate regressions at the urban and rural level, doubling the number of observations seen at the national level. An urban dummy variable (coded 1 if the observation was from an urban area and 0 otherwise) is included

in the second equation in order to reflect any changes in fertility decline dependent on whether the survey participants lived in an urban area or a rural area. If the urban dummy is associated with fertility decline, this would be consistent with previous work by Kreider et al. (2009) suggesting that when fertility transition begins, it tends to start in the urban regions of a country and gradually disseminates to rural areas as the transition progresses. Since most of the sub-Saharan African countries that are experiencing fertility decline are in earlier stages of transition than the majority of the developing world, it is understandable that observations from urban areas would see greater declines in fertility as a reflection of these earlier stages of transition.

At the urban/rural level, the coefficient for the percentage of women with no schooling is highly significant and negative, indicating that increasing the percentage of women with at least some schooling is associated with more rapid fertility decline. The percentage of women with at least a secondary education is again significantly associated with fertility decline.

Increases in the use of modern contraception are significantly associated with increases in the pace of fertility decline. In the first of the two equations, increases in the infant and child mortality rate are also significantly associated with fertility decline but negatively so. As at the national level, this indicates that as the infant and child mortality rate in a country decreases, fertility also declines all else equal. Increases in the growth in GDP per capita over five years are also weakly and negatively associated with fertility decline in the first equation. The coefficient measuring the time trend is, again, highly significant and negatively associated with fertility decline in all three equations.

The second equation uses the same socioeconomic development indicators with the inclusion of the initial level of fertility and the urban dummy variable. The initial level of fertility is weakly and positively associated with fertility decline, indicating that observations beginning at a higher level of fertility will experience greater fertility decline, all else constant. In this second equation, the significance for both infant and child mortality and the percentage growth in GDP per capita observed in the first equation are lost. When the dummy variable is added, it is significantly associated with fertility decline, which is consistent with previous work (see Kreider et al., 2009). Both equations account for around half of the variance of fertility decline.

In the third equation, the variables for the initial levels of the TFR and the infant and child mortality rate are again highly significant. At the urban/rural level, there is also a visible boost in the significance of the variable measuring the increase in the infant and child mortality rate, which was not seen at the national level due to it already being highly significant. The urban dummy variable also increases in magnitude and in significance. This equation explains around 68 percent of the variance in fertility decline.

Table 2-3. Regression Analysis of the Decline in the TFR Between Consecutive Surveys Regional Data

Variable	**1**	**2**	**3**
Increase in percentage of women with no schooling	-.031**	-.028**	-.022**
Increase in percentage of women with at least secondary education	.011*	.014**	.010*
Growth in the percentage of women using modern contraception	.0030	.0058	-.0020
Increase in the infant and child mortality rate[a]	-.0033*	-.0027[+]	-.0070**
Percentage growth in GDP per capita over 5 years (3-year lag)	-.0051*	-.0051*	-.0021
Time Trend	-.061**	-.053**	-.042**
Initial total fertility rate	--	.095*	.34**
Initial percentage of women with no schooling	--	--	.0025
Initial percentage of women with at least secondary education	--	--	.0010*
Initial percentage of women using modern contraception	--	--	.00060
Initial infant and child mortality rate	--	--	-.0058**
Intercept	.82**	.15	-.77**
R-squared	.240	.258	.412
Adjusted R-squared	.220	.235	.382
F-ratio	12.21**	11.46**	14.37**
N	239	239	239

a The infant and child mortality rate for the period 0-14 years prior to the survey was used.

** Significant at the .01 level.
* Significant at the .05 level.
[+] Significant at the .10 level.

Table 2-3 shows the multivariate regression analyses of the regional data given in the DHS surveys. This includes all regional changes between consecutive surveys with identical regional distinctions, yielding 239 observations in total.

In all three equations, the socioeconomic development indicators for changes in the women's education tend to be highly significant and are consistent with the other levels of analysis in which improvements in women's education are associated with fertility decline. Increases in the infant and child mortality rate and percentage growth in

GDP per capita are again negatively and significantly associated with fertility decline. When the variable for the initial level of the total fertility rate is included in the second equation, it is again positively and significantly associated with fertility decline. These two regional equations capture just over twenty percent of the variance in fertility decline.

