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THE FERTILITY TRANSITION IN SUB-SAHARAN AFRICA: A THREE-COUNTRY CASE STUDY

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Abstract

The countries in sub-Saharan Africa have among the highest total fertility rates in the world today; however, some of these nations are farther along in the demographic transition than others. This study selects three sub-Saharan African nations based on total fertility rate and explores some of the basic determinants of fertility in each county. After background information is given on each nation an ordinary least squares regression and a logit regression is performed on individual-level DHS data from each nation, using age, education, religion, and ethnicity as the independent variables. The ordinary least squares regression uses children ever born as the dependent variable, which gives a longer outlook, while the dependent variable in the logit regression is the event of a birth in the past year. This enables comparison between determinants and their effect in the long term and short term. Women's education emerges as a very important determinant in both regressions, and is also amenable to public policy.

Acknowledgments

Many thanks are due first and foremost to Dr. David Shapiro, my undergraduate advisor and thesis supervisor. This paper would have been impossible without his guidance and insight, and for that I am grateful. In addition, I am indebted to Dr. Bee-Yan Roberts for serving as my second reader, but more importantly for her support and guidance during my undergraduate career. I would also like to recognize the 2010-2011 members of the Honors Program in Economics. It helped greatly to know that others were struggling with the same issues that I was encountering. And finally, many thanks to my friend Timothy Dooley, whose support and feedback were invaluable throughout this process.

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Introduction

Africa is the location where humanity probably started, making the continent home to the oldest history that we know. In modern times, after Asia, Africa is the biggest and most populous continent in the world. Typically it is separated into two regions. The first is the group of countries north of the Sahara desert, which includes the Western Sahara, Morocco, Algeria, Tunisia, Libya, and Egypt. The rest of Africa is usually referred to as sub-Saharan Africa. This portion of Africa is extremely poor when compared to the rest of the world, which makes it an area of extensive study for development economists.

In the summer of 2010 I assisted Dr. David Shapiro in some of the research that he was undertaking. I was involved primarily in his work on the Democratic Republic of the Congo, specifically its largest city, Kinshasa. One of the topics that I worked heavily on was fertility in the area. A fact that was reaffirmed through my work was that the countries of sub-Saharan Africa, in addition to being quite poor, are also characterized by high fertility rates. Thus the demographic transition is very important to the countries in sub-Saharan Africa, as the transition from high birth and death rates to low birth and death rates is a hallmark of most modern, developed societies. Since that summer I have become more familiar with the demographic transition, and grew interested in using the knowledge I gained to explore the nature of the transition in other contexts. The result is this study.

This thesis explores fertility in three sub-Saharan African countries in hopes of finding patterns between them. Niger, Sierra Leone, and Ghana were chosen as the subjects for the study because they represent the different levels of fertility that exist at present in sub-Saharan Africa. After a brief review of the work of other scholars there is discussion of the demographic transition itself, and why it is important to development. Next, background information on the

three countries chosen for the study is provided. Following that is the substantive portion of the paper: the regression analysis of data from each nation coupled with interpretation. I conclude that the education of women is the most important determinant of fertility that is explored in this paper. It demonstrates a high level of significance in both the long run and short run, it can be manipulated greatly by public policy, and it should be a primary focus of the development community when thinking about the demographic transition.

Literature Review

A study of note would be the inspiration for this thesis, *Kinshasa in Transition: Women's Education, Employment, and Fertility*, a book by David Shapiro and B. Oleko Tambashe. In the fourth chapter they analyze fertility and women's education, using a similar regression that was the genesis of the regression in this paper. Here the significance of women's education is an important point of emphasis, as it had replaced ethnicity as the key influence on fertility in Kinshasa. Higher levels of education seem to be particularly influential (Shapiro and Tambashe 2003). John Bongaarts also conducted a study on fertility and the relationships between its basic determinants. His study analyzes these relationships in an interesting way, but most importantly he reaffirms the inverse relationship between women's education and fertility. All 30 countries in his study had lower fertility rates for women with less than secondary education when compared to those with at least some secondary education. He also notes that women with higher levels of education have fertility rates lower than their desired family size, which is an example of a problem that can occur once lower fertility rates are achieved (Bongaarts 2010).

There have been other studies done in sub-Saharan Africa that draw similar conclusions to this study. A prime example is a 1996 article about a study conducted by Martha Ainsworth, Kathleen Beegle, and Andrew Nyamete, whose paper has a very similar theme to this thesis. In

it they examined Demographic and Health Surveys (DHS) data from the 1980s for 14 sub-Saharan African nations, which included Niger and Ghana. Their analysis focused on how women's education affects fertility and contraceptive use. The model that they used was a bit more extensive than the one in this paper, as they include many more variables in their analysis; however, their results on the relationship between women's education and fertility are quite similar. Overall they support the general inverse relationship between women's education and fertility, especially for higher levels of education, and also conclude that education has a positive effect on contraceptive use. Yet they also obtain results that indicating that an increase in women's primary education may coincide with an increase in fertility, though they do not find this to necessarily be a causal relationship (Ainsworth et al. 1996).

Teresa Martin explores the relationship between education and fertility behavior as well. She uses earlier data sets from 26 developing countries in Africa, Asia, and Latin America, so the scope of her research extends well beyond this paper. In addition to also noting some exceptions to the typical inverse relationship between women's education and fertility, she concludes that women's education does not have the same effects in every context. Much of the effect depends on culture, economic development, and notably on the stage in the fertility transition in which the society finds itself (Martin 1995). Work by John Cleland characterizes the relationship between women's education and fertility as only temporal. In societies that have yet to start the transition there is often little evidence of a link between the two. The onset of fertility decline is usually characterized by widening fertility differentials by level of education, but after a few decades they typically have converged. Thus the relationship is only a temporary one, as a society moves from high fertility to low fertility (Cleland 2002).

The work in this paper is also directly expanded upon by Shapiro in "Women's Education

and Fertility Transition in Sub-Saharan Africa," specifically the exploration of women's education and its influence in countries at different stages of the demographic transition. The study is grander in scope, and he anticipated a narrowing of fertility differentials by education as fertility declined that did not appear in the data. These results are similar to those discussed by Cleland. Shapiro suggests that the demographic transition is potentially not advanced enough in sub-Saharan Africa to illustrate this expected trend (Shapiro 2011). Bongaarts explores educational differentials at different points in the fertility transition, detailing two models of how fertility changes over time during the transition for different educational groups. He concludes that there are differentials that are present, and that they remain significant even when low levels of fertility are reached (Bongaarts 2003).

The Demographic Transition

A low fertility rate is an important component of the demographic transition, and a good place to start thinking about this transition is Malthusian era stagnation. Though there are debates about the rationale behind the ideas in the Malthusian model, the main concept is quite simple. In this universe there are no productivity advances, so a direct relationship affecting income exists between growth of output and growth of population. If there is a negative shock to population (plague for example), then the result would be increased income per capita for the population. When population recovers, the previous equilibrium is restored, consistent with the law of diminishing returns. In the same way, if a positive shock greatly increases output, the resulting increase in population would bring income back down to the previous levels. Long run economic development is not possible. When productivity increases through technology are introduced, sustained increases in income are made possible (Easterlin 1996).

Starting from a state of low income paired with high rates of fertility and mortality, this

