

**HUMAN CAPITAL DEVELOPMENT, PRODUCTIVITY AND FERTILITY IN
SUB-SAHARAN AFRICA, WITH SPECIAL REFERENCE TO MALAWI**

DOCTOR OF PHILOSOPHY(ECONOMICS) THESIS

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UNIVERSITY OF MALAWI

JULY, 2022



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SUB-SAHARAN AFRICA, WITH SPECIAL REFERENCE TO MALAWI**

PhD (Economics) Thesis

By

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Submitted to the Department of Economics, Faculty of Social Sciences, in partial
fulfilment of the requirements for the degree of Doctor of Philosophy in Economics

University of Malawi

July, 2022

DECLARATION

I, Lamulo Nsanja, hereby declare that the work contained in this dissertation is the product of my own original work and that I have not previously in its entirety or in part submitted it at any university for a degree.



Lamulo Nsanja

July 2022

CERTIFICATE OF APPROVAL

I certify that I have read this dissertation and that, in my opinion, it is fully adequate in scope and quality as a dissertation for the degree of Doctor of Philosophy.

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Supervisor

DEDICATION

To my incredible wife, Tapiwa, and our rays of sunshine: Ellard, Elijah, Eliana and Elkai.

To my dearest parents, sisters and brother.

ABSTRACT

This dissertation explores three interconnected topics concerning external financing to education for human capital development in Africa, gender productivity differences in farming and effects of education on fertility and labour supply. Chapter 1 provides the overarching introduction for the three individual research studies covered in Chapters 2 to 4. Chapter 5 concludes with key messages and policy recommendations.

Chapter 2 explores whether education sector foreign aid has a significant effect on economic growth in Africa. The study covers 32 African countries over the period 2005 – 2017. On the supply side, the dependent variable, education aid flow, was disaggregated by education level. On the demand side, the recipient economies were categorized by income level and political system of government. The empirical analysis showed that low-income autocracies that allocate more education sector foreign aid to higher education than to primary education do so at their detriment with respect to economic growth. Middle-income democracies that allocate more education sector foreign aid to primary education compared to higher education do so at their detriment with respect to economic growth.

Chapter 3 investigates gender differences in agricultural productivity in Malawi using data from the fourth Integrated Household Survey. The study examined constraints on female farmers and forces that drive the gender gap in agricultural productivity from the perspective of female and male crops. Unequal access particularly to male labour and fertilizer were observed to be key constraints widening the gender gap. Mitigating gender biases within households around division of labour is important if women are to strengthen their income-earning capacity and improve their access to male labour, fertilizer and other critical inputs. For instance, labour-saving technologies such as energy-efficient and environmentally friendly improved cooking stoves and rainwater harvesting have the

potential to reduce women's unpaid care and domestic work burdens, save time and facilitate increased crop production, which could help generate more income.

Using data from the 2015/16 Malawi Demographic and Health Survey, Chapter 4 examined the relationship between female education, labour force participation and fertility in Malawi. Results confirmed the hypotheses that female education, especially at the secondary and post-secondary school levels, reduces fertility and increases the likelihood of women being engaged in the labour force.

Overall, the findings from this research place emphasis on the importance of education, particularly at the primary level, for promoting economic growth in low-income African countries. Expanding education to enable progression to secondary education and beyond can increase the likelihood of engaging in the labour force. This has important implications for fertility behaviour as women who work will have less time for many children. The research also highlights that closing the gender gap in agricultural productivity by improving access to key farming inputs for women can translate to an increase in crop production, which in turn would contribute to an increase in GDP and ultimately help poverty reduction.

ACKNOWLEDGMENTS

First and foremost, I would like to thank God for granting me strength and perseverance throughout the arduous doctoral journey.

I am also grateful to my family for the encouragement, patience and understanding as I cut short our family interactions while developing my dissertation.

I would like to express my sincere gratitude to my supervisors, Professor Ben Kaluwa and Professor Winford Masanjala, for their critical comments, patience and for challenging me to dig deep to reach uncharted territory. The privilege of working with them has exposed me to dizzying heights of critical thinking and analysis. I am grateful for the research and analytical skill seeds they have planted in me, which will be nourished by my continual reflection and implementation throughout my professional career as an Economist.

I am deeply indebted to the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) of the German Development Cooperation for generously providing me with a scholarship through the Chancellor College Economics Department to pursue a PhD degree.

I would also like to thank staff members in the Economics Department at Chancellor College for the various valuable assistance given to me throughout my doctoral journey.

TABLE OF CONTENTS

ABSTRACT.....	v
ACKNOWLEDGMENTS	vii
LIST OF FIGURES	xi
LIST OF TABLES.....	xii
ACRONYMS.....	xiii
CHAPTER 1	1
INTRODUCTION	1
CHAPTER 2	6
EDUCATION SECTOR FOREIGN AID AND ECONOMIC GROWTH IN AFRICA.....	6
2.1. Introduction	6
2.2. Theoretical perspectives of the aid-growth relationship	8
2.3. Empirical evidence	9
2.4. The education aid-growth nexus and political governance systems	11
2.5. Methodology	12
2.5.1 Model specification.....	12
2.5.2 Characteristics of the sampled countries and data sources	15
2.5.3 The effect of education aid (EAid) variables on growth.....	19
2.5.4 Estimation issues.....	22
2.6. Orientation of disaggregated education aid in democracies and autocracies.....	23
2.7. Econometric results	26
2.7.1 Effect of control variables on GDP per capita growth.....	26
2.7.2 The education aid-growth relation	26
2.7.3 The pooled sample	28
2.7.4 Low-income democracies vs. Low-income autocracies	29

2.7.5 Middle-income democracies vs. Middle-income autocracies.....	29
2.7.6 Aid orientation and implications for growth in different political systems .	30
2.8. Discussion	30
2.9. Conclusion.....	32
CHAPTER 3	34
WOMEN AND SMALLHOLDER AGRICULTURAL PRODUCTIVITY IN MALAWI.....	34
3.1. Introduction	34
3.2 What are women's and men's crops?	36
3.3 Theoretical framework.....	40
3.3.1 Human capital theory in agricultural productivity	40
3.4 Data, descriptives and preliminary econometric analysis.....	42
3.4.1 OLS estimation with fixed effects	51
3.5 Methodology	59
3.5.1 Oaxaca-Blinder mean decomposition method	59
3.5.2 Assumptions required to identify population parameters	62
3.6 Decomposition econometric results	62
3.6.1 Mean decomposition results	62
3.6.2 Aggregate decomposition	72
3.6.3 Detailed decomposition	73
3.7 Conclusion	74
CHAPTER 4	77
EFFECTS OF EDUCATION ON FERTILITY AND LABOUR SUPPLY: EVIDENCE FROM MALAWI	77
4.1 Introduction	77
4.2 Importance of education in fertility reduction.....	80
4.3 Female employment and fertility	83

4.4	Data	85
4.5	Trends in Malawi's fertility rates	85
4.6	Theoretical framework	87
4.7	Methodology and models for estimation.....	87
4.8	Results and interpretation.....	90
4.8.1	Results from probit model on female labour force participation	90
4.8.2	Determinants of total and cumulative fertility	93
4.9	Conclusion.....	99
CHAPTER 5		101
CONCLUSION.....		101
REFERENCES		104
APPENDICES		115

LIST OF FIGURES

Figure 2. 1: Average primary education aid (% of total education aid)	24
Figure 2. 2 Average higher education aid (% of total education aid)	25

LIST OF TABLES

Table 2.1: Categorization of countries included in the study	16
Table 2.2: Summary of regression models and variables used	21
Table 2.3: System GMM regression results.....	27
Table 2.4: Education aid-growth regression results: Signs and statistical significance	28
Table 3.1: Classification summary of women's and men's crops based on literature	39
Table 3.2: Descriptives and results from tests and mean differences for maize farmers...	43
Table 3.3: Descriptives and results from tests and mean differences for G.Nut farmers ..	45
Table 3.4: Descriptives and results from tests and mean differences for tobacco farmers	46
Table 3.5: Descriptives and results from tests and mean differences for cotton farmers ..	48
Table 3.6: Naïve regression results on gender productivity differences – Agro-Eco F.E .	51
Table 3.7: Naïve regression results on gender productivity differences – Region F.E	52
Table 3.8: Naïve regression results on gender productivity differences – District F.E	52
Table 3.9: Base OLS regression results underlying mean decomposition: Pooled plots...	53
Table 3.10: Base OLS regression results underlying mean decomposition: Male plots ...	55
Table 3.11: Base OLS regression results underlying mean decomposition: Female plots	57
Table 3.12: Decomposition of the mean gender differential	65
Table 3.13: Aggregate decomposition of the gender differential	66
Table 3.14: Detailed decomposition of the endowment effect	67
Table 3.15: Detailed decomposition of the male structural advantage	69
Table 3.16: Detailed decomposition of the female structural disadvantage	71
Table 4.1: Trends in total fertility rates in Malawi between 2010 and 2016	82
Table 4.2: Female labour force participation	91
Table 4.3: Determinants of fertility	94
Table 4.4: Determinants of cumulative fertility by ages 20, 25 and 30.....	96

ACRONYMS

AIDS	Acquired Immunodeficiency Syndrome
DAC	Development Assistance Committee
DRC	Democratic Republic of Congo
EFA	Education for All
FAO	Food and Agriculture Organization of the United Nations
FE	Fixed Effects
FISP	Farm Input Subsidy Program
GDP	Gross Domestic Product
GMM	Generalized method of moments
GPS	Global Positioning System
HIV	Human Immunodeficiency Virus
IHS	Integrated Household Survey
IMF	International Monetary Fund
MDHS	Malawi Demographic and Health Survey
NGO	A Non-Governmental Organization
NSO	National Statistics Office
ODA	Official Development Assistance
OECD	Organization of Economic Cooperation and Development
OLS	Ordinary Least Squares
STATA	Statistics and Data Analysis
TFR	Total Fertility Rate
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
USD	United States Dollar

CHAPTER 1

INTRODUCTION

Like a tree, poverty has many roots. Among the many causes of poverty, one factor stands out: education. Low levels of education are widely considered a major obstacle to economic growth and the eradication of poverty (Lin, 2003; Lau, et al., 1993; Steven & Weale, 2004). Not every person without an education is living in extreme poverty, but most of the extremely poor do lack a basic education. Those living below the poverty line will also be more likely to keep their children out of school, which means that their children will also have a higher likelihood of living in poverty. Education is often referred to as the great equalizer: it can open the door to jobs, resources and skills that a family needs not just to survive but to thrive. Access to high quality primary education is a globally recognized solution to the cycle of poverty. According to UNESCO, if all students in low-income countries had just basic reading skills (nothing else), an estimated 171 million people could escape extreme poverty (UNESCO, 2017).

Human capital has been identified as a key determinant of economic growth and poverty reduction and has been incorporated in growth accounting since the development of Endogenous Growth Theory. Endogenous growth models as developed by Romer (1986) and Lucas (1988) hold that human capital promotes endogenous technical progress and accelerates long-run perpetual economic growth. Economists and policy makers have therefore advocated increased investment in human capital. Consequently, in the past decade the international community has strengthened their resolve to provide universal primary education in developing countries.

Specifically, the second of the United Nation's Millennium Development Goals was "to ensure that by the year 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling" (United Nations, 2000). Also, in the 2000 meeting of the Education for All (EFA) initiative held in Senegal, the EFA identified six goals to be achieved by the year 2015. The second goal on the list was to provide free and compulsory primary education for all. A key element in these global initiative frameworks was the increase in external finance for education. Consequently, there has been a substantial increase in the amounts of foreign aid supporting education over the years. For example, aid in education from the Development Assistance Committee (DAC)¹ member countries increased from an average of USD 0.184 million per recipient country in the period 1994-97 to about USD 6.29 million between 2014-17 (OECD, 2017).

Having established that education significantly influences economic growth, it is reasonable to expect that the three main sub-levels of education, namely primary, secondary, and higher education would influence growth in different ways. Furthermore, the contribution of human capital to growth is expected to be dependent on availability of complementary inputs such as physical capital and technological know-how. Given that low- and middle-income countries have different endowments in this respect, then it is plausible that growth effects of education can be different between low- and middle-income countries. We used panel data from thirty-two African countries grouped according to per capita income classifications as well as prevailing political governance regimes from 2005 to 2017 to examine:

- how education sector foreign aid, which is treated heterogeneously, could influence economic growth in recipient countries, which are also treated heterogeneously with respect to income levels;

¹ The Organisation for Economic Cooperation and Development's (OECD) Development Assistance Committee (DAC) is a forum to discuss issues surrounding aid, development and poverty reduction in developing countries. It is the "venue and voice" of the world's major donor countries. There are thirty members of DAC including the European Union.

- whether aid effectiveness is neutral to political governance. In other words, could (and how) democratic as opposed to autocratic political regimes mediate aid effectiveness?

After exploring the education aid-growth nexus, focus switches to examining the important contribution women in Malawi make towards economic growth through agricultural production. Approximately 97% of rural women are engaged in subsistence farming in the country (Koirala et al., 2015). The World Bank (2014) made the startling observation that on average, plots managed by women in Malawi produce 25% less in terms of gross value of output per hectare than plots managed by men. Previous related research highlighting the gender gap in agricultural productivity focused largely on women's unequal access to key inputs, such as fertilizer, agricultural information and farm labour, and these studies were based on gender-neutral crops. Common conclusions reached in these studies were that if women had better access to key agricultural production inputs they would be equally as efficient as male farmers (Peterman et al., 2011; Vargas Hill & Vigneri, 2011; Quisumbing et al., 2001; Goldstein & Udry, 2008; Horrell & Krishnan, 2007; Udry, 1996; Quisumbing, 1996). Our study aims to further explore gender disparities in agricultural productivity this time from the unexplored perspective of gender-disaggregated crops grown by farmers. A body of literature exists that has categorized certain crops to be either women's crops or men's crops depending on the gender that dominates production (Makoka et al., 2016; Orr et al., 2016; Tsusaka et al. 2016; Ussar, 2016; Forsythe et al., 2015; Orr et al. 2014). Domination in production of a specific crop by a particular gender has been found to be influenced by a number of contextual factors as well as unique properties of the crops themselves. This study uses data from the fourth Malawi Integrated Household Survey (IHS 4), which was conducted between April 2016 and April 2017 within a nationally representative and multi-topic framework. With special emphasis on gender disaggregation of crop farming preferences, this study sets out to examine whether statistically significant agricultural productivity differences exist owing to gender differences in the plot manager beyond cultivation of gender neutral-crops. Specifically, for a set of gender categorized crops, we decompose the average difference in agricultural productivity between male-managed and female-managed plots into (i) the portion that is

driven by gender differences in levels of observable attributes (i.e. the endowment effect), and (ii) the portion that is driven by gender differences in returns to the same set of observables (i.e. the structure effect). Based on the emerging results from the empirical analysis, we isolate major implications of the gender gap in agricultural productivity in Malawi and then offer policy recommendations to help narrow the gap.

After gaining a better understanding of gender differences in farming beyond the limited scope of gender-neutral crops, attention then shifts to the related topic of women's empowerment through education and how this influences labour supply and fertility. Attainment of higher levels of education is a goal that features high on the agenda of many Governments in developing countries and this is recognized to be important for both individual and national development. This is even more important for females who, due to a number of factors (most of which are gender-related) have long been disadvantaged in various societal aspects (Taylor, 1985). Several traditional societies in Africa consider female education as unimportant and for many reasons girls will easily drop out of school while boys continue to higher levels. For example, if a family has two children, a boy and girl, and it faces income constraints forcing one of the children to drop out of school, it is likelier the girl who would drop out. Girls are also more involved in household chores, before and after school in comparison to their male counterparts. Girls may also drop out of school because of pregnancy, which does not affect boys. Lack of separate sanitary facilities for girls and boys in schools can cause girls to drop out of school especially when they reach adolescent age. Consequently, girls' education and performance has often fallen behind that of boys, forcing governments and non-governmental organizations (NGOs) to direct efforts towards the promotion of education, especially for girls.