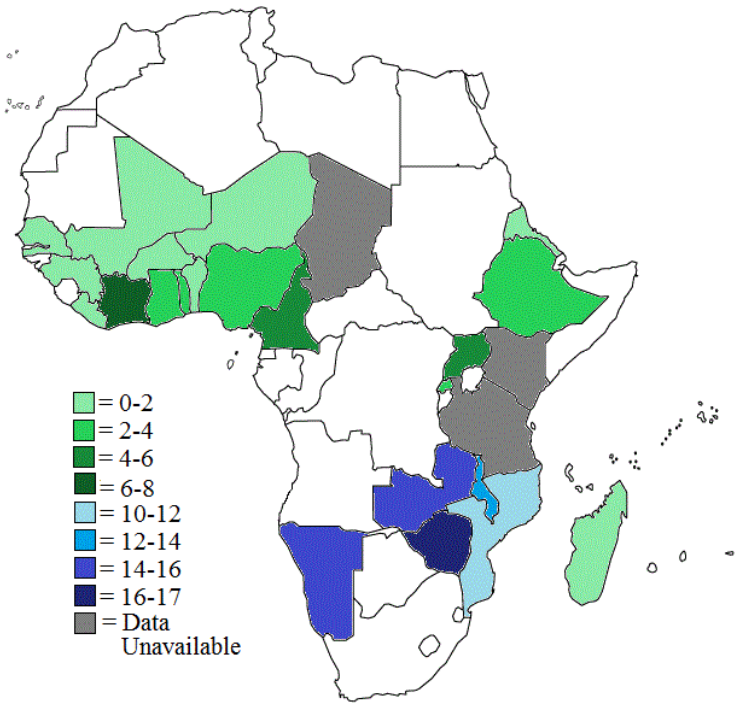
The third equation again boosts the significance of the variable for increase in the infant and child mortality rate, the initial level of the TFR, and the initial level of the infant and child mortality rate. This equation captures around 40 percent of the variance in fertility decline. The time trend variable is, once again, highly significant and negatively associated with fertility decline.

IV.
Integration of HIV/AIDS into the Fertility Discussion

The previous section comes to the conclusion that key socioeconomic determinants are necessary for sustained declines in fertility, but a discussion of fertility experiences in sub-Saharan Africa cannot be complete without including the AIDS pandemic. Along with the biological effect of lowering fertility among infected individuals, some research would suggest that the threat of contracting HIV/AIDS would encourage uninfected adults to decrease sexual activity and fertility as well. On the other hand, couples may choose to increase their fertility in order to combat the danger of their children contracting HIV/AIDS. This is a way of ensuring that an ideal number of healthy children survive to adulthood without the disease. Their demand for children could also be increased if they anticipated needing a heightened level of eldercare from their offspring if they contracted HIV.

The following map shows the 25 countries in this study, categorized by the level of adult HIV prevalence at the time of their most recent DHS survey. Again, survey years are not consistent with one another, but it does shed some light on which countries are experiencing the highest intensity of the HIV/AIDS pandemic.

Figure 2: Adult HIV prevalence at time of most recent DHS survey by country[7]



The following national-level multivariate regression analysis regresses decline in the TFR against the same socioeconomic development indicators used in the previous analysis, but with the integration of a variable representing changes in HIV prevalence between consecutive surveys. Although levels of adult HIV prevalence in the countries in this study vary greatly, from 0 to 28 percent of the population, measuring changes in HIV prevalence should accurately reflect changes in the relative threat that HIV poses in different areas of sub-Saharan Africa. The following analysis draws upon data from 2008 UNAIDS/WHO estimations of adult (ages 15-49) HIV prevalence at the national level.

[7] There were no adult HIV prevalence data available for Ghana in 2008, so the level shown here is consistent with Ghana's second to most recent DHS survey year, 2003.

Table 3. Regression Analysis of the Decline in the TFR Between Consecutive Surveys
National Data Including HIV Prevalence

Variable	**1**	**2**
Increase in percentage of women with no schooling	-.019	-.019+
Increase in percentage of women with at least secondary education	.018**	.017**
Growth in the percentage of women using modern contraception	.0039	-.0039
Increase in the infant and child mortality rate[a]	-.0094**	-.0086**
Percentage growth in GDP per capita over 5 years (3-year lag)	-.0074*	-.011**
Time Trend	-.020	.0059
Adult (15-49) HIV prevalence	--	.040+
Intercept	.22	-.034
R-squared	.745	.779
Adjusted R-squared	.689	.719
F-ratio	13.17**	13.07**
N	34	34

a The infant and child mortality rate for the period 0-14 years prior to the survey was used.

