University of Pretoria
Department of Economics Working Paper Series

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Working Paper: 2015-26
May 2015

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Education and Fertility: Panel Evidence from sub-Saharan Africa*

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May 6, 2015

Abstract

We study the effects of different levels of education on fertility in 48 sub-Saharan African countries between 1970 and 2010. The results, based on panel data analysis with fixed effects and instrumental variables, show how that lower education levels do not have a significant effect on people's fertility decisions. However, the results from the higher education levels suggest otherwise. They are indicative of a region that is transitioning from the Malthusian epoch to a modern growth regime in which people substitute quantity for quality of children. Lower fertility implies less strain on public expenditure, higher human capital and higher productivity which can lead to sustained economic growth as witnessed in most developed regions today.

Keywords: education, fertility, sub-Saharan Africa

JEL Classification: O55, J13, I25

*We acknowledge the comments that we received at the brown bag seminar at the University of Pretoria, 2014 and PhD workshop hosted by Economic Research Southern Africa in Pretoria, 2014.

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1 Introduction

Does education attainment lower fertility? This question is relevant because both education and lower fertility rates are viewed as important processes of economic development within countries transitioning from developing to developed economies (Becker, Cinnirella & Woessmann 2010; Galor 2005; Reher 2011). Education especially has been linked to improved technology and skilled labour which in turn improves productivity (Becker, Murphy & Tamura 1990; Hansen & Prescott 2002). To date empirical analysis has given significant attention to the contributory role that the rise in demand for education plays in lowering fertility rates and giving rise to the demographic transition and its spread to regions outside Western Europe (Becker *et al.* 2010; Bittencourt 2014; Doepke 2004; Galor 2005, 2012).

Our study adds to this literature by examining the post-independence transition of sub-Saharan economies using the unified growth theory. This theory has been cited as inducing the child quantity-quality trade-off which eventually resulted in the demographic transition from high to low fertility rates. Most developed economies of today are characterised by high human capital accumulation, low fertility rates and high levels of productivity.

We investigate whether the effects of different levels of education, along with other associated variables suggested by literature, such as infant mortality and income per capita, induce a decline in the fertility rates of 48 sub-Saharan African countries between 1970 and 2010. Using panel data analysis with fixed effects to control for heterogeneity and instrumental variables to account for endogeneity, we find that lower education levels do not have a significant effect on people's fertility decisions. However, the results from the secondary education levels show a consistent negative relationship with fertility, suggesting that higher levels of education are significant in lowering fertility in the region. This result is evidence of economies that are entering their own demographic transitions and moving from a Malthusian stagnation to modern economic growth, albeit more than a century after Western Europe (Galor 2005).

Several explanations in literature have been reviewed as triggering the decline in fertility rates. Firstly, the Barro-Becker theory (1988, 1989) which focuses on opportunity costs involved with rising income per capita which

may induce parents to substitute the quantity of children for higher quality[1]. Secondly, the unified growth theory which emphasises the role of technology in encouraging investments in child education (Galor 2005)[2]. Thirdly, the decrease in the gender gap which raises the cost of children (Galor & Weil 1996)[3]. Fourthly, the change in traditions regarding the old-age security hypothesis which views the younger generation as a measure of security for the older generation (Galor 2012; Reher 2011)[4]. Lastly, the declining mortality rates which reduces the need to have more children to replace those that may not survive (Conley *et al.* 2007; Murtin 2013).

However, the differences in the timing of the fertility declines have also given rise to the differences in the take-offs of the demographic transitions, and this has led to the varying levels of economic development which we find between developed and developing economies today (Cervellati & Sunde 2013; Doepke 2004; Galor 2005; Galor & Mountford 2008; Reher 2011). Figure 1 illustrates these differences within sub-Saharan Africa. The more mature economies in the region, such as Botswana, Mauritius, Seychelles and South Africa, have earlier take-offs in fertility declines than the poorer economies such as Democratic Republic of Congo, Eritrea, Niger and Rwanda.

[1] Becker and Barro (1988, 1989) find that when the opportunity costs of raising children are high, either via increased wage rates or tax on children, they lower fertility in a model of intergenerational altruism. (See also Becker, Murphy & Tamura 1990).

[2] According to the unified growth theory, the process of development is divided into three distinct periods, the Malthusian epoch which is characterised by relatively constant income per capita and population growth, negligible technological progress and low returns on investment in education. As a result the relationship between income per capita and population growth is positive. The second period is the Post-Malthusian regime. As technological rates increase, the demand for skilled labour also increases which in turn raises the returns on human capital accumulation and encourages the population to invest in the education of their children, and have less children, a process known today as the child quantity-quality trade-off. This demographic transition allows income to keep rising and helps to move the economy into the third sustained growth regime characterised by low fertility rates, low population growth rates, high skilled labour, high income per capita and high productivity (Galor 2005, 2012; Galor & Weil 1999, 2000; Galor & Moav 2002).

[3] Galor & Weil (1996) determine that the reduction in the gender gap has resulted in lower fertility rates. As demand for women's participation in the labour force increases, so do the wages for women which raise the cost of children relatively more than they raise household income, hence leading to decisions to have fewer children. (See also Schultz 2008; Van der Vleuten & Kok 2014).

[4] The introduction of capital markets, the establishment of national pension schemes, not to mention nursing homes, negated the traditional views of having many children for old age security (Galor 2012; Reher 2011).

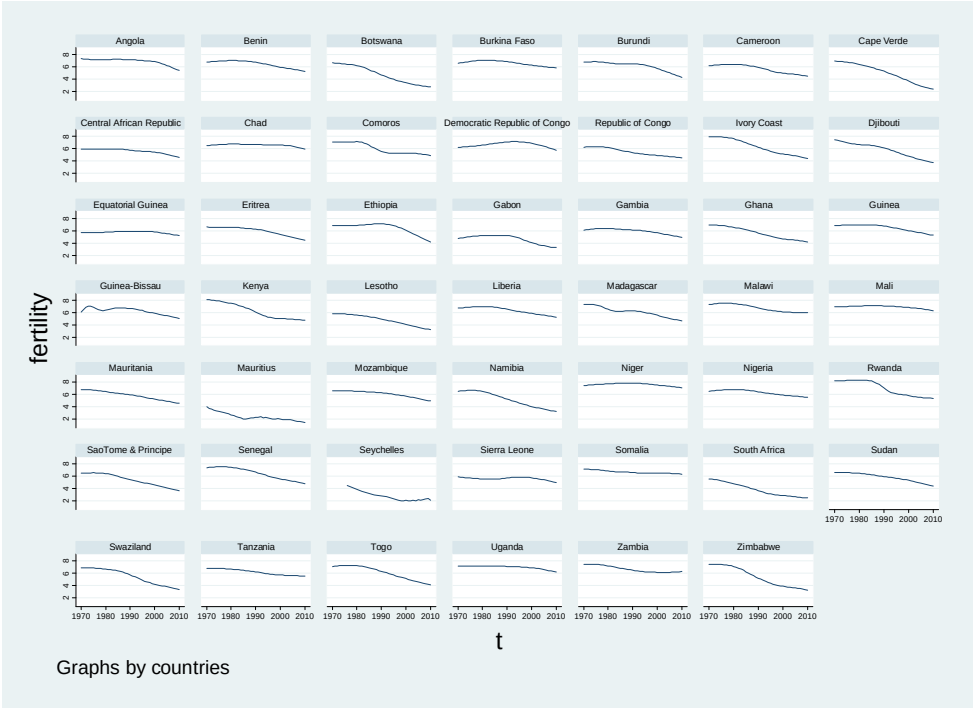

Figure 1: Fertility rates across countries (Source: World Development Indicators, 1970-2010)

A comparison of global regions' population growth and fertility rates in Figure 2 shows a delay in the decline of sub-Saharan Africa's rates. The population growth rates in the region decrease slightly during the late 1980s due to the improvements in post-independence child health care which increased survival of infants and led to fertility declines (Van der Vleuten & Kok 2014). Most of the regions, including other developing ones like South Asia and Latin America, are already exhibiting declining population growth rates by the late 1970s. The fertility rates for the other regions also decline over the period to between 2 and 3 children per women, while sub-Saharan Africa to date is still double that (Conley *et al.* 2007).