Education is one of the most important determinants to explain growth in female labour force participation. If education increases labour market opportunities for women, then education investments contribute to positive economic growth. It is therefore imperative to understand the link between female education and labour market behaviour. Chapter 4 therefore uses data from the 2015/16 Malawi Demographic and Health Survey to examine the relationships between female education, labour force participation and fertility rates for Malawi. This is conducted against the hypothesis that female education leads to higher

labour force participation, which in turn leads to higher opportunity costs of time, leading to lower fertility rate.

The aforementioned contributions are presented in three chapters of the dissertation, structured as follows: Chapter 2 looks at education sector foreign aid and economic growth in Africa, with special focus on heterogeneity of education aid and recipient countries. Examination of the factors contributing to gender productivity differences within the scope of gender categorized crop farming in Malawi is the focus of Chapter 3. Chapter 4 delves into the relationships between education, fertility and labour supply in Malawi. Finally, the major conclusions of the dissertation are presented in Chapter 5.

CHAPTER 2

EDUCATION SECTOR FOREIGN AID AND ECONOMIC GROWTH IN AFRICA

2.1. Introduction

A direct objective of education sector foreign aid to developing countries would be to contribute to the accumulation of their human capital as an investment which should spur economic growth for them and demand for imports from the donating countries. This transmission mechanism is incorporated in endogenous growth models by Lucas (1988) and Romer (1990) as well as the augmented Solow exogenous growth model by Mankiw et al. (1992), which postulate a positive relationship between education and economic growth. Several empirical studies have also found that the stock of human capital and the level of investment in education are positively associated with economic growth (e.g., McMahon, 1998; Keller, 2006; Asiedu, 2014).

Education aid in recipient sub-Saharan African countries is mainly utilized for construction of school infrastructure, training and recruitment of teachers, and procurement of teaching and learning materials, all of which are in short supply in the recipient countries. These expenditure items can influence the quality and quantity of education outputs. They also have the potential to impact GDP growth through increases in investment in education and the enhancement of the stock of human capital.

From the perspective of endogenous growth models, more and better education improves the quality, innovativeness, adaptability and productivity of labour as a factor of production.

The effects of education on economic growth are expected to be different for the three levels of education, namely primary, secondary, and higher education. For the longer term, the decline in fertility and mortality rates would likely be more relevant for primary education whereas technological spillovers would be a more relevant and direct transmission mechanism for higher education. However, an important consideration is that the contribution of labour to growth is dependent on the availability of complementary inputs such as physical capital and technological know-how. The availability of complementary inputs depends on a country's capacity, determined by the level of development suggesting that the growth effects of education can be different between low- and middle-income countries.

Previous studies have tended to overlook two important aspects: the fact and importance of the heterogeneous nature of education aid as well as that of aid recipients both of which could have different effects on economic growth. Ignoring education aid heterogeneity may explain the lack of robustness of the effect of aid on growth found in some of the previous empirical studies. Clemens et al. (2004) show that different components of aid, as opposed to aggregate aid, are more important when assessing the effect of aid on growth-related macroeconomic variables such as developing countries' creditworthiness. In their study Harms and Rauber (2004) found that aid improves countries' standings vis-a-vis international capital markets. Importantly, the strength of this effect differs across types of aid and country income groups. The relevance of heterogeneity can be extended beyond income levels to whether any aid effectiveness is neutral to political governance: could (and how) democratic as opposed to autocratic political regimes mediate aid effectiveness?

This study uses panel data from 32 African countries covering the 13-year period from 2005 to 2017 to examine whether foreign aid in the education sector has a significant effect on economic growth. The significant contribution is that on the supply side the major dependent variable, education aid flow is disaggregated by education level. On the demand

side the recipient economies are accorded their income groups as well as different political systems of government. The former accounts for capacities for human capital development complementarities for economic growth. The governance dimension accounts for the benevolent/destabilizing complementarity for economic growth. In order to concretely ascertain the importance of heterogeneity of aid and of recipients, the estimated results from these disaggregations are benchmarked against those based on pooled or aggregated aid and recipient data (i.e. where heterogeneity is ignored).

2.2. Theoretical perspectives of the aid-growth relationship

Theory suggests that foreign aid promotes economic growth by supplementing limited domestic savings of recipient developing countries. Early literature has been spurred by the work of Chenery and Strout (1966) which itself had its basis on the Harrod-Domar model of economic growth. The three elements of the Harrod-Domar model are income (growth), investment (savings) and capital-output ratio, which represents the marginal amount of investment necessary to produce an additional unit of output. With the capital-output ratio remaining constant, the rate of economic growth will be directly determined by the rate of investment. With investment assumed to be equal to savings, this implies that a poor country, with low savings, will have low investment potential and therefore low growth. It is thus expected that a supplementation of domestic savings by foreign aid would support an increase in investment, and hence economic growth. Chenery and Strout (1966) base their analysis on the case where resource limits on skills and savings are important, and describe this scenario as ‘investment limited growth,’ where the Harrod-Domar model is taken as the limiting case of no foreign assistance. Calculation of the savings gap is made possible from the Harrod-Domar equations. A savings gap occurs when the quantum of domestic savings available is less than the amount of investment required to attain the target growth rate, and this gap can be filled by foreign aid.

Over time further growth theories have emerged contesting some of the postulations of the Harrod-Domar model such as the models employed in the assessment of the impact of aid on economic growth. The crucial ones have been the neoclassical and endogenous growth theories. The neoclassical model is largely inspired by the Solow model of long-run

growth. This model assumes a continuous production function relating output to the inputs of capital and labour which (as opposed to the Harrod-Domar model) are substitutable and exhibit diminishing returns to each factor of production but constant returns to scale.

The endogenous growth theory that has Arrow (1962), Romer (1986) and Lucas (1988) as key proponents, acknowledges the importance of endogeneity of capital in the growth process. The assumption of increasing returns as opposed to diminishing returns of capital typical in the neoclassical growth theory was another distinguishing attribute.

In all the above, savings and investment (in capital and labour) are fundamental to economic growth. In the endogenous growth theory, the assumption of increasing returns to capital implies that foreign aid can improve growth well into the long run.

2.3. Empirical evidence

A fairly large number of empirical studies have been conducted to ascertain the theoretical construct of the aid-growth relationship at individual country (over time) and cross-country levels. Close variations of the following regression specification have been estimated at cross-country level by Hansen and Tarp (2001), Dalgaard et al. (2004) and Gomanee (2005):

$$\Delta y_i = \beta_0 + \beta_y \ln y_{0i} + \sum_{j=1}^n \beta_j Z_{i,j} + \varepsilon_i \dots \dots \dots (1)$$

where Δy_i is the average growth rate of per capita output for country i , between some initial date t_0 and a second date t_1 , $\ln y_{0i}$ is the log of per capita output of country i , at time t_0 , and ε_i is an error term. $Z_{i,j}$ represents a number of other variables deemed relevant by the researcher and can include some measure of the initial level of human capital or its rate of change. It could also include a variety of variables related to government policies and

institutions, such as the share of government spending in GDP, the inflation rate, an index of the rule of law, to name just a few.

To examine the relationship between foreign aid and growth in real GDP per capita, Hansen and Tarp (2001) studied a panel data set comprising 56 countries across Africa, Asia and South America for the 20 year period 1974 – 1993. They found that foreign aid increased the growth rate of real per capita GDP and this result was not conditional on ‘good’ policy. Their findings contradicted observations by Burnside and Dollar (2000), who proposed that aid has a positive impact on growth in developing countries conditional on a policy index (i.e. aid has a positive impact in countries with good fiscal, monetary, and trade policies). Burnside and Dollar’s study comprised a panel dataset with 56 countries from Sub-Saharan Africa, Latin America and South Asia for the 24 year period 1970 – 1993. Hansen and Tarp further observed that the estimated effectiveness of aid is highly sensitive to the choice of estimator and the set of control variables included in the regression. Their study also reconfirmed the empirical support for the hypothesis that aid influences growth via the investment transmission mechanism. Dalgaard, Hansen and Tarp (2004) reached a similar conclusion to Hansen and Tarp (2001) that aid is generally effective even in ‘bad policy’ environments. Their study comprised a panel dataset with 65 countries across Sub-Saharan Africa, Central America and East Asia for the 24 year period from 1974 – 1997.

Gomanee (2005) investigated aid effectiveness in a panel of 25 Sub-Saharan African countries in the 28 year period 1970 - 1997 by focusing on hypothesized transmission mechanisms through which aid impacts growth. The results indicate a highly significant positive effect of aid on growth and that investment was the most important transmission mechanism suggesting that Africa’s poor growth record should therefore not be attributed to aid ineffectiveness.

The studies mentioned above have a number of features in common. First, they all conclude that aid positively and significantly influences economic growth. Second, they each studied foreign aid in aggregate form, hence ignoring the possibility that different sectoral orientations of foreign aid could influence economic growth with varying degrees of efficacy. Third, all the studies did not consider the heterogeneity of the governance regimes

of the countries which could affect aid effectiveness and impact on growth. The main contribution of this study is to address omissions of earlier studies of the aid-growth nexus by accounting for the orientation of aid and the governance regimes of recipient countries.

2.4. The education aid-growth nexus and political governance systems

Researchers have debated whether foreign aid is good for economic growth, has no effect, or even a hindrance to progress (Hansen & Tarp, 2001; Burnside & Dollar, 2000; Easterly 2003; Arndt et al., 2010; Kargbo, 2012; Juselius et al., 2014). Some agreement has formed around the argument that aid works more effectively under specific political and economic conditions that enable foreign aid to have the greatest impact on poverty reduction and promotion of growth.

The arguments against democratic political systems were earlier proposed by Galenson (1959) and Huntington (1968) who argued that democracy generates an explosion of demands which unleash pressures for immediate consumption. These demands, through union-driven wage demands, threaten profits, negatively impact investment and retard growth. From their point of view, democracy is seen as inimical to economic growth. On the other hand, dictatorships would be better able to force savings for the huge investments in personnel and material required to launch economic growth (Rao (1984). Such investment programs imply cuts in current consumption that would be painful for the low-income in almost all developing societies and require strong measures to enforce them. Such a course would not likely survive a popular vote.

Scholars have attributed state autonomy for the superior economic performance of the four Asian Tigers since the 1960s in comparisons to Latin America. State autonomy has been defined as the capacity of the state to pursue developmentalist policies while being insulated from particularistic pressures, for example, originating from large firms or unions which could result in collective suboptimal behaviour and demands leading to underinvest (Przeworski & Limongi, 1993).

On the other side of the argument, Wittman (1989) and North (1990) view state autonomy as harmful for economic performance because, through phenomenon of “state capture” the state is always ready to prey on the society and only democratic institutions can constrain it to act in the general interest. From this view, dictatorships are a source of inefficiency

Selectorate Theory presented by de Mesquita (2003) supports the notion that democracy is ideal for promoting economic growth as democracies are more likely to provide more public goods to the population than autocracies. In the context of foreign aid, it would be logical to assume that compared to autocracies, democratic leaders in less developed countries would allocate more foreign aid and domestic resources to public goods for the needs of the wider population. This would be more effective in alleviating poverty and engendering economic growth.

From the foregoing it would be instructive to assess whether disaggregated foreign aid in the education sector would have a greater positive and significant impact in promoting growth in democratic regimes in Africa than in autocratic states.

2.5. Methodology

2.5.1 Model specification

Burnside and Dollar (2000), Hansen and Tarp (2001), Dalgaard et al. (2004) and Gomanee (2005) in their studies based on panel datasets, used a regression specification similar to the one in equation (1) and entered aid in their model endogenously. The main reason for this is that it is difficult to perceive of aid as being independent of the level of income. Empirically, a negative relationship between aid and income per capita is well established (Trumbull & Wall, 1994; Alesina & Dollar, 2000). However, Endogeneity of aid with respect to income per capita can contribute to simultaneity bias in aid-growth regressions, and thus lead to distortion in the accuracy of conclusions drawn about the impact of aid. In addition to this, the unobserved country specific factors can cause estimates from aid-growth regressions to be biased. The linear dynamic panel Generalized Method of Moments (GMM) estimator proposed by Arellano and Bond (1991) can be used to overcome these problems. This estimator uses lagged levels of the first difference of the variables as instruments. However, as pointed out by Arellano and Bover (1995), lagged

levels are often poor instruments for first differences, thus the difference GMM is said to suffer from the “weak instruments” problem (Kazuhiko, 2007; Asiedu, 2014). Blundell and Bond (1998) proposed a more efficient estimator, the system GMM estimator, which mitigates the weak instruments problem. Simulation results by Kazuhiko (2007) show that the system GMM is less biased than the difference GMM. Consequently, the preferred estimation procedure for this study is the more efficient and less biased estimator, the system GMM.

The dynamic panel data model of economic growth used in this study is based on the Lucas (1988) human capital accumulation endogenous growth model, which stipulates a positive relationship between education and economic growth. Similar to the model specifications used by Burnside and Dollar (2000), Hansen and Tarp (2001), Dalgaard et al. (2004) and Gomanee (2005), the regression specification of this study enters aid endogenously as an enhancer of capital accumulation which affects economic growth. The general specification is as follows:

$$\Delta y_{it} = \gamma \ln y_{it-1} + \varphi Aid_{it} + \sum_{j=1}^k \beta_j x_{jit} + \alpha_t + \mu_{it} \dots \dots \dots (2)$$

Where Δy_{it} denotes the average growth rate of GDP per capita, being a proxy for economic growth; $\ln y_{it-1}$ denotes initial level of per capita GDP in log form, which is lagged, capturing conditional convergence effects; Aid_{it} denotes official development assistance to education expressed as a percentage of GDP, representing education foreign aid. The aid effectiveness literature has generally relied on the key assumption that aid has a solely contemporaneous effect on growth and this is assumed by most of the papers on the topic (Minoiu & Reddy, 2010). A central issue in studies which assume that aid has a contemporaneous effect on growth is the endogeneity of aid flows. Bobba and Powell (2007) uncover strong and robust evidence that aid can have a positive contemporaneous effect on recipient countries’ average growth; x_{jit} are the k additional or control variables that are also determinants of growth; α_t is a constant term, and μ_{it} is the error term.

Masanjala and Papageorgiou (2003) have come to the conclusion that the critical explanatory variables for African economic growth are different from the rest of the world. Among the six critical explanatory variables were: initial per capita GDP and investment as a percentage of GDP. Barro (1996) found that the growth rate of real per capita GDP is enhanced by maintenance of the rule of law, smaller government consumption, lower inflation, improvements in terms of trade, and lower initial levels of real per capita GDP. Sala-i-Martin et al. (2004) examined the robustness of explanatory variables in cross-country economic growth regressions in 98 countries spread across all seven continents. They found that the initial level of real GDP per capita, investment, and primary school enrolment had the most important effect on real GDP per capita growth. In the present study the following variables were included as control variables in the general equation (2): initial GDP per capita in log form, inflation as measured by the consumer price index in log form, general government consumption as a percentage of GDP, the sum of exports and imports as a percentage of GDP (i.e. trade as a percentage of GDP) and investment as a percentage of GDP (i.e. total spending on fixed assets and inventories of raw materials which provide the basis for future production, expressed as a percentage of GDP). Following indications that the aid-investment transmission mechanism exists (Appendix A), INVRES was constructed to replace investment and represent that part of investment that is not attributed to education foreign aid.