** Significant at the .01 level.
* Significant at the .05 level.
+ Significant at the .10 level.

Due to missing data, this equation had to drop 13 observations seen previously at the national level. In order to keep the measure of the effect of adult HIV prevalence consistent, the first equation in this table regresses the decline in the TFR without HIV prevalence using only the 34 observations for which HIV data was available. It can clearly be seen in the transition from the first equation to the second that the addition of an adult HIV prevalence variable improves the significance of the increase in percentage of women with no schooling and the percentage growth in GDP per capita variables. Most of the other socioeconomic development variables from the previous set of

regressions also retain their explanatory power, exhibiting the same trends as identified in the earlier analyses.

With a p-value of .058, the positive coefficient for adult HIV prevalence would suggest that the threat of HIV among adults does contribute to a more rapid decline of fertility. It does not, however, determine the motivation for such a fertility decline. The decline in fertility could be due to conscious decisions amongst couples or by individuals to lower their fertility. Alternatively, it may be due to health-related reproductive issues that may arise amongst HIV-positive couples.

V.
Ghana Case Study

Ghana presents a unique situation for more in-depth research into key factors in changes in fertility due to the DHS website's recent release of results from a 2008 DHS survey of Ghana. The fertility rates reported in this 2008 survey qualify Ghana as a declining country, whereas it used to be experiencing fertility stall. This phenomenon is not common in sub-Saharan Africa, as most countries in the region with stalling fertility have not experienced fertility declines after the stall. This section presents an empirical analysis of the individual survey data in the 2008 survey to try to determine what factors contribute to the recent fertility experiences in Ghana. It isolates a few key explanatory variables that may influence fertility and regresses them against a measure of children ever born.

Before the empirical analysis, however, it may prove useful to look at changes in the socioeconomic indicators at the aggregate level from the 2003 survey to the 2008 survey. By simply examining improvements in these variables, it is clear that drastic socioeconomic progress has been made at the national level. This may be associated with the reduction of .4 births per woman in the national TFR (from 4.4 to 4.0) that Ghana has experienced from 2003 to 2008.

The percentage of women with no schooling dropped from 31.3 to 21.2, a 32 percent decrease. On the other hand, the percentage of women with at least some secondary education experienced a 61 percent increase, from 27.8 to 44.7. The percentage of women using modern contraception also increased from 38.9 to 50.4, a 30

percent increase. The infant and child mortality rate has decreased by 23 percent, from 213 to 165. All of these results indicate vast improvements in the socioeconomic indicators that were examined in Table 2 and 3.[8]

The following table shows a multivariate equation estimated by regressing children ever born on women's age, ethnicity, schooling level, and an urban dummy variable at the individual respondent level.

[8] Change in GDP per capita was not found due to data from the Penn World Table being unavailable after 2004.

Table 4. Regression Analysis of Children Ever Born based on Ghana 2008 Survey Individual Data

Variable		
Age Group at Survey	15 to 19	-1.70**
	20 to 24	-.93**
	25 to 29	--
	30 to 34	1.06**
	35 to 39	1.98**
	40 to 44	2.81**
	45 to 49	3.58**
Ethnicity	Akan	--
	Mole-Dagbon	-.16*
	Ewe	-.26**
	Ga/Dangme	-.17^{+}
	Other	-.023
Schooling Level	None	1.02**
	Primary	.51**
	Junior Secondary	--
	Senior Secondary	-.44**
	Tertiary	-1.10**
Urban Dummy		-.56**
Parameters	Intercept	2.04**
	R-squared	.640
	Adjusted R-squared	.639
	F-ratio	579.93**
	N	4916

** Significant at the .01 level.
* Significant at the .05 level.
$^{+}$ Significant at the .10 level.

The results above indicate that all of the variables chosen (women's age, ethnicity, level of schooling, and type of residence) play a significant role in fertility experiences in Ghana.

The first explanatory variable measures women's ages, which have been broken into seven 5-year groups. This method of measuring age allows for a relationship

between age and fertility that may be significant but may not necessarily be linear in nature[9]. The 25 to 29 age category was chosen as the reference group. The results indicate that age has a highly significant and positive impact on children ever born. The number of children ever born per woman steadily increases throughout the course of a woman's lifespan, with higher rates of fertility in the younger age categories that begins to level slightly around ages 35 to 39.

Ethnicity also has an overall highly significant effect on the number of children ever born per woman. Ghana's population is compromised of several different ethnic groups, including the Akans (49 percent), the Mole-Dagbon (17 percent), Ewe (13 percent), and Ga/Dangme (8 percent) (GSS, 2002). The Akan group was used as a reference, and as the empirical results indicate, this group has the highest level of children ever born. It is important to note that the coefficient for the Ga/Dangme group is only weakly significant, and there was no significance found for the "Other" category. This result is not surprising, however, due to the fact that this category is comprised of several ethnicities including Guan (2.4 percent), Grussi (4.6 percent), Gruma (4.11 percent), and Mande (.6 percent) as well as an "Other" category specified by the DHS survey representing 3.8 percent of the total population (GSS, 2002).