This delay in the decline of fertility rates makes our paper relevant in investigating the triggers for the take-off, specifically if there is evidence of a trade-off between education and fertility present in sub-Saharan Africa as postulated by the unified growth theory, and what the implications of this trade-off may be towards economic development in the region.

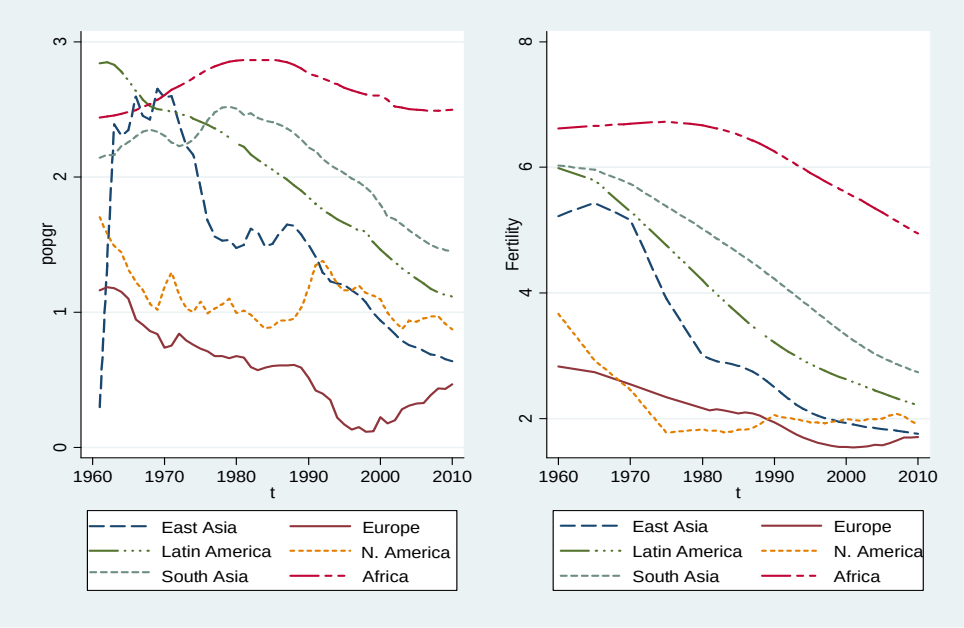

Figure 2: Population Growth Rates and Total Fertility Rates (Source: World Development Indicators, 1960-2010)

2 Empirical Analysis

2.1 Data

We use a sample of 48 countries covering 41 years from 1970 to 2010. Most data for African countries is available from the year of the country's independence, which in this case is from the 1960s onwards. Given that several European countries were already exhibiting a quantity-quality trade-off in the 19^{th} century (Becker *et al.* 2010; Galloway *et al.* 1998; Klemp & Weisdorf 2012), inclusion of countries from other regions may not give a true reflection of the effects of education on fertility in sub-Saharan Africa.

The dependent variable (*fertility*) is the total fertility rate which measures the number of births per woman and is obtained from the World Development Indicators (WDIs).

We use three different variables for education levels. Primary education (*primary educ*) measures the gross primary enrollment rate as a percentage of the population. The secondary education variable (*secondary educ*) is the gross secondary enrollment rate as a percentage of the population. The third education variable (*girl-boy educ*) is a measure of the gender gap in

schooling. The variable is the ratio of girls to boys in primary and secondary education. All three variables are obtained from the WDIs. A negative and significant coefficient for the education variables suggests a trade-off between education and fertility. This trade-off indicates a child quantity-quality preference as educated people realise the benefits of schooling and start investing more in the education of their offspring. According to the unified growth theory this quantity-quality trade-off played a significant role in the onset of the demographic transitions in Western Europe, (Becker *et al.* 2010; Galor 2012).

To avoid omitted variable bias we introduce some control variables based on the various literature (Becker & Barro 1988; Becker *et al.* 1990; Cervellati & Sunde 2013; Conley *et al.* 2007; Galor 2005). These controls include infant mortality and income per worker. The mortality variable (*mortality*) is the infant mortality rate per 1,000 live births taken from the WDIs. We expect a positive relationship between mortality and fertility rates. As fewer infants die due to improved health facilities and knowledge, fertility rates should decline (Cervellati & Sunde 2013; Conley *et al.* 2007; Reher 2011).

Income per worker (*gdp)* is taken from the Penn World Tables 7.1 and is converted using the purchasing power parity at 2005 constant prices. We expect a negative relationship between income and fertility rates which may suggest that as income increases, the opportunity cost of raising children increases resulting in people choosing to have fewer children (Becker & Barro 1988; Becker *et al.* 1990; Galor & Weil 1996; Schultz 2008).

For robustness, we also include urbanisation and conflict as added control variables (Galloway *et al.* 1998; Vandenbroucke 2004). As stated in Galloway *et al.* (1998), people that live in urban areas may have better access to information concerning contraception, differences in perceived value of children, and a greater receptivity to newer ideas when compared to rural areas. Urban areas are also more technologically advanced which according to the unified growth theory is instrumental in families ' decisions to have less children (Galor 2005). New technology creates a demand for the ability to analyse and evaluate new production possibilities, which raises the return to education (Galor & Weil 2000). As a result people have more incentive to get educated and to invest in the education of their children than rural based population. We therefore expect urbanisation to be associated with lower fertility rates. The urbanisation variable (*urban*) is taken from the

WDIs and measures urban population as a percentage of total population.

Evidence by Vandenbroucke (2014), finds that conflict may cause a negative shock to the household by increasing the probability of a woman remaining alone and reducing income via the death of the husband, or the period that he is away from home. This may negatively impact on fertility during the war. For instance, Caldwell (2004) provides evidence that fertility declined in several European countries during various episodes of social and political unrest. However, Vandenbroucke (2014) also finds that fertility rebounded postwar induced by a catch-up effect from households that could still have children. Since conflict has been persistent in sub-Saharan Africa over the years, we expect that fertility may have been adversely affected during times of unrest, but there may also be a temporary increase in birth rates during times of stability. The variable is obtained from the Armed Conflict and Intervention datasets (2013) compiled by the Center for Systemic Peace and it captures the number of major episodes of international conflict involving the country between 1970 and 2010. All variables are logged, except conflict.

2.2 Descriptive Statistics

We show the means, standard deviations, as well as the minimum and maximum statistics in Table 1. According to Van der Vleuten & Kok (2014), the fertility rates in the region have remained high until recently and this is shown by the average fertility rate in the region which is about 5.9 children per woman. Interestingly, when we look at the data in detail, we find that the richer economies, such as Botswana, Mauritius, Seychelles (with the highest income per worker at $62,338.66) and South Africa, are also characterised by lower fertility rates (Mauritius has the lowest at 1.47 children per woman), lower mortality rates (Seychelles has the lowest at 11.5 children per 1,000 births), less episodes of conflict and higher education attainment rates (both Mauritius and Seychelles are among the countries with the highest secondary and primary enrollment rates).

The opposite holds true for the poorer countries. The Democratic Republic of Congo (DRC), Eritrea, Niger and Rwanda are some of the poorer economies (DRC has the lowest income per worker at $481.95) in the region. They are characterised by high fertility rates (Rwanda is among the highest at 8.3 children per woman), high mortality rates, more episodes of conflict

(Rwanda with the highest at 10, coming from the genocide in 1994) and low education attainment rates (Eritrea and Niger have some of the lowest primary enrollment rates). These countries' economies have also been adversely affected by conflict over the years, and the high fertility rates in these countries may reflect the catch-up effect suggested by Vandenbroucke (2014).