An important question that arises is how to measure and compare the enhancement of the stock of human capital over time and between countries? The best measure would be in terms of the output of education. However, due to the difficulties of obtaining such consistent and comparable education output measures over time and between countries, input measures have instead been used as proxies (Keller, 2006; Asiedu, 2014). In this study, education aid financing (which in many cases can be considered as investment in education) will be used as a proxy for education output.

2.5.2 Characteristics of the sampled countries and data sources

This study includes 32 African countries and spans 13 years from 2005 to 2017. The countries have been divided into four groups as follows: Group 1: Low-income democratic countries; Group 2: Low-income autocratic countries; Group 3: Middle-income democratic countries; and Group 4: Middle-income autocratic countries. Table 2.1 summarizes the composition of the groups.

Table 2. 1: Categorization of countries included in the study
(Figures appear as averages for the 13 year period from 2005 – 2017)

	GDP per capita (USD)	GDP per capita growth (%)	Total ODA (% GDP)	Primary net enrolment rate (%)	Primary net enrolment rate growth (%)	Tertiary gross enrolment ratio (%)	Tertiary gross enrolment ratio growth (%)
Group 1: Low-income democracy							
Benin	646	1.3	9.0	88	0.7	10.3	5
Liberia	312	0.5	66.9	36	0.9	8.4	6.7
Madagascar	381	-0.3	11.3	70	0.6	4.8	3.3
Malawi	342	2.0	14.9	91	0.1	0.5	4.6
Mali	593	1.1	11.7	60	1.2	6.3	7.5
Mozambique	451	4.2	21.8	81	3.3	3.5	12.1
Tanzania	657	2.9	11.1	85	1.7	4.7	12.7
Uganda	512	3.2	10.6	92	0.4	4.1	3.9
Group average	486.8	1.9	19.7	75.4	1.1	5.3	7.0
Group 2: Low-income autocratic							
Chad	876	5.7	5.9	66	1.6	3.8	9.3
DRC	265	2.6	16.4	n.a.	3.6	8.2	9.8
Comoros	742	-0.2	10.3	77	1.1	9.3	7.1
Gambia	469	0.3	13.3	73	0.3	3.1	8.6
Guinea	427	0.1	7.8	67	1.3	7.7	12.4
Rwanda	468	4.7	17.1	93	1.1	5.7	9.7
Togo	473	0.8	8.6	88	0.2	6.1	6.4
Zimbabwe	754	-2.4	6.3	86	0.1	5.4	4.2

Group average	559.3	1.5	10.7	78.6	1.2	6.2	8.4
Group 3: Middle-income democracy							
Ghana	1167	3.9	7.4	75	1.8	10.3	5.2
Kenya	1072	2.4	4.2	82	2.4	5.5	4.4
Lesotho	1069	3.7	6.3	84	-0.3	7.4	9.3
Mauritius	7002	3.6	1.2	95	0.3	27.3	5.6
Namibia	4473	3.3	2.3	88	-0.4	10.4	4.1
Senegal	1052	2.2	8.7	70	0.4	8.6	5.9
South Africa	5905	1.8	0.5	87	-0.2	16.9	4.8
Zambia	1210	4.8	10.1	86	1.9	n.a.	n.a.
Group average	2868.8	3.3	5.1	83.4	0.7	12.3	5.6
Group 4: Middle-income autocratic							
Algeria	4044	2.3	0.4	96	0.3	25.3	5.2
Angola	3166	0.3	1.7	83	0.4	4.2	2.7
Cameroon	1101	0.9	4.6	85	0.8	8.9	5.2
Egypt	2171	2.2	1.3	96	0.6	28.8	0.4
Gabon	8645	0.7	0.8	n.a.	n.a.	12.6	4.8
Ivory Coast	1118	0.5	4.7	63	0.5	7.1	8.8
Morocco	2602	3	1.6	92	0.4	15.2	4.3
Swaziland	3342	1.2	2	80	0.8	4.8	3.1
Group average	3273.6	1.4	2.1	85.0	0.5	13.4	4.3

Source: World Bank World Development Indicators Database

The study has adopted World Bank's categorization of economies according to GDP per capita as of 2015 as follows: low income - USD 1,045 or less; middle income - USD 1,046 to USD 12, 735, and; high income – of USD 12,736 or more. Summary features are as follows:

Low-income countries:

- Combined average GDP per capita of USD 523 in the 13-year sample period.
- Average GDP per capita growth for democracies at 1.9% was slightly higher than for autocracies at 1.5% for the 13-year period.
- The average official development assistance (ODA) as a proportion of GDP received by democracies was nearly double that received by autocracies.
- Primary net enrolment and tertiary gross enrolment ratios were lower for democracies compared to autocracies.

Middle-income countries:

- Combined average GDP per capita of USD 3,071 in the 13 year sample period.
- Average GDP per capita growth for democracies was more than double that of middle-income autocracies.
- Average ODA as a proportion of GDP received by democracies was more than double that received by autocracies
- Primary net enrolment and tertiary gross enrolment ratio were higher for autocracies.

For categorization of countries between democratic or autocratic systems of government,² this study has employed definitions from three different sources: (i) Polity IV Project: Political Regime Characteristics and Transitions, 1800 – 2013 database by Marshall and Jaggers (2014); (ii) database of the index of democracy and dictatorship by Cheibub et al (2010), and (iii) the democracy index constructed by publications of the Economist Intelligence Unit. It was rigorously verified that none of the countries included transitioned

² Generally, definitions that have been used for categorization of countries between democracy and autocracy use indicators grouped in different categories measuring competitiveness and openness of elections, pluralism, civil liberties, and political culture.

from one type of political system of government to another between 2005 and 2017 based on the definitions from these three sources.

For the rest of the study, data sources were as follows: World Economic Outlook database of the International Monetary Fund (IMF), International Development Statistics database of the Organization of Economic Cooperation and Development (OECD), and World Development Indicators database of the World Bank.

2.5.3 The effect of education aid (EAid) variables on growth

Before attempting to tackle the education aid on growth nexus there is need to tackle the issue of double counting involving EAid which is likely to be incorporated in the investment variable in the vector k in equation (2). Any double counting would lead to a biased coefficient for the EAid variable. To avoid this by omitting the investment variable would also lead to model specification error (Feeny, 2005; Gomanee, 2005). Appendix A provides results of a model linking EAid to aggregate investment, which suggests that there is a link whereby an increase in education aid by one percentage point raises the investment share in GDP by about 0.36 percentage points. The next step would then be to isolate and purge this effect from the investment variable in equation (2). This is done by creating another investment variable, INVRES which is estimated by using the residuals from an aid-investment bivariate regression, whereby investment is regressed on aid using the Residual Generated Regressors technique proposed by Gomanee (2005) and Feeny (2005). Finally, the investment variable used, INV_{it} , is assumed to be net of the EAid component.

By design, estimated growth models in previous studies such as those by Burnside and Dollar (2000), Hansen and Tarp (2001), Dalgaard et al. (2004) and Gomanee (2005) used foreign aid in aggregated form. This study seeks to isolate education aid, which is understood to contribute to human capital accumulation and education aid is further disaggregated by educational level for countries that are themselves disaggregated by level of income and political systems of government.

In a first step, the study will analyze a scenario in which education aid is aggregated and countries are pooled, thus disregarding income or political regime categories. The results of this pooled regression will be used as a benchmark for models in which education aid is disaggregated by levels (primary, secondary and tertiary) and countries are disaggregated by income group and political regime as in Table 2.1.

The three sub-sector levels of education aid will not be entered simultaneously in a single regression in order to avoid running into multicollinearity. By including only one measure of education aid at a time in the regressions there was the risk that estimations may suffer from the omitted variable bias problem. Indeed, in order to accurately capture the effects of each of the individual education aid variables on growth, the estimations should include all the three measures at one time. However, this approach also faces the risk of producing inaccurate estimates if there is multicollinearity, which was detected among the education aid variables used in this study. Pairwise correlation coefficients between the aid variables were all significant for each of the country categories. This justified the inclusion of a single measure of education aid at a time in the regressions. The system GMM estimator used for this analysis mitigates the potential omitted variable bias problem through the use of instrumental variables.

Based on the general growth equation (2) in section 2.5, Table 2.2 summarizes the specific models to be estimated as separate regressions.

Table 2. 2: Summary of regression models and variables used*

	Regression 1: Pooled	Regression 2: Primary	Regression 3: Secondary	Regression 4: Higher
<i>Dependent variable:</i>				
GDP per capita growth	Δy_{it}	Δy_{it}	Δy_{it}	Δy_{it}
<i>Aid variables (% of GDP):</i>				
Aggregate education aid	A_Aid_{it}			
Primary education aid		P_Aid_{it}		
Secondary education aid			S_Aid_{it}	
Higher education aid				H_Aid_{it}
<i>Control variables:</i>				
Log of initial GDP per capita	$\log(y_{it-1})$	$\log(y_{it-1})$	$\log(y_{it-1})$	$\log(y_{it-1})$
Log (1+ inflation rate)	INF_{it}	INF_{it}	INF_{it}	INF_{it}
Investment (% of GDP)	INV_{it}	INV_{it}	INV_{it}	INV_{it}
Government consumption (% of GDP)	GVT_{it}	GVT_{it}	GVT_{it}	GVT_{it}
Trade (% GDP)	TRD_{it}	TRD_{it}	TRD_{it}	TRD_{it}

***Note: all four models are estimated for each of the four country categories.**

2.5.4 Estimation issues

With panel data country matrices of time-series are stacked so that models of the kind specified in equation (2) are characterized by an error term decomposed into $\mu_{it} = \vartheta_i + \varepsilon_{it}$ where ϑ_i represents time invariant, country specific characteristics (fixed effects), and disturbances, ε_{it} , which change across time and across countries. Use of ordinary estimation techniques such as Ordinary Least Squares (OLS) and the Instrumental Variable (IV) approach cannot handle these characteristics. Moreover, there are other issues in the dynamic specification of equation (2) and its specification application to the aid-growth context. Firstly, there is correlation between the lagged dependent variable y_{it-1} and the disturbance term for the fixed effects (ϑ_i). Secondly, a negative relationship between aid and income per capita has been noted, (see Trumbull and Wall (1994) and Alesina and Dollar (2000)) implying endogeneity running from the dependent variable to aid in equation (2).

The two ways to work around the endogeneity problems are the Arellano – Bond (1991) Difference GMM estimator, and the Arellano-Bover (1995) and Blundell and Bond (1998) System GMM estimator. The problem with the Difference GMM is that it is inefficient in that it relies on transforming the variables through first differencing which removes the fixed country-specific effects as they do not vary with time. It also does not address the endogeneity problem and differencing can introduce serial correlation where disturbance terms $\Delta\varepsilon_{it}$ may no longer be independent and could thus reduce accuracy ($\Delta\varepsilon_{it} = \varepsilon_{it} - \varepsilon_{it-1}$ can be correlated with $\Delta\varepsilon_{it-1} = \varepsilon_{it-1} - \varepsilon_{it-2}$ through the shared ε_{it-1} term).

To overcome the shortcomings of the difference GMM estimator, Arellano-Bover (1995) and Blundell and Bond (1998) proposed the use of extra moment conditions that rely on certain stationarity conditions of the initial observation. The resulting system GMM estimator has been shown to have much better finite sample properties in terms of bias and root mean squared error than that of the difference GMM estimator. The system GMM estimator for dynamic panel data models combines moment conditions for the model in first differences with moment conditions for the model in levels. It augments difference GMM by estimating simultaneously in differences and levels, the two equations being

distinctly instrumented. Blundell and Bond (1998) argued that the system GMM estimator performs better than the difference GMM estimator because the instruments in the levels model remain good predictors for the endogenous variables in this model. They showed that for an autoregressive panel data model of order 1, the reduced form parameters in the levels model do not approach zero when the autoregressive parameter approaches one, whereas the reduced form parameters in the difference model do. Furthermore, this estimator is designed for panel datasets comprising many cross-sectional units and few time periods (i.e. large N and small T), which is particularly suitable for this study.

A feature of interest with system GMM is the set of internal instruments built from past observations of the instrumented variables. A caveat of the system GMM estimator is that it is susceptible to Type 1 error (i.e., producing significant results even though there is no underlying association between the variables involved). This is particularly true when the number of instruments relative to the sample size is large (Roodman, 2009). While no widely accepted rule of thumb for the instrument count exists, the software, STATA, recommends that the number of instruments should not exceed the sample size. Initially, the number of lags of the instrumenting variables in the regressions with a disaggregated education aid variable was equal to the sample size of countries for each of the four country groups. Subsequent regressions were run with instruments limited by restricting the number of lags of the variables used as instruments. After restricting the number of lags to two the number of instruments declined to 7 and the estimated coefficients of the disaggregated education aid variables retained their signs and the same significance status.

2.6. Orientation of disaggregated education aid in democratic and autocratic countries

Figure 2.1 shows average primary education aid as a percentage of total education aid³ for low and middle-income countries for the thirteen-year period from 2005 to 2017. Section A shows how low-income democracies allocated more education aid to primary education

³ Here total education aid is defined as a summation of education aid towards early childhood development, primary education, secondary education, higher education and technical and vocational education and training.

compared to low income autocracies. Throughout the sample period, low-income democracies allocated an average of 38% of total education aid to primary education compared to an average of 28% by low-income autocracies but the trend in the former has been declining over time. Similarly, in Section B, throughout the sample period middle-income democracies allocated a higher proportion (an average of 32%) of total education aid to primary education compared to middle-income autocracies (an average of 20%).