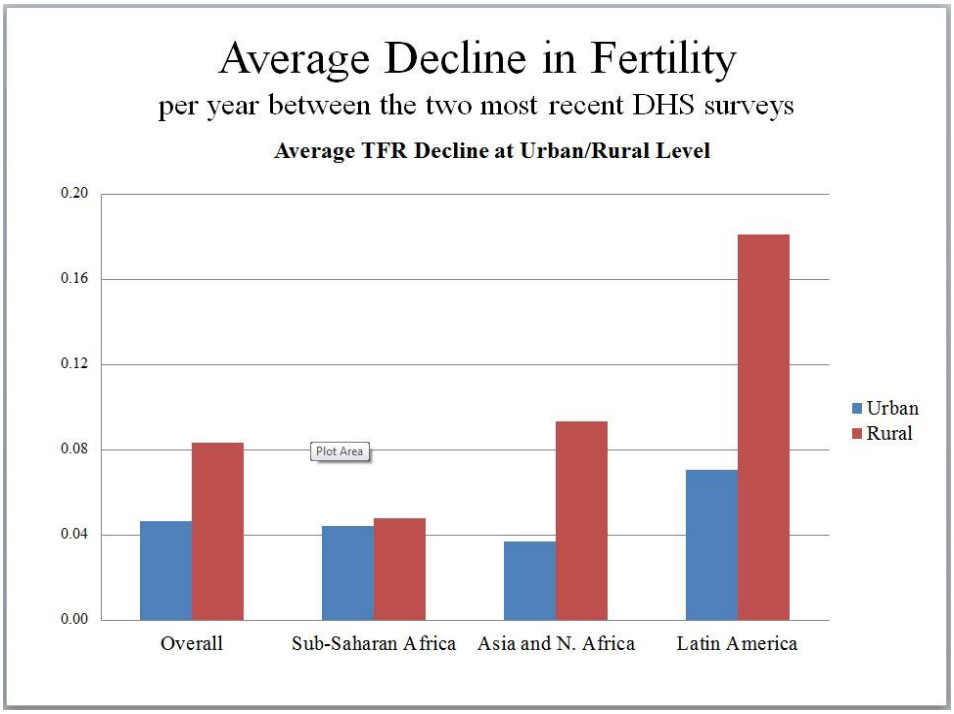
surge in productivity allows population to grow rapidly, which occurs partially through a decrease in mortality. Adding to the population growth is the delayed decrease in the fertility rate. As income continues to increase fertility begins to decline, and the end result is higher income with low birth and death rates, while the growth in population is slow. This is the demographic transition (Strulik 1997). The portion of this transition that is the focus of this paper is the decrease in the fertility rate, as it is the last step in the transition and the gateway to benefits for society. This decline has been universal in development, as the industrialized nations of the world have made the transition, and much of the developing world is far along in the transition as well. Linked to it is an increased life expectancy in these countries. The ability of fertility declines to halt high rates of population growth also prevents the physical and human capital from being spread too thinly in the population, occurrences which would lower the income per capita (Doepke 2004).

A quick transition also increases the share of the population that is of working age, which is known as the demographic dividend. It is closely related to the demographic transition because lower fertility allows for more members of the population to be of working age in two ways. First, just purely by the numbers there will be more people between the ages of 15 and 64. Additionally, lower fertility typically enables more women to participate in the labor force. These conditions usually allow for more savings within the population and promote a focus on increasing human capital, both of which are beneficial to the national economy. However, the window for the demographic dividend is not permanent, and the countries that have the right policies and are prepared to make the right investments at the right time can spur a decline in fertility and the resulting economic growth (Bloom et al. 2003).

The demographic dividend has contributed to growth in several of the countries in East

Asia, where the term "growth miracle" is often used. These nations took advantage of the swell in the percentage of the population that was of working age, which was mentioned above. The existence of many children in a population that is already poor does not allow for families to make the appropriate investments in their children, and in addition the children themselves also place a heavy monetary burden on their parents. A high fertility rate also can pump more uneducated, unskilled workers into the population, which brings down wages for everybody. There are several other ways in which high birth rates can subtly affect the economic situation in a country. The higher dependency ratios that are associated with high fertility are a burden on the economy in general. The opportunity cost of having a lot of children is also high, as an elevated fertility rate also prevents the women in the population from fully engaging in the workforce (UNFPA 2002).

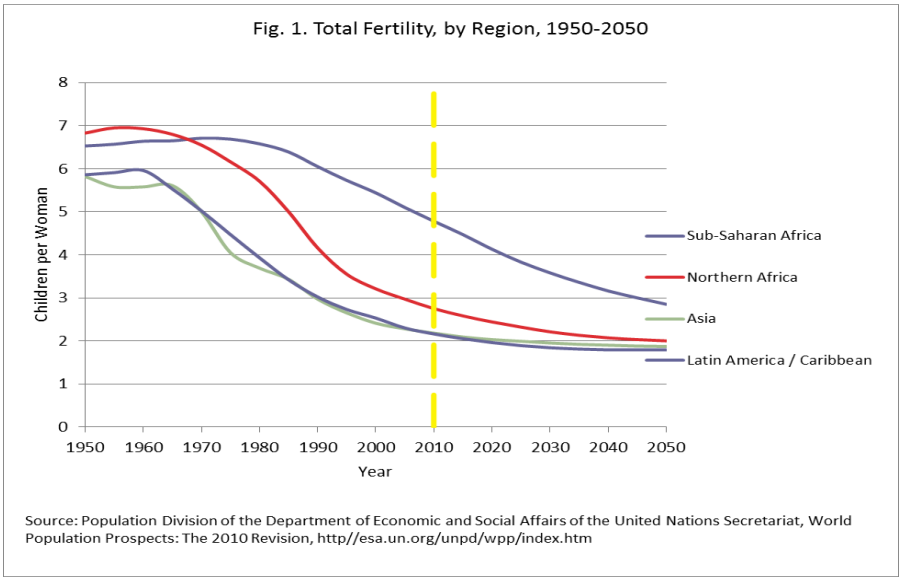
Figure 1



David Shapiro. 2011. PowerPoint presentation on David Shapiro et al., "Stalling of Fertility Transitions and Socioeconomic Change in the Developing World: Evidence from the Demographic and Health Surveys," March 2011. University Park, PA.: Department of Economics, Pennsylvania State University.

Of all of the continents on the globe, the demographic transition remains the biggest issue in Africa, specifically in sub-Saharan Africa. This can be seen in Figure 1, where the decline in the total fertility rate lags behind even the other developing regions of the world by a substantial amount. The other areas of the world all have started the transition. Western Europe started the transition at the end of the nineteenth century, ending for the most part by World War II. Eastern European nations experienced the transition a bit later, along with Japan. Other countries that were settled by these European nations also began the transition during this time period. The Third World countries began the transition in the latter half of the 20th century; however, sub-Saharan Africa still lagged behind, and as can be seen in Figure 2, the fertility rates typically remain high today (Easterlin 1996).

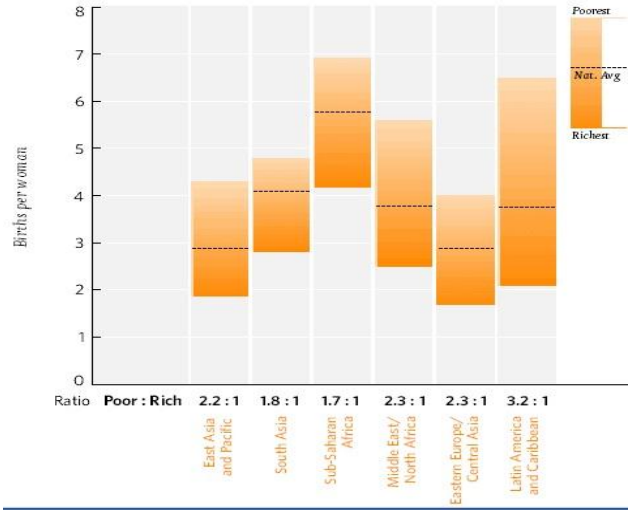
Figure 2



David Shapiro. "Women's Education and Fertility Transition in Sub-Saharan Africa." October 2011.

To better understand the demographic transition it helps to visually conceptualize the progress that has been made so far, which is not uniform across countries. Even in the poorest nations the differences in fertility rate are dependent partially on income, which can be seen in Figure 3.

Figure 3



Source: State of the World Population, United Nations Population Fund, 2002

Demographic and Health Surveys

The Demographic and Health Surveys (DHS) project, started by the U.S. Agency for International Development (USAID), provides data and analysis on problems in developing nations. Over 240 surveys have been conducted in 84 countries. They typically include information on issues like fertility rates, mortality rates, and women's education, and have also started to gather data on malaria and HIV/AIDS, which have emerged as issues as well. Since its creation in 1984 DHS has been merged with USAID's MEASURE program and is now run by ICF Macro. The goal remains to collect and compile data that can be utilized in policy decisions. For each completed survey DHS provides several services, some of which were used for this paper. Data are collected, analyzed, and disseminated for use, and ICF Macro works with local officials to make sure that the results of the surveys are put to good use. In an effort to provide the most current and pertinent results, the data in this paper are taken from the most recent survey of each nation. For Ghana and Sierra Leone that is 2008, and for Niger the most recent survey was in 2006. These countries were chosen due to the time period in which the survey was undertaken and the differing levels in fertility rate. As stated previously, sub-Saharan Africa has