Table 1: Descriptive Statistics

Variables	Obs	Mean	Std. Dev.	Min	Max	Sources
Fertility	1945	5.89	1.23	1.47	8.29	World Bank
Primary Educ	1612	80.27	32.95	7.86	207.82	World Bank
Secondary educ	1244	25.28	22.35	1.06	122.20	World Bank
Girl-boy educ	1113	79.19	20.32	29.42	146.83	World Bank
Mortality	1924	94.27	35.35	11.50	199.50	World Bank
Gdp	1916	5226.45	7343.16	481.95	62338.66	Penn World Tables
Urban	1968	30.63	15.67	2.38	85.84	World Bank
Conflict	1812	0.85	1.81	0	10	Center for Systemic Peace

Figure 3 depicts the geographical distribution of fertility and gross primary enrollment rates in the region for 1989 and 2009. The distribution confirms that the relatively mature economies, such as Botswana, Mauritius and South Africa show higher levels of education and lower fertility rates compared to the poorer economies, such as Niger and Rwanda. Data coverage also improves over the years in the region, especially primary enrollment rates, which helps with more accurate analysis of the economies.

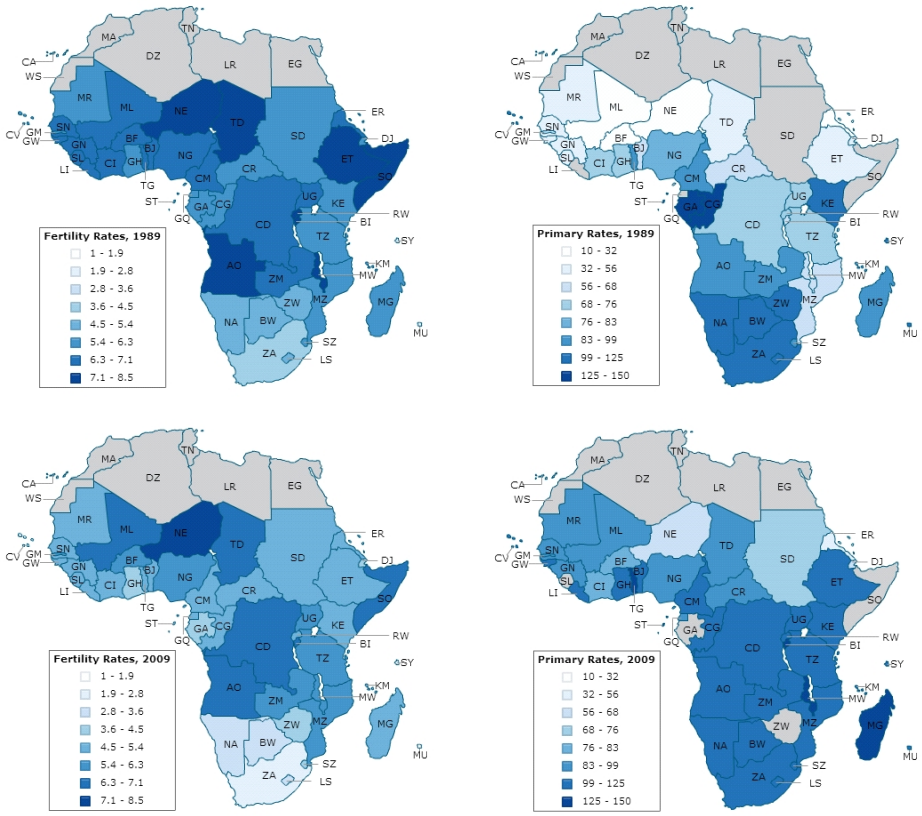

Figure 3: Fertility and Primary Enrollment Rates in sub-Saharan Africa (Source: World Development Indicators)

We offer a brief look at the correlations in Table 2. The negative correlation between the education variables and fertility suggests a trade-off in education and fertility. The remaining controls are statistically in line with expectations. Infant mortality is positively correlated with fertility, as is the conflict variable suggesting a postwar catch-up effect in the region. Both urbanisation and income per worker are negatively correlated with fertility suggesting that as countries become more developed, fertility rates start to decline. Among the determinants of fertility, secondary education, the ratio of girls to boys education and infant mortality are the most correlated with the dependent variable.

Table 2: Correlation Matrix

	Fertility	Primary educ	Secondary educ	Girl-boy educ	Mortality	Gdp	Urban	Conflict
Fertility	1.000							
Primary educ	-0.494*	1.000						
Secondary educ	-0.797*	0.576*	1.000					
Girl-boy educ	-0.568*	0.676*	0.530*	1.000				
Mortality	0.699*	-0.555*	-0.728*	-0.661*	1.000			
Gdp	-0.492*	0.332*	0.660*	0.341*	-0.478*	1.000		
Urban	-0.546*	0.317*	0.523*	0.190*	-0.438*	0.506*	1.000	
Conflict	0.168*	-0.124*	-0.169*	-0.091*	0.207*	-0.129*	-0.137*	1.000

Sources: World Bank, Center for Systemic Peace, Penn World Tables

When we plot the different mean education levels against mean fertility rates in Figure 4, a similar negative relationship is depicted in the graphs. This characteristic is in line with the quantity-quality trade-off theory which may indicate the onset of demographic transitions within the region.

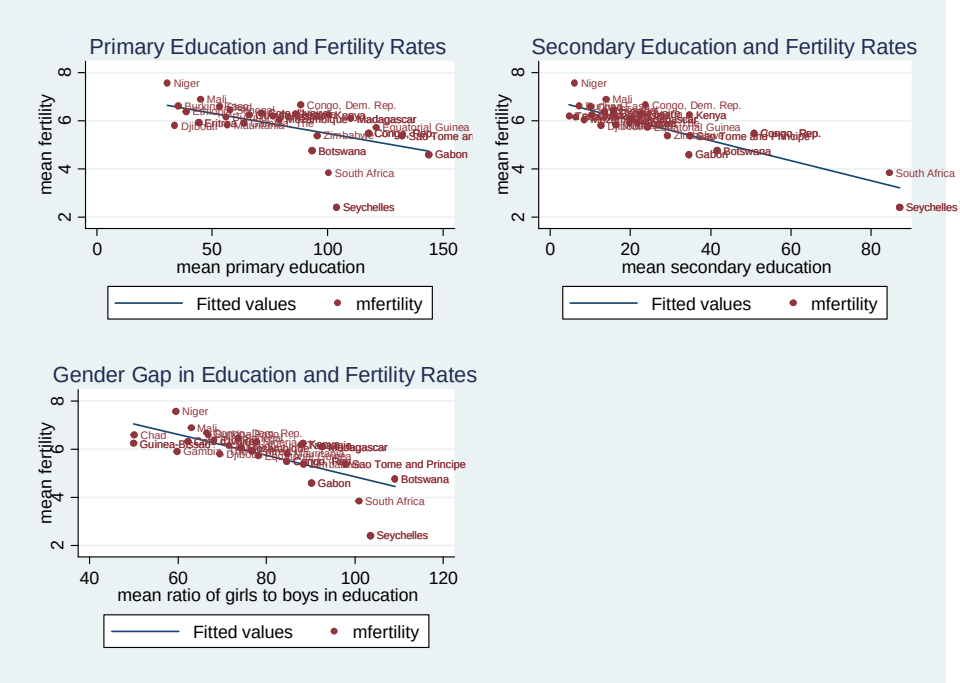

Figure 4: Education and Fertility Rates in sub-Saharan Africa (Source: World Development Indicators, 1970-2010)

3 Methodology

We estimate the following equation using panel data techniques:

$$fertility_{it} = \alpha_i + \beta_1 educ_{it} + \beta_i \mathbf{X}_{it} + \mu_{it}$$

where $fertility$ represents the dependent variable, *educ* represents the three education explanatory variables entered in separate models and $\mathbf{X}$ is a vector of control variables. The panel data approach allows us to control for heterogeneity, as well as test for more behavioural models than purely cross section or time series. This helps us to get a more informative analysis of the region.

We estimate a baseline pooled OLS (POLS) model which assumes homogeneity among the countries, that is they share common intercepts and slopes. However, countries like South Africa and Nigeria will not necessarily exhibit similar characteristics in trade policies, fiscal and monetary policies, political barriers, population growth, geographic location or access to technology. The fixed effects α_i capture the heterogeneity present in the model by taking these differences into account and incorporating individual specific effects, allowing for more efficient estimates.