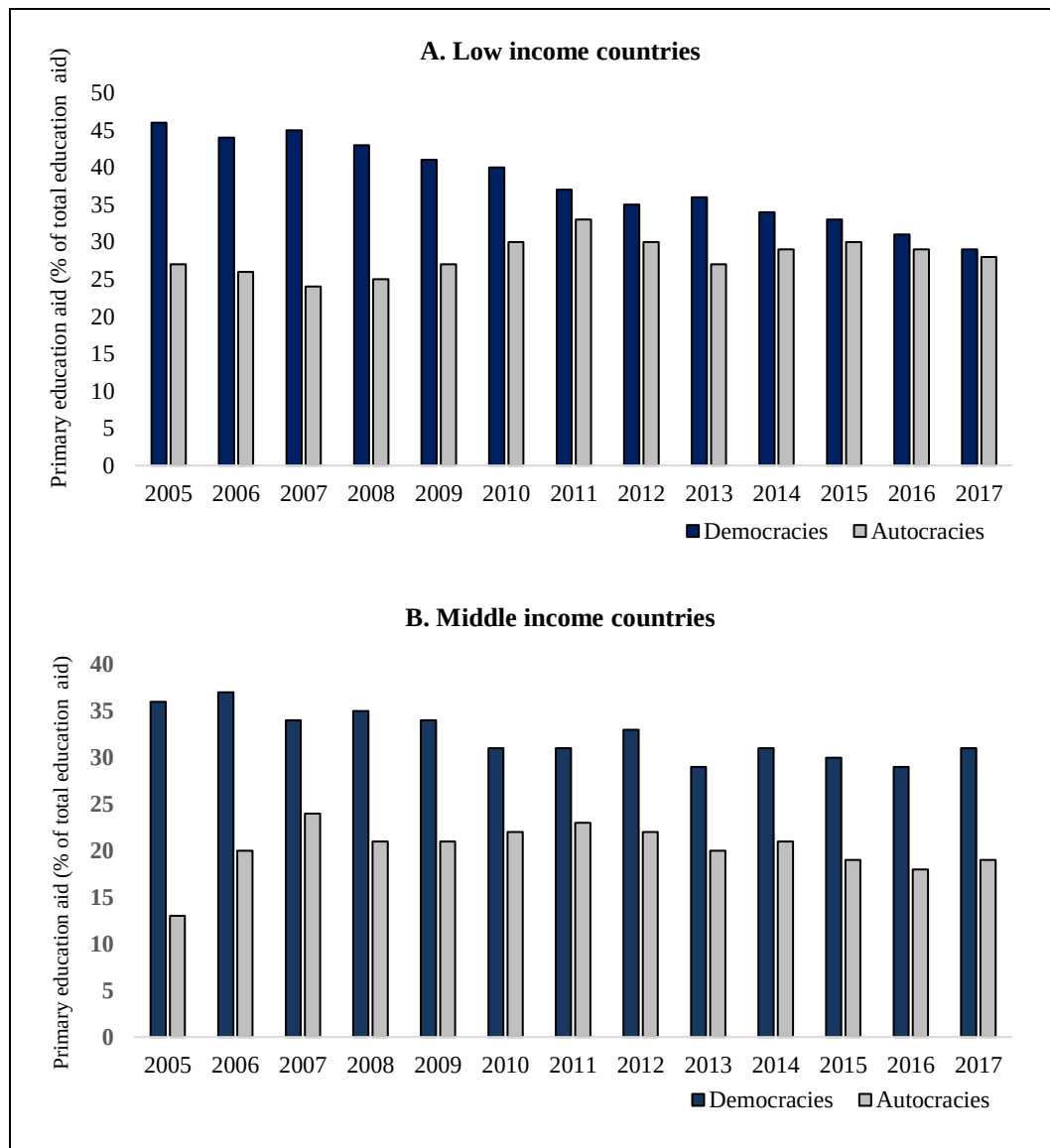


Figure 2. 1: Average primary education aid (% of total education aid)
Data source: OECD

Figure 2.2 shows average higher education aid as a percentage of total education aid for low and middle-income countries for the study period. Here, autocracies consistently allocated a higher proportion of total education aid to higher education compared to democracies. Between 2005 and 2017 low-income autocracies allocated a group average of 35% of total education aid to higher education compared to 20% by low-income countries. Middle-income autocracies allocated a group average of 40% of total education aid to higher education compared to 30% by middle-income democracies.

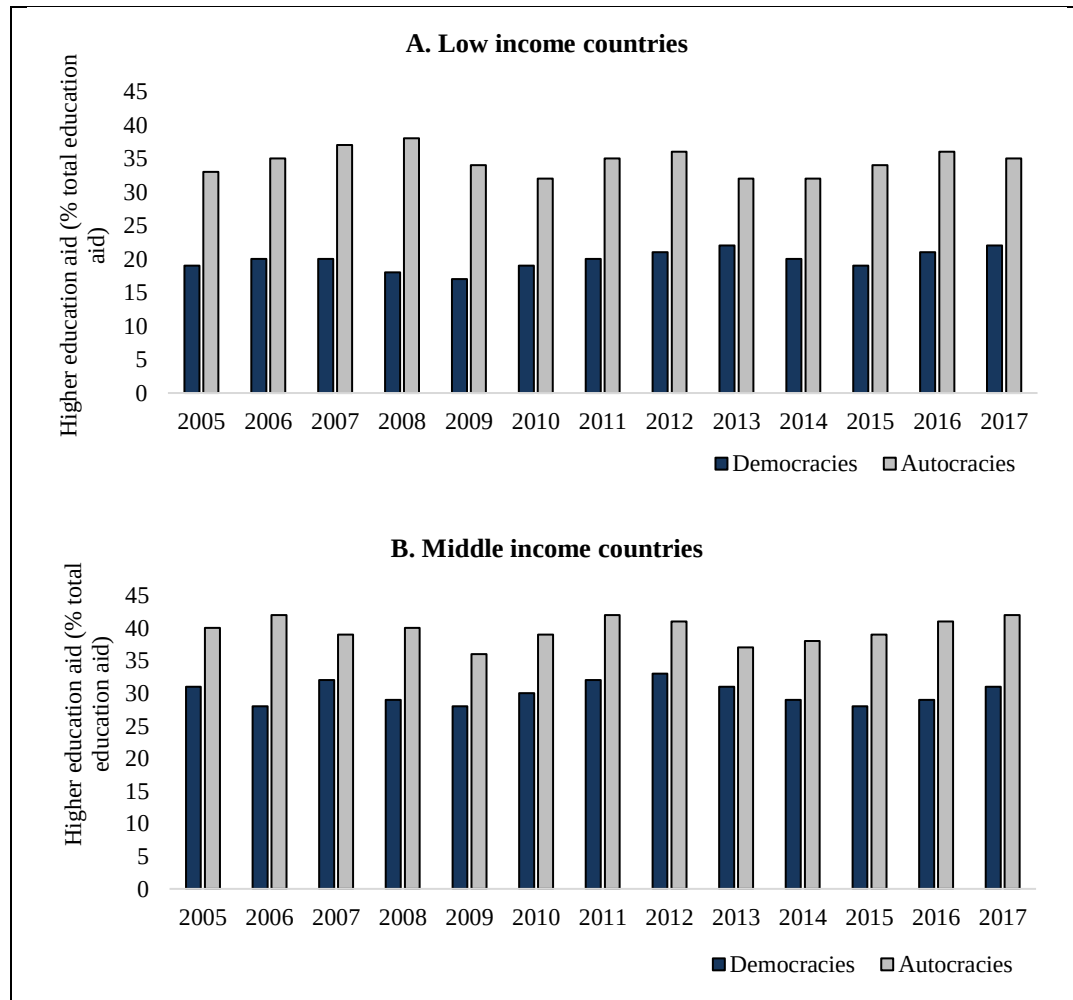


Figure 2. 2 Average higher education aid (% of total education aid)
Data source: OECD

The data shows that democracies included in this study have a tendency to prioritize aid allocation to primary education while autocracies have a tendency to prioritize aid allocation to higher education.

2.7. Econometric results

2.7.1 Effect of control variables on GDP per capita growth

The sign of the estimated coefficient of initial GDP per capita in log form was not consistent across all estimations and the estimated coefficient was consistently statistically insignificant. This suggests that there was no evidence of convergence in the sample of countries in this study. Government consumption and inflation both had inverse and statistically significant relationships with per capita GDP growth across all estimations while investment consistently had a positive and statistically significant relationship with per capita GDP growth. Trade does not display a consistent relationship with growth. In conclusion, the results suggest that lower government consumption, lower inflation, and high investment promote economic growth.

2.7.2 The education aid-growth relation

Table 2.3 provides the education aid-growth regression output from the 20 system GMM growth regressions that were estimated. The table shows the estimated coefficients for the education aid variables and their P-values. In a first step to ascertain the importance of heterogeneity of aid flows and heterogeneity of aid recipients, the system GMM regression results from the pooled sample of countries are presented. This analysis uses aggregated data for education aid, country income group, and system of government. These results are next compared with regression results from a second step using disaggregated data for education aid, country income group and political system of government (columns B, C and D). Table 2.4 summarizes the results from table 2.3 by showing the emerging patterns with the coefficient signs and significance levels.

Table 2. 3: System GMM regression results

	A. Aggregate aid	B. Primary aid	C. Secondary aid	D. Higher aid
Pooled sample	0.141 [0.133]	0.109 [0.137]	-0.088 [0.225]	0.151 [0.285]
Low income democracies	0.413** [0.014]	1.367** [0.004]	-1.055 [0.248]	0.569 [0.291]
Low income autocracies	0.384* [0.065]	1.181** [0.040]	-1.963 [0.192]	0.670 [0.115]
Middle income democracies	0.103 [0.528]	-0.724* [0.079]	-0.655** [0.036]	1.341** [0.005]
Middle income autocracies	0.170 [0.339]	-0.831** [0.048]	-0.749** [0.019]	1.539** [0.004]

Notes: P-values in parentheses. * denotes significance at 10%; ** significance at 5%; * significance at 1%.**

Table 2. 4: Education aid-growth regression results: Signs and statistical significance

Income group	Governance	Aggregate	Primary	Secondary	Higher	Comment
Pooled	Pooled					No impact, all countries, all aid
Low-income	Democracies	***	+			(+) for aggregate and primary
	Autocracies	+	***			
Middle-income	Democracies		-	-	+	(-) for primary and secondary; (+) for higher
	Autocracies		-	-	+	

* denotes significance at 10%; ** significance at 5%; *** significance at 1%.

2.7.3 The pooled sample

The pooled sample ignores the heterogeneity of aid recipients and the heterogeneity of education aid flows. The estimated coefficient of aggregate aid in row 1, column A of table 2.3 for the pooled sample is not significant suggesting that aggregate education aid does not have a significant effect on growth for the 32 countries pooled together whatever their income or governance status. The heterogeneity of education aid flows by disaggregating education aid data into primary, secondary and higher education aid, but without considering the heterogeneity of aid recipients is reported in row 1 under columns B, C, and D. None of the estimated coefficients are statistically significant. In short, no type of education aid has any significant effect on growth in African countries if recipients' heterogeneity is not taken into account. In the next step we examine the issue of recipient heterogeneity.

2.7.4 Low-income democracies vs. Low-income autocracies

For low-income countries both aggregate aid and primary level aid have a positive and significant effect on per capita growth regardless of governance system. When the effects of other variables are held constant, a 1% increase in aggregate education aid increases GDP per capita growth by approximately 0.41% in low-income democracies and by 0.38% in low-income autocracies. A 1% increase in primary education aid will increase GDP per capita growth by approximately 1.4% in low-income democracies and by 1.2% in low-income autocracies on average. Higher and secondary education aid have no significant effect.

2.7.5 Middle-income democracies vs. Middle-income autocracies

For middle-income countries, democracies and autocracies alike, aggregate education aid has no significant effect on growth while primary and secondary aid have negative and significant effects. Other variables held constant, a 1% increase in primary education aid leads to approximately a 0.72% and 0.83% decline in growth in middle-income democracies and autocracies on average respectively, while for secondary level aid the declines would be 0.66% and 0.75% respectively. In both middle-income democracies and autocracies, higher education aid has a positive, significant and strong effect on GDP per capita growth. Holding other variables constant, a 1% increase in higher education aid leads to a 1.3% and 1.5% increase in growth on average in democracies and autocracies respectively.

2.7.6 Aid orientation and implications for growth in different political systems

Contrary to a priori expectation, aggregate education aid is seen to be important for growth in low-income countries. Conversely, middle-income countries conform to a priori expectation with respect to aggregate education aid not being statistically important for growth. Possible reasons for this will be discussed in section 2.8. For both low-income and middle-income countries, heterogeneity of education aid is seen to have important effects for growth. Specifically, primary education aid appears to be more important for increasing growth in low-income countries compared to secondary and higher education aid irrespective of the prevailing political system of government. Conversely, for middle-income countries, higher education aid appears to be more important for promoting growth than primary and secondary education aid irrespective of the prevailing political system of government. This suggests that it is in the interest of both low-income democracies and autocracies to skew their education sector financing (and education aid) to the primary education subsector. However, the data analysis in section 2.6 on orientation of disaggregated education aid in democratic and autocratic countries shows that low-income autocracies are less inclined to follow this path, to their detriment. On the other hand, low-income democracies have a preference for this type of prioritization, to their benefit. For middle-income countries in this study collectively, the empirical results show that it is more advantageous to skew education sector spending (and education aid) to higher education because that is where there are greater returns for economic growth. However, the data analysis in section 2.6 shows that middle-income autocracies are more inclined to follow this path to their benefit compared to middle-income democracies.

2.8. Discussion

On average, tax revenues covered approximately 84% of total public spending during the period 2005 to 2017 in the sample of low-income African countries in this study and 182% in the sample of middle-income countries (World Bank, 2017). ODA from bilateral and multilateral donors is an important source of public sector financing and it fills much of the financing gap, particularly in low-income countries. ODA to the sample of low-income

countries amounted to an average of 90% of total public spending between 2005 and 2017. In contrast, ODA to the sample of middle-income countries amounted to just 12% of total public spending on average over the same period (OECD, 2017; World Bank, 2017). ODA is therefore a more important source of public spending in low-income countries and this lends explanation to why the coefficient of aggregate education aid was positive and significant for low-income democracies and autocracies but insignificant for the middle-income counterparts.

A possible explanation for the significant and positive effect of primary education aid in low-income countries is that many of these countries have not achieved universal primary education. This is largely due to inadequacies in key areas such as school infrastructure, teaching and learning materials, and teachers to accommodate the large numbers of eligible pupils into the system. The conditions in public primary schools in many low-income African countries are such that repetition rates and dropout rates are high owing to poor teaching and learning conditions. This means marginal productivity per dollar is high for primary education aid in low-income countries since the need for investment is large at primary level in these countries. By contrast, most of the middle-income countries included in this study are closer to achieving universal primary and secondary education, therefore the marginal productivity per dollar is relatively lower for primary and secondary education aid in middle-income countries. In addition, primary education is comparatively more relevant for low-income economies given that many of these economies are predominantly engaged in subsistence agricultural production where basic traditional practices are used which do not require high levels of education.

Governments in low-income countries spend much more per capita on average on higher education compared to middle-income countries. During the sample period, governments in low-income countries spent 169% more per pupil in higher education compared to middle-income counterparts (World Bank, 2017). The fact that government per capita expenditure on higher education is substantially lower in middle income countries could be explained by several factors but the main one is perhaps that enrolments are substantially much higher in middle-income countries compared to low-income countries. From the

study data, for each year in the sample period, the average gross enrolment ratio for higher education in middle-income countries was more than double that in low-income countries. Higher education is comparatively more important for middle-income countries than low-income countries because as countries progress into middle-income status it is often the case that the share of agriculture in GDP declines while the share of industry and services sectors expands. Industry and services sectors are more dependent on higher education hence incentivizing the larger enrolments in higher education. This could explain the positive and significant effect of higher education aid for both categories of middle-income countries in this study.

2.9. Conclusion

This study has investigated the impact that foreign aid in the education sector has had on economic growth in selected African countries. Distinction was made between low and middle-income countries as well as between democracies and autocracies. Education sector foreign aid to these countries was treated heterogeneously. With these distinctions in mind, we looked at two issues. First, we assessed the impact of the different categories of disaggregated education foreign aid on economic growth in groups of countries disaggregated by level of income and political system of government. We found that for low-income countries education aid in aggregate form and primary education aid both enhance economic growth, while post-primary education aid has no significant effect. For middle-income countries higher education aid was observed to be more important for promoting economic growth than primary and secondary education foreign aid.

Second, this study assessed whether foreign aid in the education sector has a greater impact in promoting growth in democratic regimes in Africa than in autocratic ones. The data revealed that in democracies there is a stronger tendency to allocate more education sector foreign aid to primary education, while in autocracies there is a stronger tendency to allocate more education sector foreign aid to higher education. When democracies have a stronger tendency to allocate more education sector foreign aid to primary education, this is generally beneficial to low-income countries where returns to primary education were observed to be higher through the econometric analysis of this study. Low-income

autocratic countries that allocate more education sector foreign aid to higher education than to primary education do so at their detriment with respect to economic growth. When autocracies have a stronger tendency to allocate more education foreign aid to higher education this is generally beneficial to middle-income countries where returns to higher education were seen to be higher. Middle-income democracies that allocate more education sector foreign aid to primary education compared to higher education do so at their detriment with respect to economic growth.

This study has an important caveat. It makes the implicit assumption that more spending on education both at aggregate and disaggregated levels entails more schooling either in levels or in quality. More spending on education can translate in more schooling or more quality of schooling rather imperfectly.