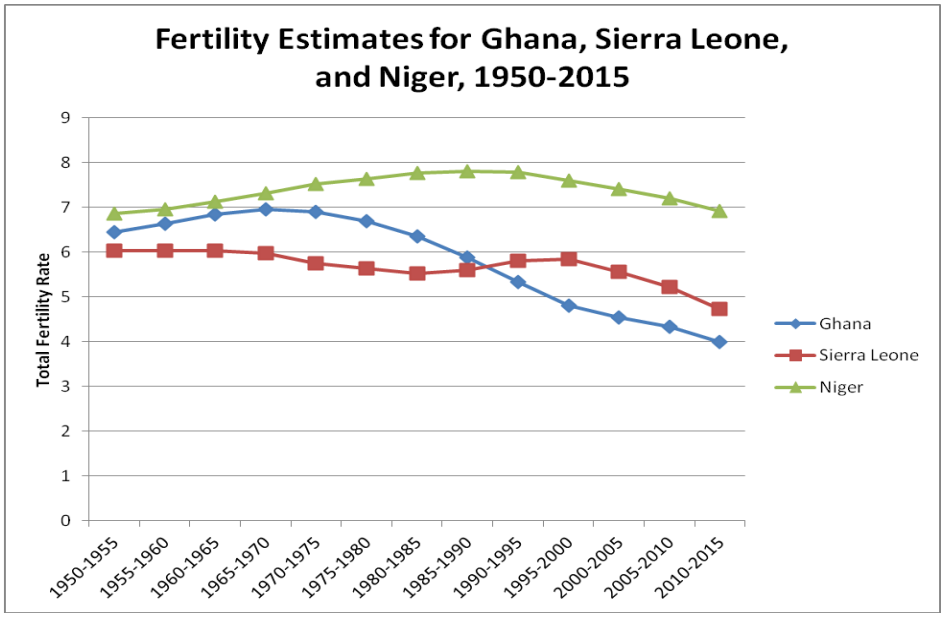
a much higher average level of fertility than the rest of the world; however, these three countries align with the high, middle, and low ends of that scale within sub-Saharan Africa. Table 1[1] shows the countries of sub-Saharan Africa that have had a DHS survey in order of the total fertility rate.[2]

Table 1- Total Fertility Rate by Country, Sub-Saharan Africa	
South Africa	2.9
Lesotho	3.5
Namibia	3.6
Swaziland	3.9
Cape Verde[1]	4
Ghana	4
Gabon	4.2
Mauritania	4.5
Comoros	4.6
Kenya	4.6
Sudan	4.7
Congo (Brazzaville)	4.8
Eritrea	4.8
Madagascar	4.8
Botswana	4.9
Senegal[2]	4.9
Cameroon	5
CAR	5.1
Sierra Leone	5.1
Cote d'Ivoire	5.2
Togo	5.2
Ethiopia	5.4
Mozambique	5.5
Rwanda[3]	5.5
Benin	5.7
Guinea	5.7
Nigeria	5.7
Tanzania	5.7
Angola[2]	5.8
Burkina Faso	5.9
Liberia[2]	5.9
Malawi	6
Chad	6.3
Congo Democratic Republic	6.3
Mali	6.6
Uganda	6.7
Burundi	6.9
Niger	7

[1] Each value in the table comes from the most recent DHS survey, except where noted: 1- RHS, 2- Malaria Indicator Survey (MIS), and 3- Interim DHS. Source: ICF Macro 2011. Measure DHS STATcompiler- http://www.statcompiler.com – 3 Oct. 2011

[2] Total fertility rate (TFR) is the estimate for how many children a given woman in the population would have over her lifetime, given that the birth rate of that year remains unchanged.

Figure 4

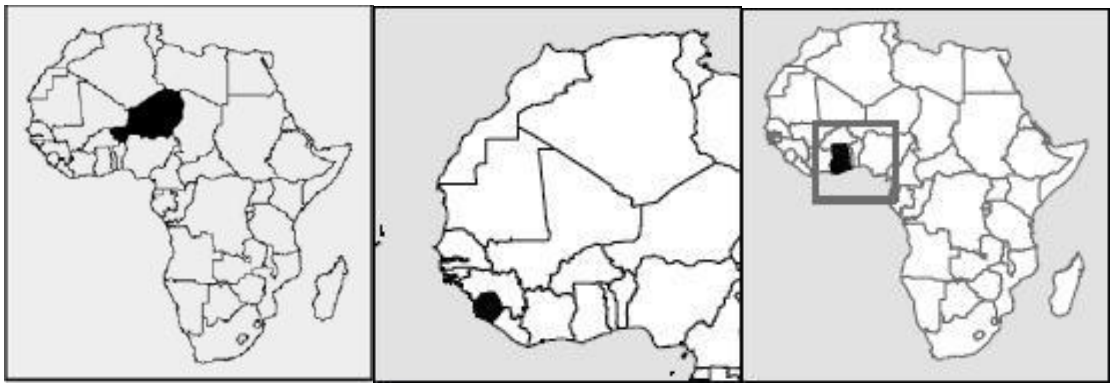


Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2010 Revision, http://esa.un.org/unpd/wpp/index.htm

Niger has the highest TFR with 7, followed by Sierra Leone with 5.1. Ghana is among the lowest in the region with a TFR of 4. Figure 4 shows that since 1950 Niger has had consistently high fertility, while Sierra Leone and Ghana are farther along in the demographic transition. Ghana began the transition in the second half of the last century, while Sierra Leone has seen a decrease much more recently. Thus these choices were specifically made to explore the determinants that were similar in countries at different stages of the demographic transition.

Country Profiles

This section contains some background information on each of these countries. When considering the results of the regressions it is always important to be aware of the situation from which the numbers come. Since these three countries are located in sub-Saharan Africa there are obvious overlaps. However, each country is distinct and has its own story. Included in these profiles is information detailing the demographics, history, economy, and educational systems of the countries in the study.



Niger Sierra Leone Ghana

A. Niger

Niger is a completely landlocked country in West Africa which shares borders with Algeria, Libya, Chad, Nigeria, Benin, Burkina Faso, and Mali. The climate is tropical, and the seasons alternate between a dry season and a rainy season. The average temperature is quite hot, sometimes surpassing 40 degrees Celsius. The country is divided into three climatic zones, and politically Niger is made up of 8 administrative units. These are divided into departments, of which there are 36. There are 265 municipalities, 213 of which are considered rural and 52 are urban (DHS Niger 2006). The people of Niger are ethnically diverse. The Hausa (53%) make up the majority of the population, followed by the Djerma (21%), Tuareg (11%), Fulani (7%), and Beri Beri (6%). Arabs, Toubou, and Gourmantche make up the remaining 2%. The people are predominantly Muslim, with Christians and traditional religions making up less than 3% of the population (U.S. Department of State, 2010b). The life expectancy at birth is only 47.56 years, and the infant mortality rate is 112.22 deaths per thousand live births. This is the third highest in the world. For those children who survive, 39.9% of the children under five years of age are underweight (CIA Niger 2011). Contraceptive use is quite low, as only 8% of the female population of childbearing age and in some form of union uses any method; however the majority of users (6% of the population) use a modern method (United Nations 2011).

Historically, the French exerted their power in Niger in a similar fashion to the rest of their African colonies, but slowly Niger gained the right to be self-governing. The transition was completed on August 3, 1960, when Niger gained full independence from France. For 14 years Niger was run by a single-party civilian regime, but corruption combined with drought led to a military coup in 1974 that overthrew the government. This regime, led originally by Lieutenant Colonel Seyni Kountche and then by Brigadier General Ali Saibou, ruled until 1990, when the leadership yielded to demands from unions and students for the implementation of a multi-party system. After three years the new government was put into place. This transition is one of importance for Niger, as there were several major accomplishments during this period. The country successfully conducted a constitutional referendum, and additionally held "free, fair, and nonviolent" elections throughout the nation. However, for all their successes, the Nigeriens were in no way rid of their problems with governance (U.S. Department of State, 2010b).

Efforts for peace that had started in 1991 eventually brought peace accords in 1995. The Third Republic, which was institutionalized in 1993, soon developed factions in the ruling coalition that led to a "governmental paralysis." This became an excuse for another coup, which occurred in January 1996, led by another Colonel, Ibrahim Bare Mainassara. In the transitional period a new constitution was drafted and made public in May of that year. In conjunction with the constitution Bare conducted rigged elections in which he won the presidency and his party gained control of 90% of the seats in parliament. Bare's regime was one which violated many civil rights. Under his rule "opposition leaders were imprisoned; journalists often arrested, beaten, and deported by an unofficial militia composed of police and military; and independent media offices were looted and burned with impunity" (U.S. Department of State, 2010b). Then in 1999 Major Daouda Mallam Wanke led a coup that led to Bare's assassination, and in July

legitimate elections were held that produced a new president, Mamadou Tandja. He was reelected in 2004, and since then Niger has been working on democracy, though they face some opposition from the Movement of Nigeriens for Justice, whose actions in the north of Niger have led to a shrinking tourist sector and decreased investment in other industries (U.S. Department of State, 2010b).