Since endogeneity, in the form of reverse causality, may be present in the model via education and mortality, we use instrumental variables (IV) to minimise this problem[5]. The IV method allows consistent estimation in large samples where the explanatory variables are correlated with the error terms of a regression relationship. In other words, the instrumental variables used only influence the level of fertility through their impact on education and mortality. We instrument primary education with financial development (*credit*), secondary education with globalisation (*globalisation*), the ratio of girls to boys education with a post cold war dummy (*post-cold war*), and infant mortality with immunisation against measles (*measles*).

[5]For instance, Becker *et al.* (2010) find that causation between fertility and education runs both ways. Higher fertility may also discourage investments in human capital. Alternatively, higher stocks of capital may reduce the demand for children because that raises the cost of the time spent on child care (Becker *et al.* 1990). Furthermore, Klemp & Weisdorf (2012) show that having more children in a family reduces their chances of becoming literate and skilled in the 18^{th}-19^{th} century England. Conley *et al.* (2007) highlight the question of causal directionality between child mortality and fertility rates. They argue that increased child mortality may be due to increased fertility which increases strain on household resources, decreases parental care and supervision with the addition of more children. As reported by Dreze & Murthi (2001), high fertility may raise child mortality for biological (age of giving birth) or behavioural reasons (cultural preferences for sons instead of daughters), while high child mortality may raise fertility rates by inducing parents to replace the lost children.

All the instrumental variables are logged, except the dummy.

Finding instruments always proves a difficult task in empirical analysis, however in our opinion, these instruments represent exogenous shocks to sub-Saharan countries during the post-independence period. As such, we do not expect them to influence fertility rates directly, but rather to work through the various channels of education and infant mortality in reducing fertility rates. For example, if there are credit constraints making borrowing difficult and costly, then access to invest in human capital is impeded, whereas easy access to credit allows people to make investment decisions in education or otherwise (Becker *et al.* 1990; Galor & Moav 2004; Galor & Zeira 1993). In this instance, the exclusion restriction is that the financial development instrument is correlated with primary education, but not with fertility rates. The instrument therefore indirectly influences fertility rates through its effect in increasing access to education which in turn will lower fertility rates. According to Schultz (2008), women with access to credit or who own marketable titles to lands and other assets tend to improve their welfare and that of their children by choosing education over quantity of children. The financial development instrument is obtained from the WDIs and measures money and quasi money as a percentage of GDP.

The second instrument accounts for the latest external wave of globalisation taking place in the world including sub-Saharan Africa. The globalisation instrument is taken from a dataset compiled by Dreher (2006) and updated by Dreher, Gaston and Martens (2008). It is made up of economic, social and political globalisation which captures the international flows of goods, capital, people, information and ideas. Research undertaken by Avelino, Brown & Hunter (2005) on the effects of trade openness on education finds a positive association between the two variables. Greater international interaction between people from different nations facilitates the diffusion of ideas thus stimulating aggregate productivity (Andersen and Dalgaard 2011). Evidence by Galor and Mountford (2008) finds that gains from trade in developing countries is concentrated in non-industrial unskilled-intensive goods, such as agricultural produce, which results in little incentive to invest in education but rather encourages further increase in population. On the other hand, gains from trade in developed economies is used to improve the specialisation of industrial skill-intensive goods which induces a rise in demand for skilled labour and leads to a gradual investment

in the quality of the population. We expect globalisation to have no direct bearing on fertility rates, but rather, as cited in the literature, to increase education which in turn will lower fertility rates.

The third instrument accounts for the external democratic shock coming with the end of the cold war in the 1990s. The end of the cold war was accompanied by a movement towards promoting democratic institutions and economic development in third world countries through technical and financial assistance. One of the main aims for international assistance to developing countries is to allow poor countries to redirect their resources to programs for improving education, health and poverty. In his analysis, Dunning (2004) finds that the end of the cold war improved the effectiveness of the Western aid conditionality, whereas during the cold war, the donor's geopolitical objectives reduced the credibility of threats to condition aid on the adoption of democratic reforms. Research by Dreher *et al.* (2006) investigates the link between aid and education and they find results in favour of aid increasing primary school enrollment. Given that the Millennium Development Goals from international organisations and donors include increasing universal primary education and promoting gender equality, the end of the cold war dummy should only affect fertility through better education, suggesting the effectiveness of international assistance in increasing education levels in the region.

The instrument for mortality is the immunisation against measles (% of children ages 12-23 months) and is obtained from the WDIs. Measles outbreaks are still common in many developing countries, particularly in parts of Africa which are characterised by weak health infrastructures due to overpopulation, lack of vaccines, poor dissemination of health information and conflict (World Health Organisation, WHO; United Nations International Children's Emergency Fund, UNICEF). In view of these facts, routine measles vaccination coverage has been selected as an indicator of progress towards achieving the fourth Millennium Development Goal to reduce child mortality in developing countries (WHO). According to literature, declines in mortality are largely driven by improvements in public health, education and adoption of technologies (Soares 2007; Reher (2011; Van der Vleuten & Kok 2014; Schultz 2008). As such, increase in health awareness through the media and government programmes, as well as increase in imported preventative medicines from abroad such as vaccines, antibiotics,

artificial contraception, mosquito nets, antiretroviral drugs, *etc.* has helped infant mortality rates in sub-Saharan Africa to decline over the years. Figure 5 shows the decline in sub-Saharan Africa's infant mortality rates over the period. But it is interesting to note in the diagrams that the mortality rates start to decline earlier than the fertility rates. This suggests that the preventative measures, such as immunisations, influence fertility rates through their effects in lowering infant mortality rates[6].

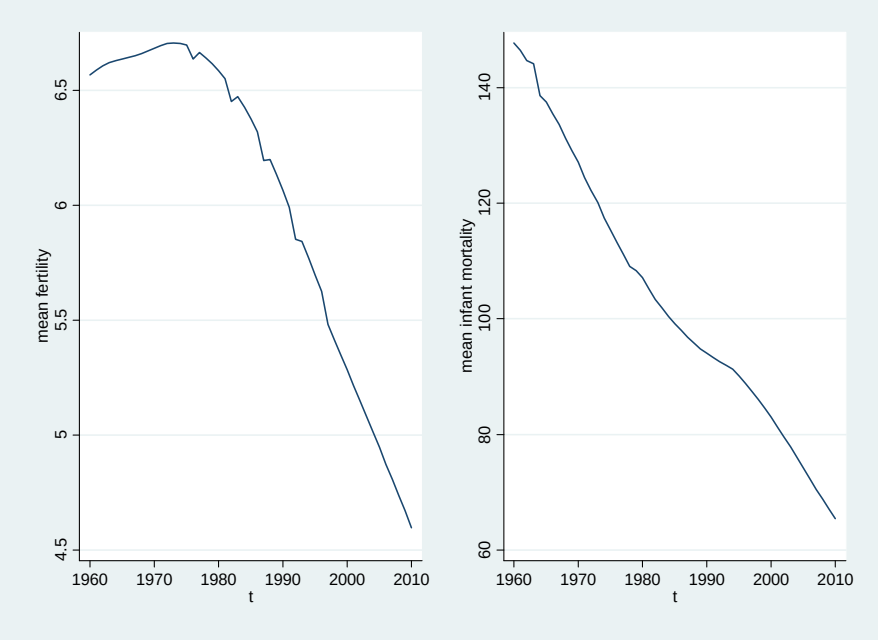

Figure 5: Total Fertility Rates and Infant Mortality Rates in sub-Saharan Africa (Source: World Development Indicators, 1960-2010)

4 Results

4.1 Basic Results

We report the results in Table 3 for both the pooled OLS and the fixed effects models. These results are the baseline regressions which include the variables stated by literature as encouraging the quantity-quality trade-off (Galor 2005). The results indicate a negative and significant relationship between secondary education and fertility rates, while the primary and gender

[6] Other instruments used in literature for infant mortality include adult male mortality (Galloway *et al.* 1998), lagged mortality (Murtin 2013); malaria ecology and percentage of population at risk of malaria (Conley *et al.* 2007).

gap education variables become positive and insignificant once we account for the heterogeneity in our panel and include control variables.