CHAPTER 3

WOMEN AND SMALLHOLDER AGRICULTURAL PRODUCTIVITY IN MALAWI

3.1. Introduction

In his analysis of smallholder agricultural development in Malawi, Chipande (1983) observed that during the colonial and federal eras there was a general neglect of smallholder agricultural development in favour of estate agriculture, which was in the hands of European settler farmers and companies. Government fiscal, marketing and pricing policies were manipulated in such a way that provided the estate sector with cheap labour. The post-independence era saw an abandoning of the coercive approach to agricultural modernization. Instead, the Government sought to teach the people better methods of farming through persuasion and example (Chipande, 1983).

Over time, smallholder agriculture has become increasingly recognized as a means to address issues of poverty and nutrition insecurity in Malawi as the sector both feeds the population and employs the largest number of people in the country. There is near universal participation in agriculture by households throughout Malawi, with women responsible for a significant volume of the total labour. Approximately 97% of rural women in the country are engaged in subsistence farming¹ (Koirala et al., 2015).

In terms of types of crops grown, it has been observed that female farmers in many instances grow lower value subsistence crops not necessarily because they prefer to do so but rather because they cannot access the resources that would permit them to do otherwise.

Consequently, cash and export crops are frequently regarded as ‘men's crops’ and subsistence crops as ‘women's crops.’ In Malawi, female farmers are less likely to cultivate the country’s primary cash crop, tobacco, compared to men. The crop is only planted on 1.3% of female-managed plots compared to 5.4% of male-managed plots (NSO, 2017). UN Women (2015) uncovered a 28% gender gap between women and men in the fraction of land devoted to export crops in Malawi.

Gender differences in cash crop production create two key challenges: first, at the micro level, there is potential for widening income inequality arising from cash crops, grown mainly by men, commanding higher market value than traditional staple crops, grown mainly by women. Second, at the macro level, failure to maximize the important contribution that women can make in cash crop production is costly to the national development agenda as it results in forgone aggregate agricultural output and incomes.

O’Sullivan et al. (2014) found that, on average, plots managed by women in Malawi produce 25% less in terms of gross value of output per hectare than plots managed by men. Previous related research highlighting the gender gap in agricultural production efficiency focused largely on women’s unequal access to key inputs, such as fertilizer, agricultural information and farm labour, concluding that if women had better access, they would be equally efficient (Peterman et al., 2011; Vargas Hill & Vigneri, 2011; Quisumbing et al., 2001; Goldstein & Udry, 2008; Horrell & Krishnan, 2007; Udry, 1996; Quisumbing, 1996). The methodology used in this paper looks not only at the quantity of resources that women use, but also assesses the returns that they receive from these resources, or how well these resources actually translate into increased agricultural productivity.

It is possible that even if women had access to the same amount of inputs as men, this equal access would not automatically always achieve the same effect in terms of productivity. Such a paradox could result from broader norms, market failures or institutional constraints that alter the effectiveness of these resources for women. Furthermore, despite what could be perceived as a well-established base on the extent and proximate causes of the gender gap across sub-Saharan Africa, the overwhelming majority of empirical studies on the topic

have used data from small-scale surveys that were limited in terms of geographic coverage, topic, or attention to intra-household dynamics (or in some cases, all three). The failure by previous studies to use nationally-representative, methodologically sound data collected in heterogeneous settings has in turn inhibited the computation of rigorous estimates. This study contributes to the literature by providing a nationally representative analysis of the gender gap in Malawi from the perspective of men's and women's crops using the Oaxaca-Blinder decomposition methodology. The substantively interesting question we set out to address is why productivity differences arise between men and women for a variety of crops, which have been designated as women's and men's crops in the literature.

3.2 What are women's and men's crops?

A body of literature exists that has categorized certain crops to be either women's crops or men's crops depending on the gender that dominates production. This literature will be reviewed in this section. Domination in production of a specific crop by gender has been found to be influenced by several contextual factors as well as unique properties of the crops themselves.

There is a strong association between cassava cultivation and women in Sub-Saharan Africa where cassava is often referred to as a 'women's crop' (Forsythe et al., 2015). The association is derived from several factors including the low market value of cassava as a traditional food that is mainly grown and consumed at home, along with characteristics such as its low input requirements. Prevailing climate change increases the importance of the crop as it is drought tolerant and can do well in poor soils and requires less strenuous management. Chiwona-Karltun (2005) noted that cassava has gained popularity as an important crop in view of the HIV and AIDS pandemic in which labour-constrained households find it ideal as it has minimal labour requirements compared to crops such as maize. Practically, the low-risk and low-input requirements of cassava are particularly important for women who experience more severe constraints in accessing agricultural inputs in comparison to men, and also face more constraints in participating in alternative markets such as cash crops.

Groundnut is also regarded as a women's crop primarily because much of the labour is provided by women, especially during the post-harvest handling such as stripping, and shelling (Tsusaka et al., 2016). This has resulted in women perceiving greater control over groundnut production than men, where control extends to decision making at various steps in production (Orr et al., 2016). This is consistent with Doss's (2001) argument that women's crops are defined not only by who controls the output but also by who makes the management decisions.

As in many parts of Africa, men dominate the production and control of high-value cash crops in Malawi (Makoka et al., 2016). Malawi's primary cash crop is tobacco and the country is the world's most tobacco-dependent economy in the world (Otanez et al., 2009). The commodity contributed 52% of the total export value for the country in 2012. In the 2009/10 farming season tobacco was disproportionately cultivated on 10.4% of male-managed plots compared to 3.3% of female-managed plots (NSO, 2012). In the 2015/16 farming season, the crop was cultivated on 5.4% of male-managed plots and just 1.3% of female-managed plots (NSO, 2017). Although women are involved in a substantial amount of the labour associated with tobacco, they are less involved in decision-making in the production process (Makoka et al., 2016).

Cotton is a significant cash crop and the fourth largest agricultural export after tobacco, sugar, and tea in Malawi. Cotton requires considerable amount of inputs, thereby restricting the ability of low-income smallholders, many of whom are women farmers, to engage in the sector. Cotton is grown by approximately 300,000 smallholder farmers in Malawi and it is estimated that approximately 20% to 30% of these are female (i.e. those involved in decision-making in the production process on the farm) (Ussar, 2016). Many other women who are not involved in decision-making in the cotton production process work as labourers on their husband's cotton farms or are employed as casual workers on other people's farms. Cotton is therefore also regarded as a men's crop.

In Malawi, maize is the staple food crop cultivated on 73% of male-managed plots and 83% of female-managed plots (NSO, 2017). Orr et al. (2016) observed that both men and women viewed maize as a crop where over 60% of decisions were non-dominated and where control was shared. Therefore, maize occupies the middle ground, with control shared fairly evenly between women and men and thus can be viewed as a gender-neutral crop. Here control is viewed from three perspectives: strategic – encompassing area planted, weeding, and inputs; operational – encompassing hired labour, harvesting and land preparation; and financial – encompassing selling and use of income.

Table 3.1 summarizes the classification of women's and men's crops from the foregoing overview.

Table 3.1: Classification summary of women's and men's crops based on literature

Crop	Gender domination	Explanation	Reference
Cassava	Female	Low risk; low input requirement; does not require strenuous management.	Forsythe et al., (2015)
Groundnut	Female	Bulk of labour provided by women; women are involved to a large extent in management decisions in production.	Orr et al. (2016); Tsusaka et al. (2016)
Tobacco	Male	Men dominate decision-making process; considerable input requirements; strenuous management involved.	Makoka et al. (2016); NSO, (2017)
Cotton	Male	Men dominate decision-making process; considerable input requirements; strenuous management involved.	Ussar (2016); NSO, (2017)
Maize	Neutral	More than 60% of decision making is non-dominated and control is generally shared.	NSO, (2017); Orr et al. (2016)

Previous research including Horrell and Krishnan (2007), Quisumbing (1996) and Udry (1996) concluded that women were on average less productive compared to men in farming largely due to unequal access to key agricultural inputs and information. These conclusions

were drawn exclusively on the basis of production of gender-neutral crops and without a clear, explicit focus on distinguishing between male-dominated or female dominated crops. But is it really the case that men display superior efficiency in farming compared to women even for female-dominated crops? This study will look to address this question.

Based on data availability for the variables of interest, this study will analyse agricultural productivity differences between male-managed and female-managed plots for maize, groundnut, tobacco and cotton farming. While cassava was included in the overview in this section, it was excluded in the subsequent analysis of this study due to inadequate production information being available at a gender disaggregated level for our specific study sample.

3.3 Theoretical framework

3.3.1 Human capital theory in agricultural productivity

Whereas classical economics had tended to view the workforce in purely quantitative terms, human capital theory introduced a qualitative aspect. Education and training were seen as the most important ways in which the quality of the workforce could be enhanced. The theory suggests that economic growth could be generated by improving the quality and reach of the education system and its outcomes. At the macro level, the economy's human capital can be proxied by the rates of enrolment in primary, secondary and post-secondary education institutions (Medard et al., 2012). It is assumed that high enrolment rates in education and training institutions indicate that more people are accumulating human capital and that the workforce, as a whole, is becoming more productive.

For Malawi, where agriculture forms the bedrock of economic activities, improvement in human capital capacity for agricultural productivity is an important pre-requisite for social and economic development particularly in rural areas. To this end, one of the most important subsectors in agriculture is extension services, which concerns provision of support to people engaged in agricultural production to solve problems and to obtain information, skills, and technologies to improve productivity. Its aim is to teach improved

methods of production and marketing leading to higher farm incomes and also ways of establishing a better home and community life. An important underlying objective of extension services will be to make farmers more receptive to new ideas so that they seek on their own initiative ways of improving their farm operations. Agricultural extension will be effective to the extent that it is backed by general (formal) education tending to widen the farmer's horizon and make them more receptive to new ideas. Illiteracy is high in rural areas of Malawi, where educational facilities are generally less adequate than in urban areas. Nevertheless, illiteracy does not preclude the teaching of better farming methods. FAO (2011) observes that extension provision in Malawi and many other developing countries has been low for both women and men, and uptake for women especially tends to be lower compared to men. The way in which extension services are delivered can also constrain women farmers in receiving information on innovations. Women tend to have lower levels of education than men (UN Women et al., 2015), which may limit their active participation in training that uses a lot of written material.

In order to be effective, education and extension services must incentive rural populations to absorb and put into practice new ideas, skills, and techniques, and to adjust to a way of life which in time may depart widely from the accustomed pattern. Many of the presently accepted concepts of production and consumption have arisen from the slow accumulation of experience and tradition. They have become part of a cultural heritage, embodying many values, attitudes, sentiments, and even superstitions which are so deeply rooted that they can be changed only slowly and with difficulty.

In their study to determine the influence of education on maize and tobacco productivity in Malawi, Ebiyam et al. (2017) discovered that primary and secondary education had significant positive influence on farm labour productivity while tertiary education did not significantly affect productivity of farm labour. They further uncovered that secondary education had the largest impact on enhancing farmers productivity. Consequently, they recommended that the primary school curriculum be revised with the aim of making the teaching of agriculture more practical so that learners who do not succeed in accessing secondary education can still be productive in the agriculture sector.

Agriculture extension receipt (as a qualitative variable) and years of schooling (as a quantitative variable) have been included in the regression analysis of this study to ascertain the degree of influence of these variables on productivity in maize, groundnut, tobacco and cotton farming in Malawi.

3.4 Data, descriptives and preliminary econometric analysis

The economic, social and demographic data for this study are drawn from the fourth Malawi Integrated Household Survey (IHS 4). It is statistically designed to be representative at national, district, urban and rural levels. The survey was conducted by the Malawi National Statistical Office from April 2016 to April 2017. The survey collected information from a sample of 12,447 households; 2,272 (representing 18.3%) were urban households, and 10,175 (representing 81.7%) were rural households. The survey collected socio-economic data at the household level and on individuals within the households including highest education qualifications attained and gender of the plot manager. It also collected detailed data on farming activities including crop output, land usage, labour and other farming inputs.

In rural Africa, plots are not necessarily managed at the household level but at individual level. It is not uncommon to have three generations living together and the person declared as the head of the household might just be the patriarch whose influence on productivity is in fact limited. The head of the household does not have identical observable and non-observable characteristics as the other household members. Therefore, the scope of the conclusions drawn from studies that aim to explain gender differences in agricultural productivity based on gender of the household head will likely be limited in terms of public policy. Following the approach by Chipeta (1986; 1976), the method used in this study entails estimation of a production function with a gender dummy as an independent variable (in the pooled regression), with estimation at the plot level as opposed to the household level. This plot level approach outperforms the household level approach in that

it is better able to isolate the differences in productivity caused by gender among all the factors that influence productivity (Chipeta, 1976).

Descriptive statistics and results from tests and mean differences by gender of the plot manager are presented in Tables 3.2 to 3.5 for each of the four crops separately. Plots were dropped that were missing production information, or where unit values could not be computed reliably for the crops reported to be cultivated on the plot, or where a clear manager of the plot could not be identified, or plots that had missing values among the independent variables of interest. These exclusions left us with the final analysis sample of 784 maize plots, 46% of which were managed by female farmers; 232 groundnut plots, 48% of which were managed by female farmers; 212 tobacco plots, 35% of which were managed by female farmers; and 199 cotton plots, 36% of which were managed by female farmers.

Table 3.2: Descriptives and results from tests and mean differences by gender of maize farmers

Variable	Pooled sample	Male managed plot sample	Female managed plot sample	Difference
<i>Outcome variable</i>				
Output per acre (kg/ac)	651.96	667.89	635.37	32.52**
<i>Plot manager characteristics</i>				
Age (years)	41.59	40.15	43.39	-3.24**
Years of schooling	5.42	6.55	4.87	1.68*
Agriculture extension receipt δ	0.26	0.27	0.23	0.04
<i>Household characteristics</i>				
Household size	4.83	6.09	5.12	0.97*
Child dependency ratio	0.65	0.67	0.71	-0.04*
<i>Plot area</i>				
Acres	0.83	0.84	0.81	0.03***
<i>Plot input use</i>				
Fertilizer use (organic or inorganic) δ	0.48	0.49	0.46	0.03*

Variable	Pooled sample	Male managed plot sample	Female managed plot sample	Difference
Household male labour use (days/ac)	18.12	21.95	12.52	9.43**
Household female labour use (days/ac)	21.14	18.98	27.17	-8.19**
Incidence of hired labour use (days/ac)	8.12	7.33	9.59	-2.26**
<i>Agro-ecological characteristics</i>				
Sandy soil δ	0.217	0.219	0.213	0.006**
Clay soil δ	0.135	0.129	0.141	-0.012**
Sandy and clay (the base category) δ	0.648	0.652	0.646	0.006**
Tropic-warm/semiarid δ	0.46	0.47	0.46	0.01
Tropic-warm/sub-humid δ	0.32	0.37	0.31	0.06***
Tropic-cool/semiarid δ	0.13	0.13	0.10	0.03
Tropic-cool/sub-humid δ	0.09	0.09	0.07	0.02***
<i>Observations</i>	784	423	361	

***/**/* indicate statistical significance at the 1/5/10 percent level, respectively. δ denotes a dummy variable.

Table 3.3: Descriptives and results from tests and mean differences by gender of G.Nut farmers