Niger is a very poor nation, and its economy is one of the weakest in the world. It is classified as one of the Least Developed Countries, and is eligible for the Heavily Indebted Poor Country Program (HIPC), which qualifies it for debt relief (DHS Niger 2006). It also ranks last on the United Nations Human Development Index (U.S. Department of State, 2010b). The poverty situation actually became worse throughout the 20th century as living standards deteriorated, and economic growth rates, though positive, have not been sufficient to promote sustained development (DHS Niger 2006). In 2010 the GDP of Niger was $5.603 billion, which comes out to $700 GDP per capita. This last figure is at the bottom of the rankings of GDP per capita of countries around the world (CIA Niger 2011). The growth rates of the economy in the years 2003-2005 were 3.3%, 1%, and 7% (DHS Niger 2006). In the years 2008-2010 they were 9.3%, -1.2%, and 3.5%. This fluctuation in growth rates is caused by a dependence on subsistence crops and livestock, which are susceptible to drought and desertification, two problems present in Niger. Ninety percent of the workforce works in agriculture, and they produce 39% of GDP, while the remaining 10% work in industry and the service sector. Uranium mining remains an integral part of the economy (CIA Niger 2011).

As one of the world's poorest areas, Niger also has one of the most ineffective educational systems. One of the biggest problems is enrollment, and enrollment for girls is especially alarming. Only 3% of children are enrolled in some form of pre-primary school. In

addition, 50% of primary school aged children are not enrolled, and only 38% of children complete a full course of primary school. That enrollment rate for primary school breaks down into 43% for girls and 55% for boys. The students also fight a high pupil/teacher ratio, as there are 41 of them for every instructor. The problem gets worse for the higher levels of education, as only 1% of the population in the age range for tertiary education are enrolled (UNESCO Niger 2010). The literacy rate reflects these shortcomings, as only 28.7% of adults are literate. Again, there is a stark contrast between men and women, as only 15.1% of women are literate as compared to 42.9% of men. Education for a pupil in Niger is expected to last only 6 years. Part of the problem is government support, as only 3.7% of GDP goes towards educational expenditures, which ranked Niger 124th in the world in 2005. Although this ranking can be affected by relative levels of GDP, it is still clear that the government does not emphasize education (CIA Niger 2011). An upside is that more youth (36.5%) are literate than adults, which hopefully signals improvement in education (UNESCO Niger 2010).

B. Sierra Leone

Sierra Leone is a nation in West Africa which borders the nations of Guinea and Liberia. It also has a 211 mile Atlantic Ocean coastline. Climate in the country is determined by the movement of two air masses, and Sierra Leone has only two seasons. There is a dry season that lasts from November to May, and a rainy season from April/May to November. The country is divided up into four provinces, and each province has districts that are split into chiefdoms. There are 14 districts that contain 149 chiefdoms. Governance is attained partially through local councils, of which there are 19. Each district has one, and additionally there are five city councils (DHS Sierra Leone 2008). There are about 5.7 million people in Sierra Leone, coming from a variety of ethnicities. The most common are Temne (35%), Mende (31%), and Limba

(8%), while there are also other African ethnic groups and refugees from other countries. About 60% of the population is Muslim, 30% is Christian, and the remaining 10% is animist. English is widely spoken, as well as Krio, Temne, Mende, and 15 other indigenous languages (U.S. Department of State, 2010c). The life expectancy at birth in Sierra Leone is 56.13 years, and the infant mortality rate is 78.38 deaths per thousand live births. For the children who survive beyond infancy, 21.3% of those under five years of age are underweight (CIA Niger 2011). Contraceptive use is low. Eleven percent of the female population in a union uses any method, and about half of those (5% of the population) use a modern method (United Nations 2011).

In April of 1961, after some years in transition, Sierra Leone gained its independence from Britain. In the country's first general election Sir Milton Margai of the Sierra Leone Peoples Party (SLPP) was chosen as the first Prime Minister in 1962. Five years later Siaka Stevens, representing the All Peoples Congress (APC), became Prime Minister. He led the nation until 1985, and during his rule he amended the constitution to ban all political parties except for the APC. In that year the APC chose Major General Joseph Saidu Momoh as the new leader, and although he re-established the multi-party system in 1991, his rule was characterized by abuses in power (U.S. Department of State, 2010c).

This mismanagement prompted the formation of the Revolutionary United Front (RUF), which began attacking settlements near the Liberian border. Eventually the RUF gained control of diamond mines, and Momoh was exiled in a military coup that established the National Provisional Ruling Council (NPRC) as the new leadership in Sierra Leone. However, they were as unsuccessful as Momoh's government in dealing with the RUF, and ultimately resorted to hiring mercenaries to repel RUF forces. Power was eventually returned to the civilians, but civil unrest remained for the rest of the decade. Control of government changed hands frequently and

there was fighting in many parts of Sierra Leone, which at times included the capital, Freetown. Such an instance came in 1999 when thousands were left dead or wounded in the city. The civil war lasted until 2002, when, with assistance from the United Nations, it was officially ended by President Ahmad Tejan Kabbah. He was then elected to a five year term representing the SLPP (U.S. Department of State, 2010c).

Since the end of the war Sierra Leone has tried to resume life as normal, including holding elections. There were also special courts tasked with punishing those who committed war crimes and trying to encourage "genuine reconciliation." In addition, Sierra Leone is continuing to improve an economy that was all but ruined in the civil war. Better management of natural resources and electricity are two issues that continue to be of importance (U.S. Department of State, 2010c).

Sierra Leone is another sub-Saharan African nation that is also amongst the poorest in the world, ranking near the bottom of the Human Development Index. In 2005 it was estimated that 52% of the population lived on less than $1 per day, and about 70% are below the poverty line. Growth in the country has been relatively steady in recent years. The growth rates of GDP for the last five years starting in 2006 were 7.3%, 6.4% (DHS Sierra Leone 2008), 5.5%, 4.4%, and 5.2% (CIA Sierra Leone 2011). Even in spite of this growth, the low starting point due to the chaos in the 1990s left Sierra Leone's 2010 GDP at $1.901 billion, which results in a GDP per capita of about $900. In addition, income inequality is quite high. Many problems are caused or exacerbated by the effects of the civil war, from which the country has not yet fully recovered. Indeed, Sierra Leone does have considerable mineral, agricultural, and fishery resources. Its well-known diamond industry does remain the major source of hard currency, and accounts for about half of the country's exports. It is estimated that half the people work in agriculture, about

30% work in manufacturing, and the remaining 20% in the service industry. Newly found political stability and the development of offshore oil reserves are beginning to help Sierra Leone develop further (CIA Sierra Leone 2011).

The educational system in Sierra Leone is not the best, and some of the problems are similar to those found in the rest of the region. The literacy rate in the country is 39.8%, but there is a disparity based on gender. Only 28.9% of females are literate, which does not compare well to the 51.7% literacy rate for males. Youth in the country have a higher literacy rate, which rests at 55.7%; however, only 45.9% of girls are literate, while 66% of boys have achieved literacy (UNESCO Sierra Leone 2010). The school life expectancy is 12 years, indicating that those who do attend school usually do so for an extended period of time. It is evident that there is definite room for improvement. It can start with the government, whose expenditure on education is only 3.8% of GDP, which ranked Sierra Leone 114th in the world in 2005 (CIA Sierra Leone 2011).

C. Ghana

Ghana is a West African coastal nation that shares borders with Togo, Burkina Faso and Cote d'Ivoire. The climate is tropical, and there are two distinct rainy seasons from April to June and September to November. Distance from the coast can have interesting effects on climate, and the ecological zones are based on distance from the equator. Nearest to the coast is a sandy coastline, then heavy forests, and last are the northern savannah (DHS Ghana 2008). The dominant ethnic groups in Ghana are the Akan (45%), Mole Dagbon (15%), Ewe (12%), and Ga-Dangme (7%). English is the official language, and each ethnic group also retains a language of its own. Christianity is the dominant religion, as almost 70% of the population identifies as Christian. The second most practiced religion is Islam, and other traditional religions are also

present (U.S. Department of State, 2010a). Of these three countries Ghana has the highest life expectancy at birth, at 61 years. This is one of the better figures in sub-Saharan Africa, but is only good for 185th in the world. The infant mortality rate is 48.55 deaths per thousand live births. Of the children surviving infancy 14.3% end up underweight before the age of five (CIA Niger 2011). Twenty-four percent of women of reproductive age that are married or in a union use some form of contraception, which is a significantly higher figure than in Niger or Sierra Leone. Only 17% of the population utilizes a modern form of contraception, again a better figure than the other two nations studied in this paper (United Nations 2011).