A 10% increase in secondary education diminishes fertility by about 0.5% to 2% suggesting that investing in higher education has more effect in reducing fertility than primary level or the ratio of girls to boys in schooling.

Our results are in line with Bittencourt (2014), Lehr (2009) and Murtin (2013). Empirical analysis by Bittencourt (2014) finds a negative and significant relationship between secondary enrollment rates and fertility within the Southern African Development Community (SADC) region. Similarly, Lehr (2009) also finds that secondary education is negatively related with fertility across both high and low-productivity economies, whereas primary education is positively related to fertility, more so in low-productivity economies that have not yet experienced the demographic transition. On the other hand, Murtin (2013) finds a negative and significant relationship between fertility and all three levels of education (primary, secondary and tertiary schooling), while Becker *et al.* (2010) find that primary school enrollments already had a negative impact on fertility in 19^{th} century Prussia.

Results are ambiguous for primary education and the gender gap education variable. The primary education variable is negative and significant in most of the regressions. However the inclusion of fixed effects and control variables appears to undermine these results, as with the results for ratio of girls to boys in schooling. The positive primary education effects may act through channels that improve health, fecundity and changes in social norms of women (Lehr 2009). Educated women may have better basic knowledge on health and thus have greater fecundity.

According to Ainsworth *et al.* (1996), a possible reason for the positive relationship may be that girls who complete only a few years of schooling are those who become pregnant and thus do not receive the full benefit of higher education, or those that are forced by family to get married early as they will bring in income through the customary bridal price. Their research however shows that the last years of primary female schooling affect fertility negatively in about half of the fourteen sub-Saharan African countries under review, while secondary education is associated with significantly lower fertility across all the countries in their sample.

Alternatively, the negative effect of the gender gap works through several channels in reducing fertility. Increasing female education may raise a

woman's age at marriage (Ainsworth *et al.* 1996; Galor & Weil 1996), and it may encourage women to invest in the education of their children (Ainsworth *et al.* 1996). Increased education also raises women's knowledge of contraceptive methods (Dreze & Murthi 2001), and it may increase the wage that women can earn in the labour market which raises the opportunity cost of having children (Becker & Barro 1988; Becker *et al.* 1990; Galloway *et al.* 1998; Galor and Weil 1996).

Infant mortality is positively and significantly related to fertility rates (Cervellati & Sunde 2013; Conley *et al.* 2007; Murtin 2013). Survival of infants was low in the past due to adverse health conditions during childbirth, and women may have therefore spent a considerable amount of time replacing the lost children. However, with better education in health and hygiene for mothers, and improvements in health facilities, mortality rates have gradually started to decrease reducing the need to have many children (Reher 2011). Evidence by Conley *et al.* (2007) indicates that the infant mortality may be the most important factor in explaining declining fertility rates globally. Moreover, Cervellati and Sunde (2013) suggest that differences in infant mortality may explain a substantial part of the observed differences in the timing of the demographic transition across countries, as witnessed in sub-Saharan Africa's delay in fertility declines (Figure 5). The delay may also highlight that people's perceptions take some time to adjust (Montgomery 2000)[7].

The results for income per worker are negative and sometimes significant. According to the unified growth theory, the increase in technological progress, not only allows income per worker to keep rising, but also raises the demand for skilled labour. This effect encourages people to invest in quality rather than quantity and thus reduces fertility (Galor & Weil 1999). The negative income results are also in line with the Barro-Becker (1988, 1989) hypothesis. Rising income per worker, through increased labour opportunities for women, may increase the opportunity costs of raising children, thus lowering fertility (Galloway *et al.* 1998; Galor & Weil 1996).

[7] The decline in infant mortality in Western Europe during the 1800s was associated at first with increasing fertility rates (Galor 2012). Empirical evidence by Doepke (2005) and Murphy (2010) shows that infant mortality rates were already declining before fertility rates in England and France during the 19^{th} century.

Table 3: Pooled OLS and Fixed Effects

	1	2	3	4	5	6	7	8	9	10	11	12
FERTILITY	POLS	POLS	POLS	POLS	POLS	POLS	FE	FE	FE	FE	FE	FE
Primary educ	-0.224***			-0.017**			-0.212***			0.019		
	(0.010)			(0.007)			(0.029)			(0.032)		
Secondary educ		-0.217***			-0.048***			-0.182***			-0.060*	
		(0.010)			(0.007)			(0.027)			(0.031)	
Girl-boy educ			-0.568***			-0.031			-0.435***			0.073
			(0.030)			(0.022)			(0.089)			(0.073)
Mortality				0.435***	0.401***	0.434***				0.531***	0.404***	0.548***
				(0.014)	(0.018)	(0.018)				(0.051)	(0.065)	(0.053)
Gdp				-0.039***	-0.032***	-0.055***				0.028	-0.00008	-0.021
				(0.005)	(0.006)	(0.007)				(0.040)	(0.046)	(0.045)
Observations	1,590	1,223	1,093	1,540	1,183	1,059	1,590	1,223	1,093	1,540	1,183	1,059
F test	501.61***	492.72***	351.02***	618.55***	526.44***	487.48***	52.85***	44.37***	23.98***	52.52***	44.34***	53.02***
R-squared	0.184	0.445	0.271	0.672	0.691	0.696	0.167	0.405	0.158	0.548	0.556	0.598
Number of i							47	47	48	47	47	48
Country FE							YES	YES	YES	YES	YES	YES

Coefficients reported. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Given that reverse causality may be present in the model, we also use instrumental variables for the potentially endogenous variables and report the results in Table 4. The identifying instruments are statistically significant in the first stage regressions, as well as the F-tests for joint significance which minimises the issues of weak instruments.

The financial development proxy is positively related to education which is in line with expectations. More access to finance gives people more options as it alleviates budgetary constraints, (Avelino *et al.* 2005; Galor & Moav 2004; Galor & Zeira 1993). The increase in the availability of financial loans, suggests more people, especially the poor, can also invest in education. According to Becker *et al.* (1990), specialisation in the accumulation of human capital, such as teachers, may not be feasible if the capital market is undeveloped. The teachers may be unable to borrow the resources to finance human capital.

Globalisation is positively and significantly related to education. Results by Rodrik (1998) find that open countries have bigger governments which may imply they have increased public expenditure towards health, education, housing, *etc.*[8]. The post-Cold war dummy also significantly increases education. The results of both instruments suggest the possible flow of private investment from abroad to stimulate public expenditure, and the increased influence of international organisations in sub-Saharan Africa after the cold war through increased technical and financial assistance.

[8] Kaufman and Segura-Ubiergo (2001), on the other hand, find that the negative effect of globalisation works mainly in the area of social security expenses, while health and education are less affected.

The immunisation against measles reduces infant mortality and is statistically significant. This is in line with expectations since over the years most of the sub-Saharan African countries have benefited from imported vaccines which have assisted in reducing mortality rates caused by epidemics, such as measles, polio, AIDS, *etc.*

Primary education is negative and significant when entered alone, but insignificant when control variables are included. Secondary education remains negative and significant. The economic effect is also now larger than that of our fixed effects regressions. A 10% increase in secondary education lowers fertility by about 2.7% to 4.9%, results which are similar to Lehr (2009). The ratio of girls to boys in schooling has ambiguous results.

Infant mortality is still positively and sometimes significantly related to fertility. However, the income per worker is now positive and sometimes significant suggesting a dominant income effect at play in the region. Results by Dreze and Murthi (2001) suggest that income effects depend on whether children are perceived as an economic burden or productive asset. In developed countries, they are seen as a consumption good leading to a focus on the cost of children and the quality-quantity trade-off as income rises. In developing countries, children are more likely to be regarded as productive assets because they are a source of labour power and old-age security. Hence developing regions, such as sub-Saharan Africa, are probably inclined to have more children with rising incomes. Evidence from a transitioning Western Europe in the 19^{th} century supports our result which suggest that the sub-Saharan African region may be in a Post-Malthusian stage where rising income initially raises fertility[9]. Galor and Weil (1999) also state that rising income may increase fertility by encouraging marriages.