Variable	Pooled sample	Male managed plot sample	Female managed plot sample	Difference
<i>Outcome variable</i>				
Output per acre (kg/ac)	418.92	425.25	413.83	11.42*
<i>Plot manager characteristics</i>				
Age (years)	40.64	39.36	42.52	-3.16**
Years of schooling	6.08	6.68	5.13	1.55*
Agriculture extension receipt δ	0.29	0.31	0.27	0.04
<i>Household characteristics</i>				
Household size	4.74	5.69	4.81	0.88*
Child dependency ratio	0.66	0.69	0.74	-0.05*
<i>Plot area</i>				
Acres	0.74	0.75	0.73	0.02****
<i>Plot input use</i>				
Fertilizer use (organic or inorganic) δ	0.04	0.04	0.03	0.01
Household male labour use (days/ac)	19.04	22.13	15.62	6.51*
Household female labour use (days/ac)	22.48	20.37	28.23	-7.86*
Incidence of hired labour use (days/ac)	7.68	8.19	9.37	-1.18**
<i>Agro-ecological characteristics</i>				
Sandy soil δ	0.223	0.226	0.224	0.002*
Clay soil δ	0.126	0.120	0.129	-0.009*
Sandy and clay (the base category) δ	0.651	0.654	0.647	0.007*

Variable	Pooled sample	Male managed plot sample	Female managed plot sample	Difference
Tropic-warm/semiarid δ	0.47	0.49	0.48	0.01
Tropic-warm/sub-humid δ	0.38	0.40	0.35	0.05***
Tropic-cool/semiarid δ	0.09	0.09	0.07	0.02
Tropic-cool/sub-humid δ	0.06	0.07	0.05	0.02***
Observations	232	120	112	

***/**/* indicate statistical significance at the 1/5/10 percent level, respectively. δ denotes a dummy variable.

Table 3.4: Descriptives and results from tests and mean differences by gender of tobacco farmers

Variable	Pooled sample	Male managed plot sample	Female managed plot sample	Difference
Outcome variable				
Output per acre (kg/ac)	212.82	259.44	166.15	93.29***
Plot manager characteristics				
Age (years)	46.29	45.36	47.58	-2.22**
Years of schooling	7.43	7.89	6.94	0.95*
Agriculture extension receipt δ	0.32	0.35	0.31	0.04*
Household characteristics				
Household size	4.91	5.77	5.03	0.74*
Child dependency ratio	0.68	0.69	0.72	-0.03*
Plot area				
Acres	1.22	1.35	1.11	0.24***
Plot input use				
Fertilizer use (organic or inorganic) δ	0.98	0.99	0.97	0.02

Variable	Pooled sample	Male managed plot sample	Female managed plot sample	Difference
Household male labour use (days/ac)	28.41	30.17	20.98	9.19**
Household female labour use (days/ac)	30.13	19.95	36.67	-16.72**
Incidence of hired labour use (days/ac)	12.88	10.70	11.82	-1.12*
<i>Agro-ecological characteristics</i>				
Sandy soil δ	0.207	0.198	0.219	-0.021*
Clay soil δ	0.153	0.112	0.121	-0.009*
Sandy and clay (the base category) δ	0.640	0.690	0.660	0.03*
Tropic-warm/semiarid δ	0.44	0.45	0.46	-0.01
Tropic-warm/sub-humid δ	0.45	0.46	0.44	0.02**
Tropic-cool/semiarid δ	0.06	0.04	0.05	-0.01
Tropic-cool/sub-humid δ	0.05	0.05	0.05	0.00
<i>Observations</i>	212	138	74	

***/**/* indicate statistical significance at the 1/5/10 percent level, respectively. δ denotes a dummy variable.

Table 3.5: Descriptives and results from tests and mean differences by gender of cotton farmers

Variable	Pooled sample	Male managed plot sample	Female managed plot sample	Difference
<i>Outcome variable</i>				
Output per acre (kg/ac)	143.44	163.23	123.94	39.29***
<i>Plot manager characteristics</i>				
Age (years)	43.36	42.71	44.42	-1.71**
Years of schooling	6.94	7.16	6.29	0.87*
Agriculture extension receipt δ	0.29	0.33	0.30	0.03*
<i>Household characteristics</i>				
Household size	4.97	5.51	4.90	0.61*
Child dependency ratio	0.63	0.64	0.68	-0.04*
<i>Plot area</i>				
Acres	0.73	0.76	0.69	0.07*
<i>Plot input use</i>				
Fertilizer use (organic or inorganic) δ	0.99	0.99	0.98	0.02
Household male labour use (days/ac)	26.15	31.28	22.62	8.66*
Household female labour use (days/ac)	29.77	20.54	33.80	-13.26*
Incidence of hired labour use (days/ac)	10.39	9.51	12.07	-2.56*
<i>Agro-ecological characteristics</i>				
Sandy soil δ	0.200	0.205	0.210	-0.005**
Clay soil δ	0.117	0.103	0.102	0.001**
Sandy and clay (the base category) δ	0.683	0.692	0.688	0.004**
Tropic-warm/semiarid δ	0.45	0.43	0.46	-0.03

Variable	Pooled sample	Male managed plot sample	Female managed plot sample	Difference
Tropic-warm/sub-humid δ	0.46	0.46	0.45	0.01**
Tropic-cool/semiarid δ	0.05	0.05	0.04	0.01
Tropic-cool/sub-humid δ	0.04	0.06	0.05	0.01
Observations	199	127	72	55

***/**/* indicate statistical significance at the 1/5/10 percent level, respectively. δ denotes a dummy variable.

Sampled households include, on average, 4.9 household members, with a child dependency ratio, defined as the number of children under 10 years of age divided by number of household members over 10 years of age, of 0.7 children.

The average output per acre, which is the proxy for agricultural productivity, is seen to be lower across all the four crop types for female managed plot samples. Gender productivity gaps for all four crops were statistically significant. Of the four crop types, the largest gender productivity gap was seen in tobacco production where average output per acre was 36% lower on female managed plots and the difference was statistically significant at the 1% level. In cotton production female managed plots produced 24% less average output per acre. In maize production female managed plots produced 5% less output per acre. The gender productivity gap was smallest in groundnut production where female managed plots produced 3% less output per acre compared to male managed plots.

Female managed plots, on average, are overseen by individuals that are older and have slightly fewer years of schooling compared to male-managed plots across all the four crop types. Specifically, female-managed maize plots and groundnut plots are, on average, overseen by individuals that are approximately 3 years older and have approximately 2 years less of schooling compared to male-managed plots. Female-managed tobacco and cotton plots are overseen by individuals that are on average 2 years older with approximately 1 year less of schooling.

The average GPS-based plot area for male farmers across all four crop types is 0.93 acres compared to 0.84 acres for female managed plots. Female-managed plots are, on average, 10% smaller than male-managed plots and the gender difference in plot sizes is statistically significant for all crop types. Tobacco farmers tend to have relatively larger land sizes. In terms of land utilization, most farmers in Malawi allocate more land to maize and tobacco. Together, these two crops take up almost 85% of the total land under cultivation (NSO, 2017). In the data sample for this study, tobacco was grown on relatively larger plots compared to the other three crops. Tobacco plots in the pooled sample have an average size of 1.22 acres. It is in tobacco farming where the largest gender difference in plot size is seen where female managed plots are, on average, 18% smaller compared to male managed tobacco plots. The smallest gender differences in plot size were seen in groundnut and maize farming where female-managed plots were 3% and 4% smaller respectively compared to male managed plots.

Intensity of input application is often cited as a key determinant of the gender productivity gap. The incidence of organic or inorganic fertilizer application is lower on female managed plots across all four crop types but the difference is only statistically significant for maize farming. This trend could signal gender differences in Farm Input Fertilizer Subsidy Program (FISP) voucher distribution and redemption outcomes. Kilic (2015) observes that based on data from the third Malawi Integrated Household Survey, the average number of fertilizer vouchers that were received among female-headed households were lower than the analogous statistic for male-headed households and the difference was statistically significant at the 1% level. Similarly, the average number of fertilizer vouchers that were redeemed by female-headed households was lower compared to male-headed households and the difference was again statistically significant at the 1% level.

Female managed plots are associated with overall higher labour use (both household and hired) compared to male managed plots, and they are, on average, 4% less likely to be associated with households that receive agricultural extension services on topics that relate to crop production and marketing.

3.4.1 OLS estimation with fixed effects

Before delving into the factors that contribute to male-female productivity differences, we first examine the existence and magnitude of the gender productivity gap in our dataset. Tables 3.6, 3.7 and 3.8 present the naïve plot-level OLS regression results on the gender gap, where the dependent variable is log of gross output per acre. In addition to the dummy variable on female plot management, the regression only controlled for agro-ecological zone, regional and district fixed effects (F.E).

Table 3.6: Naïve regression results on gender productivity differences – Agro-Eco Zone F.E

	Dependent variable: Log[plot gross output / acre]			
	<i>Maize</i>	<i>G.Nut</i>	<i>Tobacco</i>	<i>Cotton</i>
Fixed effects	Agro-Ecological Zones			
Female Plot Management	-0.142 (0.021)	-0.083 (0.022)	-0.222** (0.023)	-0.175** (0.024)
Observations	784	232	212	199
R-Squared	0.019	0.016	0.022	0.024

Note: */**/* indicate statistical significance at the 1/5/10 percent level, respectively.**

Table 3.7: Naïve regression results on gender productivity differences – Region F.E

	Dependent variable: Log[plot gross output / acre]			
	<i>Maize</i>	<i>G.Nut</i>	<i>Tobacco</i>	<i>Cotton</i>
Fixed effects	Regions			
Female Plot Management	-0.111 (0.021)	-0.067 (0.021)	-0.184** (0.022)	-0.156** (0.023)
Observations	784	232	212	199
R-Squared	0.024	0.021	0.029	0.031

Note: */**/* indicate statistical significance at the 1/5/10 percent level, respectively.**

Table 3.8: Naïve regression results on gender productivity differences – District F.E

	Dependent variable: Log[plot gross output / acre]			
	<i>Maize</i>	<i>G.Nut</i>	<i>Tobacco</i>	<i>Cotton</i>
Fixed effects	Districts			
Female Plot Management	-0.113 (0.020)	-0.072 (0.021)	-0.218** (0.020)	-0.141** (0.023)
Observations	784	232	212	199
R-Squared	0.066	0.057	0.068	0.064

Note: */**/* indicate statistical significance at the 1/5/10 percent level, respectively.**

The gender gap estimate ranges recorded were: 11 to 14 percent for maize farming; 7 to 8 percent for groundnut farming; 18 to 22 percent for tobacco farming; and 14 to 18 percent for cotton farming. The gender gap estimates were statistically significant for all crops except groundnut. These results indicate a statistically and economically large difference between male and female farmers, particularly for men's crops. In what follows, we seek to understand the factors associated with these gaps.

Table 3.9: Base OLS regression results underlying mean decomposition: Pooled

Dependent variable: Log(Gross output/ac)	Maize	G/Nuts	Tobacco	Cotton
<i>Plot manager characteristics</i>				
Female δ	-0.038* (0.029)	-0.015** (0.033)	-0.058** (0.024)	-0.051* (0.032)
Age(years)	-0.001 (0.001)	-0.002 (0.003)	-0.002 (0.003)	-0.006 (0.004)
Years of schooling	0.006* (0.002)	0.007* (0.004)	0.017* (0.007)	0.013* (0.009)
Agriculture extension receipt δ	0.064 (0.027)	0.071 (0.040)	0.087** (0.033)	0.084** (0.028)
<i>Household characteristics</i>				
Household size	0.012** (0.006)	0.010* (0.008)	0.020** (0.012)	0.015* (0.014)
Child dependency ratio	-0.010 (0.015)	-0.012 (0.016)	-0.018 (0.016)	-0.014 (0.012)
<i>Plot area</i>				
Log[GPS based plot area/ac]	-0.108** (0.037)	-0.087* (0.048)	0.072** (0.041)	0.069* (0.036)
Log[GPS based plot area/ac squared]	0.033** (0.010)	0.029** (0.012)	0.035** (0.012)	0.028* (0.017)
<i>Plot input use</i>				
Incidence of fertilizer use (organic or inorganic) δ	0.067** (0.012)	0.010 (0.019)	0.070*** (0.018)	0.077** (0.023)
Log[Household male labour use (days/ac)]	0.031** (0.009)	0.024* (0.007)	0.045*** (0.011)	0.041*** (0.012)
Log[Household female labour use (days/ac)]	0.040** (0.007)	0.037** (0.006)	0.048*** (0.012)	0.044*** (0.014)
Log[Hired labour use (days/ac)]	0.071**	0.077***	0.076**	0.069**

Dependent variable: Log(Gross output/ac)	Maize	G/Nuts	Tobacco	Cotton
	(0.009)	(0.023)	(0.013)	(0.019)
<i>Agro-ecological characteristics</i>				
Sandy soil δ	0.065 (0.080)	0.057 (0.091)	0.061 (0.057)	0.067 (0.051)
Clay soil δ	0.071 (0.083)	0.064 (0.088)	0.069 (0.062)	0.061 (0.054)
Sandy and clay (the base category) δ	0.105* (0.068)	0.097* (0.073)	0.108* (0.059)	0.092* (0.060)
Tropic-warm/semiarid δ	0.112* (0.073)	0.109* (0.089)	0.109* (0.064)	0.102* (0.059)
Tropic-warm/sub-humid δ	0.097 (0.071)	0.083 (0.077)	0.072 (0.055)	0.076 (0.058)
Tropic-cool/semiarid δ	0.075 (0.077)	0.064 (0.088)	0.062 (0.051)	0.067 (0.053)
Observations	784	232	212	199
R-squared	0.412	0.449	0.448	0.439

Note: */**/* indicate statistical significance at the 1/5/10 percent level, respectively. δ denotes dummy variable.**

Table 3.10: Base OLS regression results underlying mean decomposition: Males

Dependent variable: Log(Gross output/ac)	Maize	G/Nuts	Tobacco	Cotton
<i>Plot manager characteristics</i>				
Age(years)	-0.002 (0.001)	-0.003 (0.002)	-0.003 (0.004)	-0.004 (0.003)
Years of schooling	0.004 (0.002)	0.005 (0.003)	0.014 (0.008)	0.011 (0.010)
Agriculture extension receipt δ	0.047 (0.025)	0.052 (0.029)	0.089** (0.038)	0.086** (0.031)
<i>Household characteristics</i>				
Household size	0.010* (0.008)	0.013* (0.011)	0.017** (0.014)	0.013* (0.011)
Child dependency ratio	0.030 (0.018)	0.033 (0.022)	0.038 (0.019)	0.029 (0.018)
<i>Plot area</i>				
Log[GPS based plot area/ac]	-0.107** (0.41)	-0.084* (0.53)	0.079** (0.44)	0.071* (0.40)
Log[GPS based plot area/ac squared]	0.032** (0.011)	0.026** (0.013)	0.038** (0.014)	0.033* (0.019)
<i>Plot input use</i>				
Incidence of fertilizer use (organic or inorganic) δ	0.072** (0.011)	0.016 (0.024)	0.074*** (0.021)	0.079** (0.025)
Log[Household male labour use (days/ac)]	0.072** (0.012)	0.065* (0.010)	0.077*** (0.014)	0.074*** (0.016)
Log[Household female labour use (days/ac)]	0.021* (0.009)	0.018* (0.007)	0.036** (0.013)	0.039** (0.016)
Log[Hired labour use (days/ac)]	0.073** (0.010)	0.080*** (0.027)	0.079** (0.016)	0.070** (0.021)