The British gained complete control of Ghana, or the Gold Coast, in 1902. Different parcels of land were added throughout the 20th century, and in the 1950's there was a real push towards independence. A constitution was drafted in 1954, and two years later government officials put forth a plan for independence. This was achieved on March 6, 1957. Directly after, the government, led by Prime Minister Kwame Nkrumah, tried to make Ghana "a modern, semi-industrialized, unitary socialist state." Unfortunately this included some abuses of power, like detaining people without trial and censoring newspapers. Eventually this led the army and police forces to overthrow the leadership in 1966, citing corruption and a failing economy as two primary reasons (U.S. Department of State, 2010a).

This new group of leaders led from 1966 until 1972, during which time they attempted to establish a fair government dictated by civilians. However, the economy did not improve, and this led to another coup, this time without bloodshed. General Acheampong, the leader of this coup, again promised to make Ghana self-reliant and to turn around the economy, but again the leadership was unable to deliver. The introduction of union government, which would effectively make Ghana a non-party state, incited strikes and demonstrations, and this combined

with more corruption ended in Acheampong's arrest in 1978. The trend of bad governance continued, and in 1979 power was taken through a violent coup. This group executed former leaders and modeled a new constitution on Western democracies, though it was not long until it was suspended (U.S. Department of State, 2010a).

Unstable rule continued into the 1980's, but finally international pressure led to some reform. In the early 1990's a constitution was adopted for the Fourth Republic, while presidential and parliamentary elections were held, electing Jerry John Rawlings the first president. He was re-elected in 1996 in elections that were judged to be free of corruption. Four years later Ghana successfully transferred presidential power for the first time in its history. This success has continued into the 21st century (U.S. Department of State, 2010a).

Economically Ghana is definitely the most well off of the three countries in this study. Its 2010 GDP is far higher than either of the other two countries, at $18.06 billion. This divides out to a GDP per capita of $1600, more than double that of Niger. The economy has sustained a healthy growth rate over the past several years, usually around 5% in a given year. The service sector, the fastest growing sector in the economy, recently surpassed agriculture as the biggest, producing an estimated 41.6% of GDP in 2010; however, the majority of people still work in the agricultural sector. Agriculture follows at 33.7% of GDP, and last is industry at 24.7% (CIA Ghana 2011). The biggest exports from Ghana are cocoa, gold, and timber, and there have been new additions to the traditional exports as well, like pineapples, yams, and cashews. Tourism, an industry that would not be prominent in most sub-Saharan African nations, is also a growing part of the economy, and is becoming a bigger foreign exchange earner. This progress is in line with many of the changes that the economy has undergone in the past couple decades (DHS Ghana 2008). Ghana has a measurable unemployment rate, which is around 11%. In addition, only

28.5% of the population lives under the poverty line (CIA Ghana 2011). Even though Ghana does have a lower level of poverty than many other nations in the region, the government "has embarked on various economic and poverty-reduction programmes with the aim of improving the living conditions of its citizenry" (DHS Ghana 2008, 2).

Of the three countries in this study, Ghana possesses the most developed educational system, partially due to recent improvements. All primary schools are now required to also have a nursery or kindergarten, and all government basic schools are tuition-free (DHS Ghana 2008). Sixty-eight percent of children are enrolled in some sort of pre-primary school. The primary school enrollment rate for girls is 77%, which is one percentage point higher than the boys' rate. Secondary school enrollments are 49% for boys and 45% for girls. Both of these sets of numbers are recent increases. Around the turn of the 21st century the average primary enrollment rate was around 60%, while the rate for secondary school was about 34%. The adult literacy rate is 65.8%, and still displays a gender imbalance, as the literacy rate for women is 59.3% and the male counterpart is 72.3%. The youth literacy rate is higher, sitting at 79.3%, and the gender inequality no longer exists. This is again a sign of a system that has been improving in recent years (UNESCO Ghana 2010). The school life expectancy is ten years. Reflecting the improved system, in 2005 Ghana ranked 52nd in the world in spending on education as a percentage of GDP, spending 5.4% (CIA Ghana 2011).

Method

In this study I am interested in exploring how fertility is affected by its basic determinants, especially women's education. More specifically, I want to determine how the effects might be different in countries at different stages of the demographic transition. To do this I performed two types of analyses on the data. For this paper I decided to begin looking at

fertility with an estimated ordinary least squares regression which used total children ever born as the dependent variable. In order to try to produce a more robust interpretation of the results, I followed this regression by performing a logit analysis, using births in the past year as the dependent variable. This offers a much more short-term look at the fertility behavior in each of the countries. A logistic analysis was used in this case because the dependent variable, births in the past year, is almost always 0 or 1. This makes it essentially binary, which calls for logit analysis to be used.

Knowing the two regressions that I would be performing, I had to decide on variables that I wanted to use. I started by performing a recode that would result in a binary variable measuring births in the past year that I could use as the dependent variable in the logit analysis. One variable that relates directly to fertility outcomes is the age of the woman. Her age is a direct reflection on her ability and exposure to risk of having children. Biologically, both a ten year old girl and a fifty year old woman are at a much lower risk to bear a child at any given time than a twenty-five year old woman; this affects births in the past year, the dependent variable in the logistic regressions. At the same time, that fifty year old woman is much more likely to have given birth in her lifetime than a young girl, which impacts the children ever born variable. Thus, as age is directly tied to both dependent variables, I felt age was definitely an important consideration. To go along with this, I included the square of the woman's age. This allows for the existence of a nonlinear relationship between age and fertility.

Since women's education is the variable of highest interest in this study I added that along with the age and age squared variables. It is usually the young who are in school, and also the onset of formal education is usually determined by age, so I thought education made sense in the first group. In order to paint a truer picture of the relevance of women's education I had to

first create a set of dummy variables. A dummy variable takes the value of 0 or 1, indicating the presence of a variable in a certain category. So, for example, years of education is split into six dummy variables: none, primary, secondary 1-2, secondary 3-4, secondary 5-6, and university. The recoding of the data ensures that each respondent falls in only one of these categories.

Equation 1

Births per woman= $\beta_0 + \beta_1 * \text{Age} + \beta_2 * \text{Age}^2 + \beta_3 * \text{Prim} + \beta_4 * \text{Sec12} + \beta_5 * \text{Sec34} + \beta_6 * \text{Sec56} + \beta_7 \text{Univ.}$

In Equation 1, if a respondent had only up to primary education, then that respondent is coded 1 for primary and 0 for the other education dummies, ensuring that only the coefficient corresponding to primary education affects the estimate. This technique was followed with every variable except age and age squared. For each set of dummies there is a reference category that is left out of the regression when the calculation is done, which is usually chosen based on being a large proportion of the sample. I followed the first set of variables with a group of variables including the religion and ethnicity of the woman. These are strong influences on people's lives in general, and I wanted to see how much they affect fertility decisions.

With these decisions made I turned to the calculation. I used Stata to execute both the ordinary least squares analysis and the logit analysis. The resulting regressions are useful because they show how much of the variance in the dependent variable is explained by the independent variables that were just described. The output is given as a set of coefficients to an equation like the one shown in Equation 1. The given coefficient is multiplied by the variable itself, and the result is an equation that theoretically could calculate the predicted number of births per woman, all based on the explanatory power of the variables.

The fullest regression includes all variables shown in Equation 1 above (here with no education as the reference category) as well as the religion and ethnic group variables. Here β_0 is

the intercept, and the other β terms represent the coefficients that are the result of a particular regression. The preliminary expectation is that age would have a positive effect on fertility, which would decrease as age further increases. This means positive coefficients for age, while age squared would have negative coefficients. In addition, the expectation is that education will generally have a negative effect on fertility rate, while the coefficients for religion and ethnicity cannot be generalized into a pattern.