[9]Murtin (2009) and Murphy (2010) present results for OECD countries and France respectively that show that income per capita and fertility rates were positively related during the 19^{th} century.

Table 4: Instrumental variables with Fixed Effects

	1	2	3	4	5	6
FERTILITY	IV	IV	IV	IV	IV	IV
Primary educ	-0.458***			-0.447		
	(0.039)			(0.863)		
Secondary educ		-0.269***			-0.489***	
		(0.010)			(0.127)	
Girl-boy educ			-1.362***			2.215*
			(0.072)			(1.294)
Mortality				0.170	-0.166	2.147***
				(0.919)	(0.251)	(0.753)
Gdp				0.0004	0.056**	0.425**
				(0.130)	(0.0243)	(0.202)
Observations	1,368	1,173	1,093	1,012	809	756
F test	138.80***	759.89***	354.87***	75.08***	153.94***	34.10***
R squared	0.194	0.440	0.271	0.416	0.306	0.218
Number of i	46	46	48	46	46	48
Country FE	YES	YES	YES	YES	YES	YES
First Stage Regressions						
Credit	0.352***			0.156***		
	(0.023)			(0.022)		
Globalisation		2.010***			1.239***	
		(0.052)			(0.063)	
Post-Cold War			0.175***			0.086***
			(0.007)			(0.008)
Measles				-0.187***	-0.100***	-0.101***
				(0.012)	(0.013)	(0.013)
F test weak instruments	227.87***	1475.51***	543.75***	81.55***	255.20***	115.01***
F test weak instruments				204.19***	360.31***	211.35***

Coefficients reported. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

4.2 Robustness Tests

We undertake several robustness checks to verify the validity of the results obtained for the education variables.

4.2.1 Inclusion of other control variables

We include other control variables also suggested by literature as lowering fertility rates (Galloway *et al.* 1998; Vandenbroucke 2014). The results reported in Table 5 are in line with our previous regressions. Secondary education remains negative and significant when we account for both fixed effects and endogeneity, while the primary and ratio of girls to boys' levels of education have ambiguous results. Infant mortality is positively related with fertility in most regressions, as is income per worker. But interestingly,

this relationship changes when we include the squared variable of income per worker. There is a non-linear relationship which suggests that in the long run as income continues to rise, households will eventually substitute larger family sizes with smaller ones thus lowering fertility rates. The results are in line with Lehr (2009) and Murtin (2013) who both find that at low levels of development, fertility increases with rising income, while at advanced stages of development, fertility decrease with rising income. The results also give credence to the unified growth theory that suggests that rising income initially raises demand for children but is gradually offset by the technological progress and rise in demand for human capital accumulation (Galor & Weil 1999, 2000).

Urbanisation is negatively and significantly related to fertility rates. Urban areas tend to be more technologically advanced which may increase the demand for skilled labour leading to increased investment in education and a substitution effect between quantity and quality of children (Galor & Weil 2000, 2002). This trade-off suggests that the region is gradually transitioning from the Malthusian stagnation epoch to a modern growth regime as hypothesised by the unified growth theory. Urban areas also offer better employment opportunities, better availability of schools, and easily accessible health and family planning services. Ainsworth *et al.* (1996) find evidence that at every level of schooling, urban women in fourteen sub-Saharan countries have lower fertility than rural women. Moreover, Becker *et al.* (2010) and Galloway *et al.* (1998) find that urban areas in 19^{th} century Prussia exhibit lower fertility rates than the rural areas. According to Galor (2005), the rapid process of industrialisation and urbanisation in the 19^{th} century was accompanied by a gradual increase in the relative importance of human capital in less developed economies which eventually led to a decline in fertility rates.

Although the conflict variable is insignificant, it does however increase fertility suggesting a region that is recovering from periods of conflict which may encourage families to have more children if they still can (Vandenbroucke 2014).

Table 5: Regressions with other control variables

	1	2	3	4	5	6	7	8	9
FERTILITY	POLS	POLS	POLS	FE	FE	FE	IV	IV	IV
Primary educ	0.001			0.071*			-1.009		
	(0.008)			(0.037)			(2.441)		
Secondary educ		-0.035***			-0.012			-0.466***	
		(0.008)			(0.030)			(0.129)	
Girl-boy educ			-0.029			0.109			-12.67
			(0.022)			(0.077)			(55.14)
Mortality	0.418***	0.392***	0.413***	0.364***	0.304***	0.386***	-0.700	-0.293	-10.85
	(0.01)	(0.019)	(0.020)	(0.071)	(0.084)	(0.073)	(2.359)	(0.234)	(49.88)
Gdp	0.836***	0.808***	0.731***	0.527	0.845**	0.614*	2.961	0.724***	7.971
	(0.085)	(0.010)	(0.107)	(0.365)	(0.366)	(0.320)	(5.545)	(0.187)	(33.13)
Gdp^2	-0.051***	-0.050***	-0.046***	-0.029	-0.051**	-0.038*	-0.187	-0.041***	-0.620
	(0.005)	(0.006)	(0.007)	(0.022)	(0.021)	(0.019)	(0.361)	(0.011)	(2.615)
Urban	-0.080***	-0.053***	-0.067***	-0.218***	-0.170***	-0.174***	-0.168	-0.126***	-3.250
	(0.008)	(0.010)	(0.009)	(0.058)	(0.057)	(0.046)	(0.617)	(0.048)	(13.39)
Conflict	0.005	0.033	0.045**	0.016	0.039	-0.016	0.077	0.052	1.375
	(0.018)	(0.021)	(0.023)	(0.057)	(0.068)	(0.045)	(0.150)	(0.054)	(6.435)
Observations	1,491	1,150	1,036	1,491	1,150	1,036	997	790	740
F test	403.47***	320.60***	308.79***	32.10***	31.00***	42.75***	39.67***	99.54***	0.64
R-squared	0.706	0.715	0.716	0.609	0.605	0.656	0.054	0.263	0.003
Number of i				45	45	46	44	44	46
Country FE				YES	YES	YES	YES	YES	YES
First Stage Regressions									
Credit							0.127***		
							(0.0200)		
Globalisation								0.955***	
								(0.077)	
Post-Cold War									0.087***
									(0.011)
Measles							-0.114***	-0.091***	-0.086***
							(0.012)	(0.013)	(0.013)
F test weak instruments							99.04***	139.29***	60.04***
F test weak instruments							155.70***	195.39***	131.56***

Coefficients reported. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

4.2.2 Inclusion of Time Variations

We incorporate lagged independent variables to take into account that changes in variables may take time to affect fertility rates[10]. The results in Table 6 are generally robust and in line with our previous results**.** Secondary education remains significant in lowering fertility in the region, especially after taking care of heterogeneity and endogeneity. The magnitudes of the coefficients also do not vary much with the previous regressions. Primary education and the gender gap variable remain ambiguous. The control variables are not significantly different from the contemporaneous results and the instruments remain valid.

[10] We also estimate dynamic regressions. Results remain robust, though the inclusion of the lagged dependent variable may have reduced the explanatory power of some of the regressors (Achen 2001). Results are available on request.