Dependent variable: Log(Gross output/ac)	Maize	G/Nuts	Tobacco	Cotton
<i>Agro-ecological characteristics</i>				
Sandy soil δ	0.068 (0.081)	0.055 (0.094)	0.063 (0.059)	0.069 (0.053)
Clay soil δ	0.073 (0.082)	0.067 (0.092)	0.072 (0.064)	0.063 (0.057)
Sandy and clay (the base category) δ	0.107* (0.066)	0.095* (0.076)	0.110* (0.062)	0.094* (0.063)
Tropic-warm/semiarid δ	0.115* (0.071)	0.111* (0.085)	0.112* (0.066)	0.107* (0.063)
Tropic-warm/sub-humid δ	0.092 (0.069)	0.080 (0.079)	0.068 (0.053)	0.073 (0.061)
Tropic-cool/semiarid δ	0.070 (0.079)	0.060 (0.090)	0.059 (0.053)	0.063 (0.055)
Observations	423	120	138	127
R-squared	0.419	0.457	0.452	0.449

Note: */**/* indicate statistical significance at the 1/5/10 percent level, respectively. δ denotes dummy variable.**

Table 3.11: Base OLS regression results underlying mean decomposition: Females

Dependent variable: Log(Gross output/ac)	Maize	G/Nuts	Tobacco	Cotton
<i>Plot manager characteristics</i>				
Age(years)	-0.001 (0.002)	-0.002 (0.001)	-0.002 (0.003)	-0.007 (0.005)
Years of schooling	0.011** (0.004)	0.014* (0.005)	0.021** (0.010)	0.019** (0.009)
Agriculture extension receipt δ	0.113 (0.042)	0.098 (0.037)	0.082** (0.040)	0.080** (0.037)
<i>Household characteristics</i>				
Household size	0.030** (0.009)	0.034** (0.018)	0.040** (0.023)	0.035** (0.028)
Child dependency ratio	- 0.073*** (0.026)	-0.069** (0.021)	- 0.079*** (0.022)	-0.075** (0.027)
<i>Plot area</i>				
Log[GPS based plot area/ac]	-0.110** (0.044)	-0.089* (0.046)	0.064** (0.039)	0.066* (0.042)
Log[GPS based plot area/ac squared]	0.031** (0.014)	0.027** (0.013)	0.033** (0.018)	0.030* (0.021)
<i>Plot input use</i>				
Incidence of fertilizer use (organic or inorganic) δ	0.057** (0.013)	0.011 (0.027)	0.068*** (0.019)	0.075** (0.022)
Log[Household male labour use (days/ac)]	0.009 (0.010)	0.007 (0.009)	0.015 (0.017)	0.017 (0.019)
Log[Household female labour use (days/ac)]	0.060** (0.016)	0.056** (0.019)	0.068*** (0.018)	0.070*** (0.019)
Log[Hired labour use (days/ac)]	0.080**	0.085***	0.077**	0.073**

Dependent variable: Log(Gross output/ac)	Maize	G/Nuts	Tobacco	Cotton
	(0.013)	(0.029)	(0.019)	(0.024)
<i>Agro-ecological characteristics</i>				
Sandy soil δ	0.073 (0.089)	0.059 (0.097)	0.068 (0.061)	0.071 (0.056)
Clay soil δ	0.076 (0.086)	0.072 (0.095)	0.074 (0.067)	0.064 (0.059)
Sandy and clay (the base category) δ	104* (0.067)	0.101* (0.074)	0.105* (0.066)	0.097* (0.068)
Tropic-warm/semiarid δ	0.113* (0.074)	0.109* (0.081)	0.110* (0.069)	0.109* (0.066)
Tropic-warm/sub-humid δ	0.095 (0.073)	0.086 (0.080)	0.071 (0.057)	0.077 (0.064)
Tropic-cool/semiarid δ	0.074 (0.081)	0.062 (0.087)	0.060 (0.055)	0.069 (0.058)
Observations	361	112	74	72
R-squared	0.384	0.399	0.425	0.436

Note: */**/* indicate statistical significance at the 1/5/10 percent level, respectively. δ denotes dummy variable.**

Tables 3.9, 3.10 and 3.11 provide additional estimates of the gender gap, but now conditional on additional covariates commonly found in the literature (see Kilic et al. 2015; Peterman et al. 2011). Table 3.9 presents the results from a pooled regression that includes both male- and female-managed plots. Once we control for key factors of production, the gender gap is reduced to 3.8 percent for maize farming; 1.5 percent for groundnut farming; 5.8 percent for tobacco farming; and 5.1 percent for cotton farming. The gender gaps are now statistically significant for all four crops. Unfortunately, this type of analysis does not allow us to delve deeper into the processes that underlie the movement from the relatively higher unconditional to the relatively lower conditional gender gaps for all the four crop

types. In the following sections, a decomposition approach is applied that will allow unpacking the relative contributions of different factors towards this gap.

3.5 Methodology

3.5.1 Oaxaca-Blinder mean decomposition method

The OLS regression analysis presented in section 3.4 is useful in understanding the factors that influence productivity gaps that exist between plots managed by male and those managed by female farmers for the four selected crop types. However, a limitation of this approach lies in its inability to help us understand the important aspect of relative contribution of these factors to the productivity gap. We follow the decomposition approach employed in studies by Kilic et al. (2015) and Joe-Nkamuke et al. (2019) by using the Oaxaca-Blinder method. This is helpful in highlighting the relative importance of these factors to the productivity gap. The decomposition approach requires a set of assumptions and it follows a partial equilibrium approach, in which the observable outcomes of a particular group can be employed to construct various counterfactual situations for the other group (Fortin et al. 2010; Joe-Nkamuke et al. 2019). Although decompositions are relevant for estimating the relative contribution of different factors to a difference in the outcome across the group, they are based on correlation and therefore cannot be interpreted as causal inference (Fortin et al. 2010; Joe-Nkamuke et al., 2019).

The starting point of the Oaxaca-Blinder approach is modelling the expected value of yield on gender of the plot manager presented as follows:

$$E(y_g) = \vartheta_g + E(X_g)' \varphi_g \dots\dots\dots (1)$$

Where y represents gross agricultural output per acre and subscript g represents gender of the plot manager, which can either be male (m) or female (f); X is a vector of all explanatory variables; ϑ is the intercept and φ is the vector of slope coefficients. Following

equation 1, the gender gap, G , which is the mean difference in the outcome between male and female managed plots, is expressed as:

$$G = E(y_m) - E(y_f) = \vartheta_m + E(X_m)' \varphi_m - \vartheta_f - E(X_f)' \varphi_f \dots\dots\dots (2)$$

The difference in equation 2 can be categorized in two parts by including non-discriminatory coefficients which will be used to determine the contribution of the differences in predictors (Jann, 2008; Joe-Nkamuke et al. 2019). This results in a twofold decomposition:

$$G = R + S \dots\dots\dots (3)$$

The first component of equation 3, R , is the explained or endowment effect, which is the part that accounts for differences in the endowment of explanatory variables (evaluated at the mean of the estimated coefficients for the male and female samples) (Arturo et al. 2015). It is estimated as:

$$R = \left[E(X_m)' - E(X_f)' \right] \varphi^* \dots\dots\dots (4)$$

Where φ^* is the vector of coefficients obtained from a regression of y that is based on the pooled plot sample and includes the group membership identifier (i.e. a dummy variable identifying female-managed plots). The inclusion of the group membership indicator in the pooled regression for the estimation of φ^* takes into account the possibility that the mean difference in plot-level productivity measure is explained by gender of the plot manager, avoiding a possible distortion of the decomposition results due to the residual group difference reflected in φ^* (Jann, 2008; Kilic, 2015).

The second component of equation 3, S , is the unexplained or structural effect and it reflects the differences in returns to the endowment for female and male plot managers. It is estimated as:

$$S = (\vartheta_m - \vartheta) + [E(X_m)'(\varphi_m - \varphi^*)] + (\vartheta - \vartheta_f) + [E(X_f)'(\varphi^* - \varphi_f)] \cdot \dots\dots\dots (5)$$

This equation can be further divided into two parts. One part which estimates the structural advantage (discrimination in favour) of one group:

$$S_m = (\vartheta_m - \vartheta) + [E(X_m)'(\varphi_m - \varphi^*)] \dots\dots\dots (6)$$

And another part which estimates the structural disadvantage (discrimination) against the other group:

$$S_f = (\vartheta - \vartheta_f) + [E(X_f)'(\varphi^* - \varphi_f)] \dots\dots\dots (7)$$

The aggregate contribution of endowments (equation 4) is equal to the difference between the raw productivity gap and the remaining gap once all characteristics in the decomposition are accounted for. This term can be interpreted as the change in the value of the output that would occur if female plot managers had the same values of X as male plot managers. The aggregate unexplained contribution (equation 5) is equal to the remaining gap once all characteristics in the decomposition are accounted for (Ali et al. 2016; Joe-Nkamuke et al. 2019). The sum of these terms can be interpreted as the change in the value of output from the female managed plot that would occur if men and women had the same returns to the coefficient vector X .

3.5.2 Assumptions required to identify population parameters

The decomposition is performed within a partial equilibrium framework in that the vector of coefficients (φ^*) obtained from the regression of y from the pooled plot sample are assumed fixed for the purpose of counterfactual comparisons. Additionally, the aggregate decomposition assumes overlapping support, which requires that no single value of observed or unobserved characteristics is sufficient to identify group membership. The aggregate decomposition also requires that the distribution of any omitted variables conditional on X be the same for the two groups (Ali et al. 2016).

The detailed decomposition separates the aggregate decomposition into endowment and structural components. This relies on the additional assumptions of additive linearity and zero conditional mean. The latter implies that the mean of any omitted variables conditional on X be zero. In other words, we assume that there is no unobservable heterogeneity that jointly determines the outcome and observable attributes.

3.6 Decomposition econometric results

3.6.1 Mean decomposition results

The first step in the mean decomposition is estimation of the following equation separately for the pooled, male-managed and female-managed plot samples for each of the four crop types:

$$y_g = \beta_{g0} + \sum_{k=1}^K X_{gk} \beta_{gk} + \varepsilon_g \dots\dots\dots (8)$$

Where y is the log of gross output per acre with g representing the gender of the plot manager. X is a vector of the k observable, plot level explanatory variables; β is the associated vector of intercept and slope coefficients; and ε is the error term under the assumption that $E(\varepsilon_m) = E(\varepsilon_f) = 0$. The regression results for this equation are reported in Tables 3.9, 3.10 and 3.11 for the pooled, male-managed and female-managed plot samples respectively.

The log of GPS-based plot area has a negative coefficient that is statistically significant in each of the three plot samples (i.e. pooled, male-managed and female-managed) for maize and groundnuts. This rather counterintuitive finding is consistent with recent studies that have provided support for the inverse yield hypothesis (i.e. the proposition that small plots are more productive than large plots particularly for staple crops (see Ali, et al. 2016; Kilic, 2015; and Larson et al., 2012). The pure cash crops (tobacco and cotton) have a positive coefficient that is statistically significant in each of the three plot samples.

Years of schooling has a positive coefficient and is statistically significant only within female-managed plot samples, suggesting that if female plot managers acquired similar years of schooling as male counterparts, the mean gender gap in productivity could be reduced. Agriculture extension services receipt has a positive coefficient which is only statistically significant for tobacco and cotton farming for both male and female managed plots alike, suggesting that greater priority is placed on provision of extension services to plot managers that grow cash crops.

A key variable that is positively associated with gross output per acre, irrespective of the plot sample and crop type, is the log of fertilizer use per acre. However, the return to fertilizer use (i.e. the coefficient) is higher within the male-managed plot samples in comparison to the female-managed plot samples and this difference is statistically significant for all crop types except groundnut.

The log of household adult male labour hours per acre has a sizeable and positive coefficient that is statistically significant within the male-managed plot samples for all four crop types, while the comparable estimate within the female-managed plot samples is not statistically significant across all the four crop types. In contrast, the log of household adult female labour hours per acre has a positive and statistically significant coefficient across both male and female plot samples for all crop types, with a larger magnitude and statistical significance among female-managed plots.

Although household size has a positive coefficient that is statistically significant irrespective of the plot sample, the magnitude of the coefficient within the female-managed plot samples is more than double that within the male-managed plot samples. The coefficient for child dependency ratio has a negative sign for female-managed plot samples across all crop types and the coefficient is consistently statistically significant. For each crop type, the coefficient is also more than double compared to the coefficient for male-managed plot samples. Conversely, the coefficient for child dependency ratio for male-managed plots is positive but statistically insignificant across all crop types. The gender differences in returns to household size and child dependency ratio imply that the burden of childcare is more likely to reduce female agricultural productivity.

The decomposition of the mean gender gaps for the different crops, which were estimated at 14.3% for maize; 8.3% for groundnut; 22.3% for tobacco; and 17.6% for cotton, are presented in Table 3.12. Table 3.13 presents shares of the gender differential for the aggregate decomposition components, namely the endowment effect, the male structural advantage, and female structural disadvantage. Tables 3.14, 3.15 and 3.16 present results from the detailed decomposition of the endowment effect, male structural advantage and female structural disadvantage respectively for each crop. A positive coefficient suggests that the relevant covariate contributes positively to increasing the gender gap.

Table 3.12: Decomposition of the mean gender differential

Agricultural productivity proxied by Log[Gross output/acre]				
	<i>Maize</i>	<i>G/Nuts</i>	<i>Tobacco</i>	<i>Cotton</i>
Mean male-managed plot agricultural productivity	9.849** (0.020)	6.442 (0.031)	10.894*** (0.019)	9.109** (0.022)
Mean female-managed plot agricultural productivity	9.706** (0.027)	6.359 (0.037)	10.671*** (0.026)	8.933** (0.028)
Mean gender differential in agricultural productivity	0.143** (0.025)	0.083 (0.036)	0.223*** (0.024)	0.176** (0.030)

Note: */**/* indicate statistical significance at the 1/5/10 percent level, respectively.**

Table 3.13: Aggregate decomposition of the gender differential

Agricultural productivity proxied by Log[Gross output/acre]				
<i>A. Endowment effect</i>				
	<i>Maize</i>	<i>G/Nuts</i>	<i>Tobacco</i>	<i>Cotton</i>
Total	0.102** (0.028)	0.051 (0.031)	0.179*** (0.023)	0.137** (0.029)
Share of gender differential	71%	61%	80%	78%
<i>B. Male structural advantage</i>				
	<i>Maize</i>	<i>G/Nuts</i>	<i>Tobacco</i>	<i>Cotton</i>
Total	0.000 (0.002)	0.000 (0.003)	0.000 (0.002)	0.000 (0.003)
Share of gender differential	0%	0%	0%	0%
<i>C. Female structural disadvantage</i>				
	<i>Maize</i>	<i>G/Nuts</i>	<i>Tobacco</i>	<i>Cotton</i>
Total	0.041** (0.030)	0.032 (0.032)	0.044*** (0.026)	0.039** (0.033)
Share of gender differential	29%	39%	20%	22%

Note: */**/* indicate statistical significance at the 1/5/10 percent level, respectively.**

Table 3.14: Detailed decomposition of the endowment effect

Agricultural productivity proxied by Log[Gross output/acre]				
	<i>Maize</i>	<i>G/Nuts</i>	<i>Tobacco</i>	<i>Cotton</i>
<i>Plot manager characteristics</i>				
Age(years)	0.007 (0.004)	0.004 (0.003)	0.011 (0.006)	0.009 (0.007)
Years of schooling	0.018** (0.009)	0.011* (0.008)	0.028** (0.013)	0.024* (0.016)
Agriculture extension receipt δ	0.006 (0.003)	0.003 (0.001)	0.010** (0.006)	0.008** (0.005)
<i>Household characteristics</i>				
Household size	0.013** (0.006)	0.010* (0.008)	0.018** (0.007)	0.016* (0.009)
Child dependency ratio	0.00 (0.001)	0.000 (0.002)	0.000 (0.001)	0.000 (0.002)
<i>Plot area</i>				
Log[GPS based plot area/ac]	-0.025*** (0.007)	-0.020* (0.011)	0.037*** (0.009)	0.030** (0.013)
Log[GPS based plot area/ac squared]	-0.013** (0.005)	-0.010* (0.007)	0.019*** (0.004)	0.016** (0.005)
<i>Plot input use</i>				
Incidence of fertilizer use (organic or inorganic) δ	0.011* (0.007)	0.004 (0.019)	0.015*** (0.004)	0.014** (0.006)
Log[Household male labour use (days/ac)]	0.084*** (0.019)	0.079*** (0.022)	0.097*** (0.017)	0.088*** (0.020)