The first sets of coefficients reported in the tables include only age, age squared, and the education dummy variables. Then I added the religion and ethnic group variables. An important note about the regressions is that the same method was used on all regressions in all of the countries. So variables were always added in the same order, and the same variables were used on each country. The only exception here is that the ethnicity and religion variables are different for each country based on the presence of different religions and ethnicities. The first set of results is for the dependent variable of births per woman, while the second set of results reports the logit analysis using the occurrence of one or more births in the past year as the dependent variable.

The tables in the Appendix contain the mean values for the variables used in the regressions. Appendix Table 1 shows these values for Niger, the country in the study with the highest fertility rate. The average number of children ever born for women in the data set is 3.73, and the average age of the women is over 28 years. The majority of the women in the survey are Muslim. The Haoussa, Djerma/Songhai, and Touareg ethnicities make up the majority of the population. Appendix Table 2 contains similar values for Sierra Leone. Here the average number of children ever born for women in the study is 2.87, about one lower than in Niger. Roughly three quarters of the women are Muslim, and the dominant ethnic groups are

Mende and Temne. Appendix Table 3 shows the corresponding figures for Ghana, which has the lowest observed fertility rate of these countries, as the average number of children ever born for the survey respondents is 2.42. Islam is not practiced as widely, while indigenous religions are much more widespread. The Akan ethnic group makes up the biggest percentage of the population.

The most important information that comes from these three tables is the differences in educational attainment. In Niger the dominant educational category is none, which accounts for over three quarters of the women in the sample. In Sierra Leone this number is still large, as about 60% of the women are uneducated, but there is a marked decline. As for Ghana, only one quarter of the respondents is completely uneducated, and just under 50% have had some form of secondary education. This is the first evidence of a strong negative relationship between women's education and fertility rate.

Estimated Ordinary Least Squares Analysis

A. Niger

The Haoussa, Djerma/Songhai, and Touareg ethnicities make up the majority of the population. Equation 1) from Table 2 regressed children ever born on age, age squared, and education. The resulting coefficients for age and age squared are highly significant and indicate that the variable children ever born increases with age, but at a decreasing rate. According to the data, the turning point in age where births would begin to decrease is 74.5, which is beyond the relevant biological range. To find this age, one must calculate a partial derivative on the age and age squared coefficients. Using the first-order condition for finding a maximum, I set the partial derivative equal to zero and solved for the corresponding value. So essentially children ever born increases with age, but at a decreasing rate. After controlling for age, it is easy to see that

education is an extremely important variable, as each level of education is also highly significant. The coefficients become more negative as education increases, ranging from -.536 to -3.257, which indicates that as women become more educated they have fewer children. The R-squared value, which describes how much of the variance in births is explained by the model, is .653.

Table 2			
Regression Analysis of Children Ever Born, 2006, Niger			
Variable		1)	2)
Age at Survey	Age	0.462**	0.463**
	Age Squared	-0.0031**	-0.0031**
Education	None		
	Primary	-0.536**	-0.478**
	Sec. 1-2	-0.875**	-0.777**
	Sec. 3-4	-1.290**	-1.212**
	Sec. 5-6	-1.859**	-1.779**
	University	-3.257**	-3.145**
Religion	Muslim		
	Christian		-0.338
	Other Religion		0.284
Ethnic Group	Arab		-0.553**
	Djerma/Songhai		-0.576**
	Gourmantche		-0.335
	Haoussa		
	Kanouri		-0.221**
	Peul		-0.337
	Touareg		-0.468
	Toubou		-0.847
	Other		-1.307
Parameters	Constant	-6.410**	-6.173**
	R^2/Adjusted R^2	0.653/0.6527	0.6608/0.6602
	F-Ratio	2477.45	1054.85
	Number of Observations	9223	9223

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

Equation 2) adds the variables for religion and ethnic group. None of the categories in religion is statistically significant; however, the reference category accounts for ninety-eight percent of the sample, so the insignificant coefficients represent a small minority of the population. Conversely, the results for ethnicity display a strong pattern of significance, as only the Gourmantche group does not

register significantly. The others are all highly significant. Note that all ethnic groups have negative coefficients, which means the Haoussa have the highest fertility, all other things equal. All have a negative effect on children ever born, though Kanouri and Peul less so than the others. The addition of these variables does not affect the statistical significance of education, though the coefficients do get a bit less negative. The coefficients of age and age squared are essentially unchanged from Equation 1), and the R-squared value rises slightly, to 0.6608.

Table 3			
Regression Analysis of Children Ever Born, 2008, Sierra Leone			
Variable		1)	2)
Age at Survey	Age	0.370**	0.373**
	Age Squared	-0.0030**	-0.0030**
Education	None		
	Primary	-0.155*	-0.110^
	Sec. 1-2	-0.451**	-0.389**
	Sec. 3-4	-0.749**	-0.636**
	Sec. 5-6	-1.441**	-1.303**
	University	-2.092**	-1.852**
Religion	Christian		-0.172**
	Muslim		
	Other Religion		-0.215
Ethnic Group	Temne		0.227**
	Mende		
	Kriole		-0.235
	Mandingo		-0.219
	Loko		0.008
	Sherbro		-0.467**
	Limba		-0.087
	Kono		0.486**
	Other Sierra Leone		0.361**
	Other		0.229
Parameters	Constant	-4.883**	-5.032**
	R^2/Adjusted R^2	0.5204/0.5200	0.5277/0.5265
	F-Ratio	1142.03	456.54
	Number of Observations	7374	7374

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

B. Sierra Leone

In Equation 1) from Table 3 the coefficients for age and age squared are highly

significant, and show us that fertility increases with age but at an ever decreasing rate. Here the turning point is around age 62, which, though lower than in Niger, yet again is not in the pertinent range. The education variables are compared to the reference category of no education, and all are significant. In addition, all affect fertility negatively, and the range is from -.155 to -2.092, a significant decrease. The notable difference is primary education, which is only significant at the 5% confidence level, whereas the rest are significant at the 1% level. The R-squared value is .5204.

In Equation 2) religion and ethnicity are added. The two biggest categories in religion are Christian and Muslim, and the latter is omitted as the reference category. Christians have significantly lower fertility than Muslims, while the small category of other religion is not significant at all. In Sierra Leone there is a broad range of ethnicities, and several are significant to fertility behavior. Four of the ten ethnicity variables have significant coefficients, and they are all highly significant; additionally, some of the insignificant coefficients represent only small portions of the population. Yet in terms of scale none of the significant coefficients are out of the ordinary for the rest of the ethnicities. The addition of these two variables has decreased the coefficients for education in every case, though with the exception of primary they remain highly significant. Primary has become only weakly significant. Age and age squared are almost identical in influence as in the first equation, and the R-squared value has increased just a bit to 0.5277.

C. Ghana

As in the two preceding countries, Equation 1) from Table 4 shows that the coefficients for age and age squared show that age has a positive, highly significant effect on fertility, but that this effect is at a decreasing rate. A difference in this data is that both the age and age squared

coefficients are notably smaller than in the other results, especially for age squared, where the difference is a power of ten. The strong significance of the age and age squared variables is also characteristic of the education dummy variables, as each variable shares the same level of significance as age and age squared. The R-squared value for this equation is .6453.

Equation 2) adds the religion and ethnicity variables to the regression. Of the many religious categories in Ghana only

Table 4			
Regression Analysis of Children Ever Born, 2008, Ghana			
Variable		1)	2)
Age at Survey	Age	0.243**	0.246**
	Age Squared	-0.00094**	-0.0001**
Education	None		
	Primary	-0.506**	-0.421**
	Sec. 1-2	-0.825**	-0.722**
	Sec. 3-4	-1.369**	-1.261**
	Sec. 5-6	-1.777**	-1.653**
	University	-2.483**	-2.349**
Religion	Catholic		0.021
	Anglican		0.076
	Methodist		-0.049
	Presbyterian		-0.116
	Pentecostal/Charismatic		
	Other Christian		0.124
	Muslim		-0.008
	Traditional/Spiritualist		0.554**
	No religion		0.225^
	Other		-0.011
Ethnic Group	Akan		
	Ga/dangme		-0.105
	Ewe		-0.238**
	Guan		0.100
	Mole-dagbani		-0.069
	Grussi		-0.038
	Gruma		0.338**
	Mande		-0.102
	Other		-0.273*
Parameters	Constant	-2.884**	-3.001**
	R^2/Adjusted R^2	0.6443/0.6438	0.6502/0.6484
	F-Ratio	1270.27	378.72
	Number of Observations	4916	4916

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

traditional/spiritualist is strongly significant, while one other is only weakly significant. These three all have positive coefficients. Two of the ethnicities included in the regression have highly significant coefficients, and one other is significant at the 5% level; however, the majority are not significant. The pattern and significance in education remains the same as in the first equation, with the biggest difference being the modest contraction of the absolute values of the coefficients in every case. Age and age squared remain effectively unchanged, and the R-squared value increases to .6509.