Table 6: Lagged regressors

	1	2	3	4	5	6	7	8	9
FERTILITY	POLS	POLS	POLS	FE	FE	FE	IV	IV	IV
Primary educ $_{t-1}$	0.0006			0.073**			-0.322		
	(0.008)			(0.036)			(0.826)		
Secondary educ $_{t-1}$		-0.037***			-0.018			-0.466***	
		(0.008)			(0.031)			(0.125)	
Girl-boy educ $_{t-1}$			-0.040*			0.109			-5.019
			(0.022)			(0.078)			(9.028)
Mortality $_{t-1}$	0.432***	0.405***	0.425***	0.375***	0.312***	0.398***	-0.016	-0.215	-3.898
	(0.015)	(0.019)	(0.020)	(0.070)	(0.083)	(0.072)	(0.785)	(0.215)	(8.111)
Gdp $_{t-1}$	0.839***	0.811***	0.724***	0.485	0.805**	0.560*	1.419	0.625***	3.819
	(0.086)	(0.101)	(0.109)	(0.362)	(0.377)	(0.328)	(1.952)	(0.186)	(6.396)
Gdp^2 $_{t-1}$	-0.051***	-0.050***	-0.045***	-0.027	-0.048**	-0.034*	-0.086	-0.035***	-0.280
	(0.005)	(0.006)	(0.007)	(0.021)	(0.022)	(0.020)	(0.126)	(0.011)	(0.479)
Urban $_{t-1}$	-0.082***	-0.056***	-0.071***	-0.230***	-0.177***	-0.186***	-0.338	-0.119**	-1.331
	(0.008)	(0.010)	(0.009)	(0.057)	(0.056)	(0.045)	(0.217)	(0.048)	(2.047)
Conflict $_{t-1}$	0.006	0.032	0.044*	0.018	0.040	-0.016	0.041	0.038	0.478
	(0.018)	(0.021)	(0.023)	(0.057)	(0.070)	(0.046)	(0.060)	(0.052)	(1.059)
Observations	1,459	1,130	1,013	1,459	1,130	1,013	966	770	717
F test	424.68***	340.16***	320.74***	35.16***	34.35***	47.57***	148.88***	107.81***	4.32***
R-squared	0.716	0.724	0.725	0.623	0.620	0.667	0.392	0.336	0.002
Number of i				45	45	46	44	44	46
Country FE				YES	YES	YES	YES	YES	YES
First Stage Regressions									
Credit $_{t-1}$							0.119***		
							(0.020)		
Globalisation $_{t-1}$								0.887***	
								(0.076)	
Post-Cold War									0.073***
									(0.011)
Measles $_{t-1}$							-0.111***	-0.094***	-0.086***
							(0.011)	(0.012)	(0.013)
F test weak instruments							90.43***	122.36***	51.45***
F test weak instruments							142.71***	185.36***	118.15***

Coefficients reported. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

4.2.3 Different Education Variables

In Table 7, we show results for different education variables. We use the total primary completion rates (percentage of relevant age group) and number of pupils in secondary education (percentage of population) taken from the WDIs. Variables are logged. Primary completion increases fertility, while increasing the number of pupils with secondary education lowers fertility. The control variables are in line with our previous results.

Table 7: Different Education Variables

	1	2	3	4	5	6
FERTILITY	POLS	POLS	FE	FE	IV	IV
Primary completion	0.017*		0.020		0.889	
	(0.009)		(0.026)		(1.718)	
Secondary pupils		-0.031***		-0.022		-0.291***
		(0.008)		(0.027)		(0.091)
Mortality	0.483***	0.390***	0.334***	0.334***	1.796	0.012
	(0.016)	(0.019)	(0.080)	(0.076)	(2.781)	(0.181)
Gdp	0.904***	0.826***	0.571	0.694**	-2.477	0.491***
	(0.091)	(0.100)	(0.341)	(0.339)	(5.519)	(0.147)
Gdp^2	-0.054***	-0.051***	-0.034*	-0.042**	0.158	-0.028***
	(0.005)	(0.006)	(0.020)	(0.020)	(0.348)	(0.009)
Urban	-0.073***	-0.055***	-0.202***	-0.136**	-0.324**	-0.145***
	(0.009)	(0.010)	(0.058)	(0.056)	(0.127)	(0.035)
Conflict	-0.020	0.035**	-0.022	-0.003	-0.356	0.0143
	(0.022)	(0.017)	(0.050)	(0.046)	(0.623)	(0.043)
Observations	1,042	1,183	1,042	1,183	739	813
F test	397.73***	324.03***	33.19***	37.33***	20.34***	170.18***
R-squared	0.746	0.713	0.631	0.627	0.371	0.478
Number of i			45	46	44	45
Country FE			YES	YES	YES	YES
First Stage Regressions						
Credit					0.225***	
					(0.033)	
Globalisation						1.073***
						(0.082)
Measles					-0.145***	-0.061***
					(0.017)	(0.010)
F test weak instruments					57.40***	136.35***
F test weak instruments					117.11***	209.76***

Coefficients reported. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

4.2.4 Different Dependent Variable

Results also remain similar when we use a different dependent variable, the logged crude birth rates per 1,000 people (Murtin 2013). The variable is obtained from the WDIs. The results in Table 8 show that secondary education lowers birth rates, more so when country differences and endogeneity are accounted for. The control variables are generally in line with the other results.

Table 8: Different Dependent Variable

	1	2	3	4	5	6	7	8	9
BIRTH RATE	POLS	POLS	POLS	FE	FE	FE	IV	IV	IV
Primary educ	0.011*			0.048**			-0.276		
	-0.006			(0.023)			(1.008)		
Secondary educ		-0.014**			0.003			-0.255***	
		(0.006)			(0.021)			(0.085)	
Girl-boy educ			-0.033*			0.124**			-12.10
			(0.020)			(0.057)			(53.25)
Mortality	0.338***	0.336***	0.335***	0.279***	0.268***	0.326***	-0.064	-0.119	-10.53
	-0.013	(0.015)	(0.017)	(0.050)	(0.058)	(0.051)	(0.975)	(0.155)	(48.17)
Gdp	0.605***	0.588***	0.526***	0.564*	0.787**	0.653**	1.376	0.746***	7.844
	-0.064	(0.077)	(0.084)	(0.316)	(0.315)	(0.277)	(2.290)	(0.124)	(32.00)
Gdp^2	-0.038***	-0.037***	-0.034***	-0.034*	-0.049**	-0.041**	-0.087	-0.046***	-0.610
	(0.004)	(0.005)	(0.005)	(0.019)	(0.019)	(0.017)	(0.149)	(0.008)	(2.525)
Urban	-0.068***	-0.056***	-0.062***	-0.127***	-0.0966**	-0.0913**	-0.184	-0.098***	-3.034
	(0.006)	(0.007)	(0.007)	(0.044)	(0.046)	(0.034)	(0.255)	(0.032)	(12.93)
Conflict	0.008	0.039**	0.025	-0.034	-0.028	-0.053	-0.010	-0.029	1.306
	(0.014)	(0.016)	(0.017)	(0.040)	(0.052)	(0.036)	(0.062)	(0.036)	(6.215)
Observations	1,491	1,150	1,036	1,491	1,150	1,036	997	790	740
F test	402.62***	335.04***	322.28***	41.34***	41.22***	42.76***	110.68***	106.59***	0.34
R-squared	0.735	0.754	0.758	0.615	0.622	0.684	0.376	0.405	0.001
Number of i				45	45	46	44	44	46
Country FE				YES	YES	YES	YES	YES	YES
First Stage Regressions									
Credit							0.127***		
							(0.020)		
Globalisation								0.955***	
								(0.077)	
Post-Cold War									0.087***
									(0.010)
Measles							-0.114***	-0.090***	-0.094***
							(0.012)	(0.013)	(0.015)
F test weak instruments							99.04***	139.29***	60.04***
F test weak instruments							155.70***	195.39***	131.56***

Coefficients Reported. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

5 Conclusion

Overall, the results suggest that higher levels of education significantly lower fertility in sub-Saharan Africa. Given the literature, the results favour the predictions made by the unified growth theory that growth in educational attainment will bring about a decline in fertility and hence a demographic transition (Murtin 2013). The results are also consistent with the unified growth theory in which the quantity-quality trade-off is already present in the stages leading to the modern growth regime.

We also confirm evidence in support of infant mortality rates raising fertility rates, as well as the non-linear effect of income per worker on fertility rates (Galor & Weil 1999, 2000; Lehr 2009; Murtin 2013). Urbanisation also

plays a significant role in lowering fertility rates, suggesting that the substitution of quantity for quality may be in response to technological progress from the more urbanised and industrialised economies in sub-Saharan Africa. Conflict plays a minimal role in the results.