Level of women's schooling also has a highly significant impact on the number of children ever born. This variable is separated into five categories, including none,

[9] It is fairly common that empirical work includes age and age-squared variables in an equation to allow for a non-linear relationship between age and a dependent variable. While the same technique was explored here with fairly successful results, the author felt as though the system of age groupings more accurately estimated the link between women's age and fertility, allowing it to be both non-linear and not necessarily exponential in form.

primary, junior secondary, senior secondary, and tertiary. The current educational system in Ghana dictates primary education as six years of schooling, followed by three years of junior secondary school, and three more years of senior secondary school. The tertiary category encompasses any level of schooling past the completion of senior secondary school. It is evident from the empirical results that women's education is significantly and negatively associated with the number of children ever born. This is consistent with the findings of previous sections (and previous empirical work) that fertility declines are typically associated with increased women's education.

The urban dummy variable in this equation is also significantly associated with children ever born. Its negative coefficient indicates that fertility in urban areas tends to be lower than in rural areas by about half of a child or a reduction of 56 in the percentage of mean children ever born. This is consistent with the aggregate results found in Table 2-2, which found a positive and significant link between living in an urban area and fertility decline.

These results use DHS data from the responses of 4916 individual women in Ghana, and the equation accounts for just under 65 percent of the variance in the number of children ever born. The fact that women's schooling is again significantly associated with fertility measures would seem to indicate that improvements in socioeconomic development have an impact on fertility experiences. However, the significance of variables such as age and ethnic group may prove that higher levels of fertility are dependent upon cultural norms within the region that will not likely change with development. This could explain why some countries in sub-Saharan Africa report

continued stalling of fertility, even with socioeconomic development and the fact that neighboring sub-Saharan African countries are transitioning. For example, Benin is classified as experiencing an early-transitional stall, yet it has experienced a 207 percent increase in the use of modern contraception (from 7.2 to 22.1), a 17 percent decrease in infant and child mortality, and more minor improvements in women's education between its two most recent surveys (2001 and 2006). It is also adjacent to Burkina Faso, Nigeria, and Togo—all of which are experiencing declining fertility, which defies the diffusion and social interaction theory that the probability of fertility transition increases when other countries in the region are already transitioning. Perhaps cultural norms of fertility based on ethnicity or women's age could be accounting for fertility remaining high in these cases.

VI.
Conclusions and Areas for Future Research

Although the focuses of this thesis are broad, they can shed some valuable light on the overall status of fertility transition and stalling. Unlike much of the current literature on fertility transition, the specific focus on sub-Saharan Africa seen here allows conclusions to be made specific to this region.

The empirical results in Section III echo similar research, finding that changes in key socioeconomic indicators are essential for fertility transition to occur. Improvements in women's schooling, use of modern contraception, decreases in infant and child mortality rates, and increases in GDP per capita are all significantly associated with fertility decline.[10] While the variables capturing the initial levels of these socioeconomic development indicators tended not to be significant (with the exception of the initial level of the infant and child mortality rates), they did tend to improve the results of the variables measuring the changes in socioeconomic development. This would seem to indicate that Bongaarts and Watkins (1996) were correct in highlighting the importance of the initial level when trying to measure the impact of changes in socioeconomic development on fertility decline, although more work must be done in finding a more accurate time period in which to measure the initial level.

In Section IV, an important distinction between sub-Saharan Africa and the rest of the developing world is made by the inclusion of HIV/AIDS in discussions of fertility. The results of this section indicate that adult HIV prevalence has a negative impact on

[10] There was some noted variation in significance in the percentage of women with no schooling and use of modern contraception across different levels of analysis.

fertility rates, although the data used in the section were very limited. The UNAIDS/WHO website was missing HIV/AIDS data for several of the countries used in this paper, which may be skewing the results of this section drastically, depending on a possible selection bias. With more consistent and specific data on the presence of HIV/AIDS in sub-Saharan Africa, a more thorough empirical study on its effects on fertility could be conducted.

The case study of Ghana in Section V highlights the role that factors other than socioeconomic development play in fertility experiences. This empirical analysis found that ethnicity, age, and type of residence affected the number of children ever born in Ghana. This implies the persistent stalling of fertility in some sub-Saharan African countries may be due to cultural differences that will not change at as rapid of a pace as socioeconomic development has. Case studies for each of the stalling countries could solidify this hypothesis by determining the specific effects of differences in culture on differences in fertility experiences between sub-Saharan African countries.

VII.
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