D. Comparative Analysis

Based on this estimated ordinary least squares regression analysis there are several strong indicators of fertility in these African nations. First are age and age squared, which are highly significant through all the regressions, but this makes sense in a very basic way. Fertility is tied directly to biology, and age reflects that in a straightforward manner. As the overall level of fertility in a country decreases, the coefficients for age become smaller, while the coefficients for age squared also start to approach zero from the opposite direction. A more insightful result is the strong significance of women's education. Yet again, except for primary level schooling in Sierra Leone, women's education is highly significant in every regression.

Figure 5

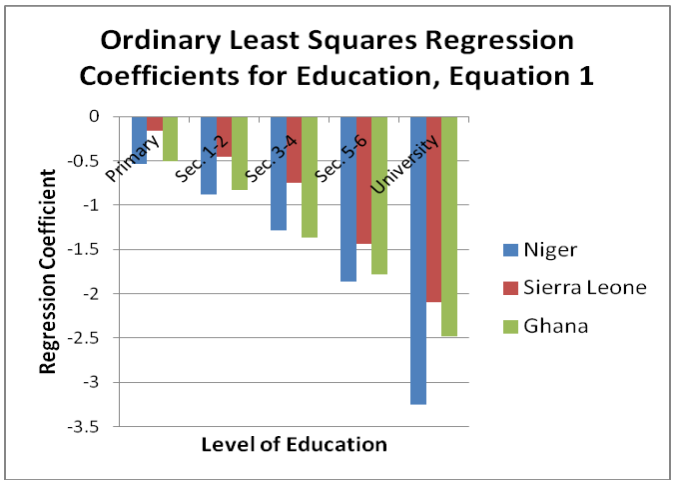


Figure 6

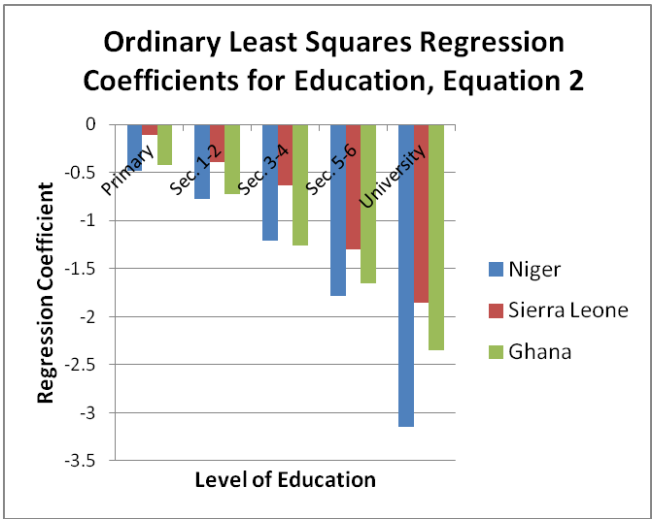


Figure 5 graphically displays the education regression coefficients for Equation 1) by country, and Figure 6 does the same for Equation 2) when additional variables are added. As can be seen from the figures, with the addition of the religion and ethnicity variables, there is a general trend that the coefficients decrease in absolute value, due to the explanatory power of the added variables. In both cases the coefficient for Niger representing university education is further removed from the other countries than at other educational levels. The coefficients for Sierra Leone are smallest in absolute value, while Niger and Ghana have values that are similar in size. This possibly suggests differences for countries squarely in the midst of the demographic transition, when much about the society may be changing. This is supportive of the temporal model suggested by Cleland. Otherwise the coefficients display strikingly similar patterns between Equation 1) and Equation 2). Ethnicity, a variable controlled for in Equation 2), is significant in the regression. Not every ethnic group registered significance, but those that accounted for a sizable proportion of the population were typically important to the results. This pattern was weakest for Ghana, where the largest ethnic group after the reference group did not register significance, but others did.

In these regressions the strongest association across countries is the age variables; however, as they are tied directly to biology, age remains insignificant to public policy. Of the three significant variables ethnicity is the most weakly significant, and again is an integral, essentially endogenous part of these populations. As such, governments and other agencies cannot focus on ethnicity as a determinant of fertility when attempting to lower birth rates. Women's education, the last significant variable, is not only of paramount importance in each nation, but is also amenable to public policy. When all of these variables are controlled for in the regressions there is constant significance of the women's education variable at all levels of education. Thus the significance of women's education emerges as the most impactful result from the first set of ordinary least squares regressions.

Logit Analysis

A. Niger

Table 5 contains the logit results for Niger. The coefficients for age and age squared are significant and tell us that the likelihood of a birth increases with age, but at a decreasing rate. This occurs until about age 28, when the probability of a birth will start to decline. The results for women's education are all highly significant. No education is the reference category, and starting with primary education the coefficients are negative and become more so. A small hiccup with this pattern is secondary 34, as the coefficient here is a bit closer to zero than secondary 12, which also happens between secondary 56 and university.

Equation 2) adds the religion and ethnicity variables to the regression; however, these variables add little significant explanatory power to the equation. Of the religion variables, Christianity is only weakly significant. Only one ethnic group, Djerma/Songhai, has a highly significant coefficient. The other eight coefficients are not significant at all. This limited effect

is reflected in the first set of variables. Age and age squared behave in much the same way as before, while the education variables also maintain the same pattern. The only difference is a slight decrease in all the absolute values of the education coefficients.

Table 5			
Logistic Analysis of Births in Past Year, 2006, Niger			
Variable		1)	2)
Age at Survey	Age	0.449**	0.452**
	Age Squared	-0.0080**	-0.0080**
Education	None		
	Primary	-0.336**	-0.300**
	Sec. 1-2	-0.901**	-0.850**
	Sec. 3-4	-0.846**	-0.807**
	Sec. 5-6	-1.535**	-1.506**
	University	-1.349**	-1.275**
Religion	Muslim		
	Christian		-0.806^
	Other Religion		0.288
Ethnic Group	Arab		-0.101
	Djerma/Songhai		-0.245**
	Gourmantche		-0.286
	Haoussa		
	Kanouri		-0.076
	Peul		-0.130
	Touareg		-0.010
	Toubou		-0.386
	Other		-0.292
Parameters	Constant	-6.874**	-6.841**
	Pseudo R^2	0.065	0.068
	Log Likelihood	-4624.476	-4611.678
	Number of Observations	9223	9223

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

B. Sierra Leone

Table 6 shows the results of the logit analysis for Sierra Leone. Age and age squared are both significant, and indicate that age and the probability of a birth in the past year increase together until about age 27, but at a decreasing rate. Education is not universally significant, as the secondary 12 is the first dummy variable to register any level of significance, here at the 5% level. The last three are all highly significant, but primary is not significant at all. The coefficients are all negative, and become more negative as education increases.

In Equation 2) religion and ethnicity are added to the regression. Of all the categories in these two variables only three register any significance, all of which are ethnicities, but none register significance at the 1% level. Some of the coefficients are positive, which indicate a higher probability of a birth relative to the reference group, and others are negative, which signify a lower probability than the reference group. The effect on the first set of variables when the religion and ethnicity variables are added is also limited. Age and age squared hold about the same significance and magnitude as before. In addition, the educational variables hold their pattern of significance, while the notable difference is a small contraction of the absolute values of the coefficients as was the case in Niger.