The implications of the results suggest that the region may be exhibiting the characteristics of economies transitioning out of the Malthusian stagnation with increasing education and technological progress contributing significantly to the decline in fertility rates. According to Galor & Moav (2002), the acceleration in technological progress in 19^{th} century Europe stimulated the accumulation of human capital and resulted in a demographic transition in which fertility rates declined rapidly. Therefore, as sub-Saharan Africa continues to develop we expect the demand for a more skilled and educated population to increase which may induce further investments in child education and lower fertility, enabling the region to enter into a complete demographic transition and an era of sustained economic growth. Despite the region's slow start, Africa may just still be on time (Pinkovskiy & Sala-i-Martin 2014; Young 2012).

References

[1] Achen, C. (2001). Why Lagged Dependent Variables Can Suppress the Explanatory Power of Other Independent Variables. Annual Meeting of the Political Methodology Section of the American Political Science Association, University of California, Los Angeles.

[2] Ainsworth, M., K. Beegle, et al. (1996). "The Impact of Women's Schooling on Fertility and Contraceptive Use: A Study of Fourteen Sub-Saharan African Countries." The World Bank Economic Review 10(1): 85-122.

[3] Ashraf, Q. and O. Galor (2011). "Dynamics and Stagnation in the Malthusian Epoch." National Bureau of Economic Research(Working Paper No. 17037).

[4] Avelino, G., D. S. Brown, et al. (2005). "The Effects of Capital Mobility, Trade Openness, and Democracy on Social Spending in Latin America." American Journal of Political Science 49(3): 625-641.

[5] Barro, R. J. and G. S. Becker (1989). "Fertility Choice in a Model of Economic Growth." Econometrica 57(2): 481-501.

[6] Barro, R. J. and J. W. Lee (2013). "A new data set of educational attainment in the world, 1950-2010." Journal of Development Economics 104: 184-498.

[7] Becker, G. S. and R. J. Barro (1988). "A Reformulation of the Economic Theory of Fertility." The Quarterly Journal of Economics 103(1): 1-25.

[8] Becker, G. S., K. M. Murphy, et al. (1990). "Human Capital, Fertility, and Economic Growth." The Journal of Political Economy 98(5): 12-37.

[9] Becker, S. O., F. Cinnirella, et al. (2010). "The trade-off between fertility and education: evidence from before the demographic transition." The Journal of Economic Growth 15: 177-204.

[10] Bittencourt, M. (2014). "Education and Fertility: Panel Time-Series Evidence from Southern Africa." Economic Research Southern Africa Working Paper 431.

[11] Caldwell, J. C. (2004). "Social upheaval and Fertility Decline." Journal of Family History 29(4): 382-406.

[12] Cervellati, M. and U. Sunde (2013). "The Economic and Demographic Transition, Mortality, and Comparative Development." IZA Discussion Paper No. 7199.

[13] Conley, D., G. C. McCord, et al. (2007). "Africa's Lagging Demographic Transition: Evidence from Exogenous Impacts of Malaria Ecology and Agricultural Technology." National Bureau of Economic Research Working Paper 12892.

[14] Doepke, M. (2004). "Accounting for Fertility Decline during the Transition to Growth." The Journal of Economic Growth 9: 347-383.

[15] Doepke, M. (2005). "Child Mortality and Fertility Decline: Does the Barro-Becker Model Fit the Facts?" Journal of Population Economics 18(2): 337-366.

[16] Dreher, A. (2006). "Does globalisation affect growth? Evidence from a new index of globalisation." Applied Economics 38(10): 1091-1110.

[17] Dreher, A., N. Gaston, et al. (2008). Measuring Globalisation - Gauging its Consequence. New York, Springer.

[18] Dreher, A., P. Nunnenkamp, et al. (2006). "Does aid for education educate children?: evidence from panel data." KOF Working Papers 06-146.

[19] Dreze, J. and M. Murthi (2001). "Fertility, Education, and Development: Evidence from India." Population and Development Review 27(1): 33-63.

[20] Dunning, T. (2004). "Conditioning the Effects of Aid: Cold War Politics, Donor Credibility, and Democracy in Africa." International Organization 58(2): 409-423.

[21] Galloway, P. R., R. D. Lee, et al. (1998). "Urban vs Rural: Fertility Decline in the Cities and Rural Districts of Prussia, 1875 to 1910." European Journal of Population 14: 209-264.

[22] Galor, O. (2005). From Stagnation to Growth: Unified Growth Theory. Handbook of Economic Growth. P. Aghion and S. N. Durlauf. Amsterdam, Elsevier. 1: 171-293.

[23] Galor, O. (2012). "The Demographic Transition: Causes and Consequences." Cliometrica, Journal of Historical Economics and Econometric History 6: 1-28.

[24] Galor, O. and O. Moav (2002). "Natural Selection and the Origin of Economic Growth." The Quarterly Journal of Economics 117(4): 1133-1191.

[25] Galor, O. and O. Moav (2004). "From Physical to Human Capital Accumulation: Inequality and the Process of Development." The Review of Economic Studies 71: 1001-1026.

[26] Galor, O. and D. N. Weil (1996). "The Gender Gap, Fertility, and Growth." The American Economic Review 86(3): 374-387.

[27] Galor, O. and D. N. Weil (1999). "From Malthusian Stagnation to Modern Growth." The American Economic Review 89(2): 150-154.

[28] Galor, O. and D. N. Weil (2000). "Population, Technology, and Growth: From Malthusian Stagnation to the Demographic Transition and Beyond." The American Economic Review 90(4): 806-828.

[29] Galor, O. and J. Zeira (1993). "Income Distribution and Macroeconomics." The Review of Economic Studies 60(1): 35-52.

[30] Hansen, G. D. and E. C. Prescott (2002). "Malthus to Solow." The American Economic Review 92(4): 1205-1217.

[31] Heston, A., R. Summers, et al. (2012). "Penn World Table Version 7.1." Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania.

[32] Kaufman, R. R. and A. Segura-Ubiergo (2001). "Globalization, Domestic Politics, and Social Spending in Latin America: A Time-Series Cross-Section Analysis, 1973-97." World Politics 53(4): 553-587.

[33] Klemp, M. P. and J. Weisdorf (2012). "Fecundity, Fertility and Family Reconstitution Data: The Child Quantity-Quality Trade-Off Revisited." Centre for Economic Policy Research Discussion Paper 9121.

[34] Lehr, C. S. (2009). "Evidence on the demographic transition." The Review of Economics and Statistics 91(4): 871-887.

[35] Marshall, M. G. (2013). "Major Episodes of Political Violence (MEPV) and Conflict Regions, 1946-2013." Center for Systemic Peace.

[36] Montgomery, M. R. (2000). "Perceiving Mortality Decline." Population and Development Review 26(4): 795-819.

[37] Murphy, T. E. (2010). "Old Habits Die Hard (Sometimes) Can département heterogeneity tell us something about the French fertility decline??" Econpapers Working Paper 364.

[38] Pinkovskiy, M. and X. Sala-i-Martin (2014). "Africa is on time." Journal of Economic Growth 19: 311-338.

[39] Murtin, F. (2013). "Long-Term Determinants of the Demographic Transition, 1870-2000." The Review of Economics and Statistics 95(2): 617-631.

[40] Reher, D. S. (2011). "Economic and Social Implications of the Demographic Transition." Population and Development Review 37 (Supplement): 11-33.

[41] Rodrik, D. (1998). "Why Do More Open Economies Have Bigger Governments?" The Journal of Political Economy 106(5): 997-1032.

[42] Schultz, T. P. (2008). Population Policies, Fertility, Women's Human Capital, and Child Quality. Handbook of Development Economics. T. P. Schultz and J. Strauss. Amsterdam, Elsevier. 4: 3249-3303.

[43] Soares, R. R. (2007). "On the Determinants of Mortality Reductions in the Developing World." Population and Development Review 33(2): 247-287.

[44] Vandenbroucke, G. (2014). "Fertility and Wars: The Case of World War 1 in France." American Economic Journal: Macroeconomics 6(2): 108-136.

[45] Vleuten, L. v. d. and J. Kok (2014). Demographic trends since 1820. How was Life?: Global Well-being since 1820. J. L. van Zanden, et al. (eds), OECD Publishing.

[46] Young, A. (2012). "The African Growth Miracle." Journal of Political Economy 120(4): 696-739.