Table 6			
Logistic Analysis of Births in Past Year, 2008, Sierra Leone			
Variable		1)	2)
Age at Survey	Age	0.351**	0.353**
	Age Squared	-0.0064**	-0.0064**
Education	None		
	Primary	-0.112	-0.105
	Sec. 1-2	-0.249*	-0.235*
	Sec. 3-4	-0.622**	-0.588**
	Sec. 5-6	-0.775**	-0.741**
	University	-0.887**	-0.827**
Religion	Christian		-0.062
	Muslim		
	Other Religion		-0.216
Ethnic Group	Temne		0.138^
	Mende		
	Kriole		0.086
	Mandingo		-0.483*
	Loko		0.000
	Sherbro		-0.241
	Limba		0.088
	Kono		0.294*
	Other Sierra Leone		0.050
	Other		-0.037
Parameters	Constant	-5.683**	-5.750**
	Pseudo R^2	0.045	0.047
	Log Likelihood	-3505.093	-3497.115
	Number of Observations	7374	7374

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

C. Ghana

The results for the logit analysis on Ghana are located in Table 7. Age and age squared both have highly significant coefficients that also signify that the probability of a birth in the past year and age rise together until about age 29, though age has an increasingly smaller effect. As with the previous logit regressions the education variables continue to be highly significant, again the exception occurring in Equation 2) for primary education. The pattern of small deviations from the general trend that more education equates to fewer births can again be seen in the education coefficients for

Table 7			
Logistic Analysis of Births in Past Year, 2008, Ghana			
		1)	2)
Variable			
Age at Survey	Age	0.639**	0.648**
	Age Squared	-0.011**	-0.011**
Education	None		
	Primary	-0.235*	-0.171
	Sec. 1-2	-0.705**	-0.62**
	Sec. 3-4	-0.676**	-0.538**
	Sec. 5-6	-1.097**	-0.976**
	University	-1.034**	-0.872**
Religion	Catholic		0.073
	Anglican		0.165
	Methodist		-0.364^
	Presbyterian		-0.140
	Pentecostal/Charismatic		
	Other Christian		0.094
	Muslim		0.148
	Traditional/Spiritualist		-0.115
	No religion		0.139
	Other		-0.572
Ethnic Group	Akan		
	Ga/dangme		-0.073
	Ewe		0.301*
	Guan		0.337
	Mole-dagbani		0.048
	Grussi		0.471*
	Gruma		0.493*
	Mande		-0.648
	Other		-0.241
Parameters	Constant	-9.862**	-10.204**
	Pseudo R^2	0.098	0.105
	Log Likelihood	-1826.619	-1812.820
	Number of Observations	4916	4916

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

Ghana.

The second column of Table 7 adds the religion and ethnic group variables to the age and education variables, but it is an addition that contributes little explanation to births in the past year. Only one religious affiliation achieves any level of significance, and it does so at the 10% level. Of the nine ethnic groups only three achieve significance (at the 5% level). Each of them affects fertility positively. The effect on the first set of variables is also not clear cut. The age coefficient is still significant at a decreasing rate, and the pattern of significance of the education variables is the same, though the coefficients are all a little smaller in absolute value.

D. Comparative Analysis

Without being too repetitive, the conclusions that were drawn from the ordinary least squares regressions are generally supported by the logit regressions, even though the dependent variable is different. The noteworthy change is the disappearing significance of the ethnic group variable, which is faded in part because of the limited scope of the dependent variable. Just like before, age and age squared are highly significant throughout the logit regressions, and the pattern of development as the women get older is the same. Education is also important, and in these regressions it is the most significant variable after age and age squared. In addition, the lack of evidence supporting religion as a determinant of fertility in the ordinary least squares regressions also manifests itself here, and is even weaker than before.

Summary and Conclusions

The analysis undertaken in this paper attempted to further characterize the determinants of fertility, which is an important part of the demographic transition. In both sets of regressions the education variables are significant, a trend which does not appear for the ethnic group variables, which are more important in the ordinary least squares regressions. The significance

of women's education is usually higher and more widespread in the ordinary least squares regressions, due to the fact that the dependent variable takes into account the entire birth history of the women in the surveys. The logit regressions only look at the incidence of at least one birth in the past year, which limits the data significantly.

In sum, the evidence here suggests that a negative relationship exists between women's education and fertility. Thus if investments are made to improve the education of women in a developing region it is likely to result in a decrease in the birth rate. This will lead directly to a demographic dividend, which represents a moment of opportunity for developing nations. If the government that presides over such a swell in working age population can continue to make the appropriate educational investments and encourage savings then the end result is a growth in the economy. In the efforts to encourage development across entire world, universal education is a goal that has been well established by the United Nations and other non-governmental organizations. Not only is the education of women beneficial for the improvements that it encourages in gender equity, but the evidence here suggests it can also begin the process of economic growth. Since education is directly amenable to public policy it should continue to be a focus for the development community into the future.

Appendix

Table 1		
Summary Table of Mean Values, Niger		
Variable		
Children Ever Born		3.727
Age		28.457
Age Squared		895.251
Education	None	0.769
	Primary	0.130
	Secondary 1-2	0.036
	Secondary 3-4	0.040
	Secondary 5-6	0.013
	University	0.011
Religion	Muslim	0.983
	Christian	0.007
	Other Religion	0.010
Ethnicity	Arab	0.009
	Djerma/Songhai	0.253
	Gourmantche	0.006
	Haoussa	0.429
	Kanouri	0.077
	Peul	0.069
	Touareg	0.132
	Toubou	0.010
	Other	0.015
Number of Observations	9223	

Table 2		
Summary Table of Mean Values, Sierra Leone		
Variable		
Children Ever Born		2.866
Age		28.975
Age Squared		919.224
Education	None	0.626
	Primary	0.142
	Secondary 1-2	0.098
	Secondary 3-4	0.052
	Secondary 5-6	0.055
	University	0.025
Religion	Muslim	0.728
	Christian	0.262
	Other Religion	0.010
Ethnicity	Temne	0.284
	Mende	0.369
	Kriole	0.020
	Mandingo	0.023
	Loko	0.024
	Sherbro	0.019
	Limba	0.075
	Kono	0.059
	Other Sierra Leone	0.119
	Other	0.008
Number of Observations	7374	

Table 3		
Summary Table of Mean Values, Ghana		
Variable		
Children Ever Born		2.418
Age		28.997
Age Squared		934.924
Education	None	0.256
	Primary	0.209
	Secondary 1-2	0.123
	Secondary 3-4	0.259
	Secondary 5-6	0.102
	University	0.046
Religion	Catholic	0.149
	Anglican	0.009
	Methodist	0.067
	Presbyterian	0.071
	Pentecostal/Charismatic	0.345
	Other Christian	0.097
	Muslim	0.169
	Traditional/Spiritualist	0.054
	No religion	0.036
	Other	0.002
Ethnicity	Akan	0.434
	Ga/dangme	0.063
	Ewe	0.130
	Guan	0.024
	Mole-dagbani	0.218
	Grussi	0.046
	Gruma	0.041
	Mande	0.006
	Other	0.039
Number of Observations	4916	

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Education

The Pennsylvania State University, University Park, PA — Fall 2007- Fall 2011
The Schreyer Honors College — Expected Graduation Date: December 2011

- Major: Economics
  - Coursework- Microeconomic and Macroeconomic Analysis, Statistical Foundations for Econometrics, Introduction to Econometrics, Labor, Growth and Development, Poverty
- Minor: Mathematics
  - Coursework- Calculus I-III, Matrices, Analysis, Probability, Matrix Algebra, Theory of Games

Experience

Honors Program in Economics — 2010-2011

- A two part, year-long seminar in the Department of Economics for senior students which required a full year seminar and the completion of an honors thesis

Teaching Assistant, Penn State University Department of Economics — Fall 2009-Fall 2011

- Worked with two different faculty members over three semesters to prepare documents for the class, grade assignments and tests, and hold office hours

Research Experiences for Undergraduates — Summer 2010

- Worked closely with my academic advisor on economic research he conducted over the summer, assisting primarily in data manipulation, calculation, and presentation

Activities

School

Penn State Lion Ambassadors — January 2009- December 2011

- President (April 2010-April 2011)
  - Coordinated executive board and general membership meetings; directed the membership, strategic planning, and philanthropy committees; represented the group on Alumni Council
- Committee Director (April 2009-April 2010)
  - Organized and executed one project each semester (S-Zone and Old Main Open House); directed the induction of new members to the committee in the spring; fulfilled executive board responsibilities

Penn State Student Handbook Committee, Co-Editor — Spring 2010-Spring 2011

- Wrote and edited specific sections of the "S-Book", a handbook made for incoming first year and transfer students.

Awards/Honors

Schreyer Honors College Academic Excellence Scholarship — Fall 2007- Spring 2011
Bunton Waller Merit Award — Fall 2007- Spring 2011
Student Leader Scholarship — 2010-2011
Lion's Paw Senior Honor Society — Spring 2010-Spring 2011

- Chosen as 1 of 14 students for outstanding leadership in the entire senior class to carry out the Lion's Paw charge of promoting the welfare and perpetuating the traditions of Penn State.

Skull and Bones Senior Honor Society — 2010-2011