Log[Household female labour use (days/ac)]	-0.013*** (0.006)	-0.010** (0.009)	-0.025*** (0.007)	-0.017* (0.013)
Log[Hired labour use (days/ac)]	0.001 (0.003)	0.004 (0.007)	0.003 (0.005)	0.002 (0.004)
<i>Agro-ecological characteristics</i>				
Household agro-ecological zone classification [aggregated]	-0.004 (0.005)	-0.003 (0.004)	-0.004 (0.003)	-0.002 (0.004)
Number of observations	784	232	212	199

Note: */**/* indicate statistical significance at the 1/5/10 percent level, respectively. δ denotes dummy variable.**

Table 3.15: Detailed decomposition of the male structural advantage

Agricultural productivity proxied by Log[Gross output/acre]				
	<i>Maize</i>	<i>G/Nuts</i>	<i>Tobacco</i>	<i>Cotton</i>
<i>Plot manager characteristics</i>				
Age(years)	-0.026 (0.021)	-0.011 (0.019)	-0.029 (0.022)	-0.031 (0.025)
Years of schooling	-0.013 (0.009)	-0.011 (0.007)	-0.017 (0.010)	-0.015 (0.011)
Agriculture extension receipt δ	-0.009 (0.004)	-0.006 (0.004)	-0.012* (0.009)	-0.010* (0.007)
<i>Household characteristics</i>				
Household size	-0.017 (0.013)	-0.013 (0.010)	-0.021 (0.015)	-0.019 (0.016)
Child dependency ratio	0.024** (0.012)	0.021* (0.014)	0.031** (0.013)	0.028* (0.016)
<i>Plot area</i>				
Log[GPS based plot area/ac]	-0.019 (0.015)	-0.015 (0.013)	0.027 (0.018)	0.021 (0.019)
Log[GPS based plot area/ac squared]	-0.002 (0.011)	-0.002 (0.014)	0.001 (0.009)	0.002 (0.010)
<i>Plot input use</i>				
Incidence of fertilizer use (organic or inorganic) δ	0.008* (0.005)	0.002 (0.009)	0.013** (0.007)	0.011** (0.008)
Log[Household male labour use (days/ac)]	0.171*** (0.059)	0.165*** (0.068)	0.193*** (0.047)	0.182*** (0.051)
Log[Household female labour use (days/ac)]	-0.060** (0.019)	-0.034* (0.023)	-0.081*** (0.017)	-0.070* (0.028)

Log[Hired labour use (days/ac)]	0.001 (0.003)	0.002 (0.004)	0.002 (0.003)	0.001 (0.003)
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Agro-ecological characteristics

Household agro-ecological zone classification [aggregated]	0.002 (0.003)	0.002 (0.004)	0.001 (0.003)	0.003 (0.004)
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Number of observations	784	232	212	199
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Note: */**/* indicate statistical significance at the 1/5/10 percent level, respectively. δ denotes dummy variable.**

Table 3.16: Detailed decomposition of the female structural disadvantage

Agricultural productivity proxied by Log[Gross output/acre]				
	<i>Maize</i>	<i>G/Nuts</i>	<i>Tobacco</i>	<i>Cotton</i>
<i>Plot manager characteristics</i>				
Age(years)	-0.046 (0.042)	-0.023 (0.028)	-0.054 (0.036)	-0.050 (0.044)
Years of schooling	-0.029* (0.016)	-0.015* (0.014)	-0.036* (0.019)	-0.031* (0.022)
Agriculture extension receipt δ	-0.014 (0.008)	-0.010 (0.009)	-0.022** (0.010)	-0.019** (0.012)
<i>Household characteristics</i>				
Household size	-0.058* (0.023)	-0.051* (0.030)	-0.077** (0.035)	-0.068* (0.039)
Child dependency ratio	0.042** (0.015)	0.039* (0.018)	0.049** (0.016)	0.045* (0.017)
<i>Plot area</i>				
Log[GPS based plot area/ac]	-0.013 (0.044)	-0.010 (0.048)	0.021 (0.052)	0.018 (0.055)
Log[GPS based plot area/ac squared]	0.004 (0.024)	0.003 (0.027)	-0.005 (0.025)	-0.004 (0.028)
<i>Plot input use</i>				
Incidence of fertilizer use (organic or inorganic) δ	0.023* (0.016)	0.011 (0.013)	0.037* (0.018)	0.032* (0.019)
Log[Household male labour use (days/ac)]	0.044*** (0.014)	0.041*** (0.017)	0.058*** (0.012)	0.055*** (0.015)

Log[Household female labour use (days/ac)]	-0.102* (0.064)	-0.055* (0.031)	-0.127* (0.071)	-0.094* (0.058)
Log[Hired labour use (days/ac)]	-0.004 (0.006)	-0.005 (0.008)	-0.007 (0.009)	-0.005 (0.007)
<i>Agro-ecological characteristics</i>				
Household agro-ecological zone classification [aggregated]	0.013 (0.017)	0.012 (0.015)	0.014 (0.018)	0.013 (0.016)
Number of observations	784	232	212	199

Note: */**/* indicate statistical significance at the 1/5/10 percent level, respectively. δ denotes dummy variable.**

3.6.2 Aggregate decomposition

The aggregate decomposition (Table 3.13) indicates that the endowment effect (10.2% for maize; 5.1% for groundnut; 17.9% for tobacco; and 13.7% for cotton), i.e. the part of the gender gap due to the differences in average characteristics, accounts for 71%, 61%, 80% and 78% of the mean gender differential in agricultural productivity for maize, groundnut, tobacco and cotton farming respectively. The female structural disadvantage is estimated at 4.1% for maize; 3.2% for groundnut; 4.4% for tobacco; and 3.9% for cotton farming, explaining the remaining 29%, 39%, 20% and 22% of the gender gap for maize, groundnut, tobacco and cotton respectively. Similar to findings by Kilic et al (2015) and Joe-Nkamuke et al. (2019), gender disparity is observed to be driven more by the endowment than the structural effect. This suggests that large and significant gender disparities in access to inputs and asset ownership are central factors behind the gender gap particularly in the case of maize, tobacco and cotton farming where statistical significance is reported for the mean gender differential in agricultural productivity. Groundnut farming reported the lowest mean gender differential in agricultural productivity and was statistically insignificant.

3.6.3 Detailed decomposition

Tables 3.14, 3.15 and 3.16 report the detailed decomposition of the endowment effect, male structural advantage and female structural disadvantage respectively, which together capture how much each factor contributes to or reduces the gender productivity disparity. A positive coefficient widens the gap while a negative coefficient reduces the gap.

The detailed decomposition of the endowment effect is presented in Table 3.14. Counterintuitively, for all four crops, female farmers have an endowment advantage arising from smaller planted area of female-managed plots in the context of strong inverse returns to area planted. This finding was corroborated by Ali et al. (2016) in Uganda for cultivation of various cash crops and by Joe-Nkamuke et al. (2019) for production of legumes in Malawi. The other major contributor to the female endowment advantage is the higher rate of household adult female labour provision in the female managed plot samples.

We observe that male-managed plots tend to be overseen by individuals that have higher years of schooling and who access agricultural extension more frequently. Male-managed plots also exhibit higher incidence of fertilizer use per acre and higher household adult male labour input per acre. In view of the positive correlation between these covariates and agricultural productivity, we find these variables to be contributing positively towards the endowment effect, thereby widening the gender gap.

The detailed decomposition of the male structural advantage and the female structural disadvantage for each crop are presented in Tables 3.15 and 3.16 respectively. The coefficients that are large and statistically significant signal differential treatments of male versus female plot managers by markets, formal institutions, and informal social institutions. Findings related to fertilizer use, plot measures of household adult male and female labour provision, household size, and child dependency ratio are noteworthy. It is not only the difference in the fertilizer endowment that contributes to the gender gap, but also relatively higher return to fertilizer among the male-managed plots in comparison to their female-managed counterparts, particularly for maize, tobacco and cotton farming. The same applies to the log of household adult male labour hours per acre for all four crops.

The fact that household adult male labour input is associated with a wider gender gap is, however, partially offset by the higher returns that household adult female labour provides on female-managed plots for all four crops. Regarding the child dependency ratio, although the contribution of this factor towards the endowment effect is zero, its contribution towards the female structural disadvantage is large and positive, driven by the sizeable and highly significant negative association between this variable and agricultural productivity solely within the female-managed plot samples for all four crops. This result highlights the differential productivity impacts of heterogeneous household roles assumed by male and female managers. Female plot managers are just as likely to be household heads or spouses and are more likely to combine farm management with household duties particularly in the Malawian rural social setting, including childcare. Consequently, their pattern of time use is directly related to their low productivity outcomes.

The structural effect measures the part of the productivity differential attributable to the differences in the returns of the covariates. A positive and significant value will imply that male managers have a structural advantage over female managers in regard to the specific covariate. Household adult female labour input is a key variable that is associated with negative and significant contributions towards both the endowment effect and the male structural advantage component. Our regression results show that the magnitude of the relationship between the variable and the endowment effect is higher for male-dominated crops (tobacco and cotton).

3.7 Conclusion

Female and male farmers face different production conditions and, as a result, do not necessarily make the same production choices, with implications for output and income. A key contribution of this study was to shed light on the understanding of the constraints on female farmers and the forces that drive the gender gap in agricultural productivity from the perspective of female and male crops. Data from the fourth Malawi Integrated Household Survey (IHS 4) was used to calculate productivity gaps and assess the contribution of various factors of production to the overall gender productivity gap, where agricultural productivity is defined as the gross output per acre of land. Considerable

gender gaps were observed across the sample of crops included in the analysis. Estimated gender gaps were 14.3%, 8.3%, 22.3%, and 17.6% at the mean for maize, groundnut, tobacco and cotton farming respectively.

Gender gaps in productivity reflect multiple sources of constraint, including women's lower access to agricultural inputs and lower returns on the inputs they use. Underlying these disadvantages are gendered norms and practices, reflecting unequal power relations and fairly rigid divisions of labour at the household level. The results indicate that unequal access to male labour is one of the most important factors across the four crop types included in the study. Typically, women have less access to male family labour in cases of divorce, separation and widowhood. For women smallholders, income constraints limit their capacity to hire male wage labour.

Significant gender differentials in the use of fertilizer were also observed. Women are especially constrained by their relative lack of access to inorganic fertilizers, which must be purchased in the marketplace. Rather, they tend to rely more on organic fertilizers, which are usually produced by livestock owned by a household. While organic fertilizers have beneficial effects for soil quality, women's over-reliance on this input reduces the productivity of their plots compared to plots of men, who are likelier to use chemical fertilizers.

Once access to agricultural inputs such as labour and fertilizer is accounted for, women can be as productive and technically efficient as men. Increasing women's access to agricultural inputs and improving the returns to those inputs is hence an important priority from a gender equality perspective. It also promises to yield broader economic and social benefits. Closing the gender gap in agricultural productivity would translate to an increase in crop production, which in turn would contribute to an increase in GDP and ultimately help in reducing poverty.

Mitigating gender biases within households around division of labour is important if women are to strengthen their income-earning capacity and improve their access to male

labour, fertilizer and other critical agricultural inputs. For instance, labour-saving technologies such as energy-efficient and environmentally friendly improved cooking stoves and rainwater harvesting have the potential to reduce women's unpaid care and domestic work burdens, save time and facilitate increased crop production, which could generate more income. Similarly, public infrastructure such as improved paths, roads and water tanks can save women time. Investments in these areas are particularly promising considering the decomposition analysis identified time and labour constraints among key bottleneck for increasing women's productivity.

A caveat of this study is that the existence, nature and form of intrahousehold and interhousehold externalities of education, which could potentially have important economic and statistical effects on productivity and efficiency, were not explored. It could be argued that community level schooling could potentially substitute for household level schooling in the sense that farmers who reside in households where members are not educated could still have relatively higher productivity and efficiency on account of living in communities where some inhabitants are educated. Data availability permitting, the degree of influence of this unexplored dimension could potentially be the focus of future research for crops which are similarly disaggregated by gender designation based on literature.

CHAPTER 4

EFFECTS OF EDUCATION ON FERTILITY AND LABOUR SUPPLY: EVIDENCE FROM MALAWI

4.1 Introduction

Malawi has recorded significant socio-economic progress over the past two decades. Real GDP per capita rose from USD 297 in 1998 to USD 391 in 2018; prevalence of stunting of children under the age of five years improved from 62% to 38% between 1998 and 2016. Infant mortality declined from 110 per 1,000 live births in 1998 to 35 per 1,000 live births in 2016, which was lower than the Sub-Saharan average of 56 and not far off from the world average of 31 (World Bank, 2017). Progress has been notable in advancing towards universal primary education enrolment with a primary net enrolment rate of 90 in 2016 and gender parity in primary education of 1.01 in 2016 (Malawi Government, 2017). Efforts in the fight against HIV and AIDS saw prevalence falling to 8.8% in 2016 from 15.2% in 1999 (World Bank, 2017).

However, challenges remain in other key socio-economic areas such as ensuring gender parity in secondary education, reducing fertility, and improving maternal health. Consequently, Malawi still experiences some of the poorest health indicators and outcomes in the world. For example, the country's maternal mortality ratio (per 100,000 live births) while improving from 859 in 2004 to 451 in 2016 was still high compared to 286 in neighboring Zambia (World Bank, 2017).

Total fertility rate (TFR) while improving from an average of 6.7 children per woman in 1992 to 4.4 in 2016 in Malawi was still almost double the world average of 2.4 (NSO, 2017; World Bank, 2017). Both women and men have consistently reported that their ideal family size is smaller than the national total fertility rate; often couples have more children than they want (NSO, 2017).

As a result of high fertility rates, Malawi registered a high population growth rate of 2.71% and high dependency ratio of 90 dependents for every 100 working-age population in 2016 (World Bank, 2017). The adverse implications of these trends are large. From both a theoretical and empirical perspective, it is notable that Malawi's high population growth is constraining its per capita income growth and service delivery prospects. In 2015, there were approximately 6.7 million child dependents in Malawi. Malawi Government and University of Malawi (2017) estimated that if the fertility rate remained constant, there would be 15.9 million child dependents by 2050. If the fertility rate declined to 2.3, this number was projected to fall to 9.6 million, which would permit greater investment in health and education per child.

Furthermore, under a reduced fertility scenario, GDP per capita was projected to be 25% higher at approximately USD 1,100 by 2050, compared to USD 880 per capita if fertility remained constant (Malawi Government & University of Malawi, 2017). Such a fertility decline would also have the potential to contribute significantly to the acceleration of reductions in poverty and inequality.

The 2015/16 Malawi Demographic and Health Survey (MDHS) prepared by the Malawi National Statistics Office elaborated on some of the factors that contribute to the high fertility rates among women in Malawi. Some of these factors include sexual characteristics of women such as the age at which a woman first enters marriage, age of first sexual relations and frequency of sexual relations. The MDHS analysis provides descriptive evidence on the underlying factors, dwelling mainly on age group and regional differences but does not provide a rigorous quantitative analysis, for example on the impact of the level of female education on fertility or the level of education on labour force participation.

There has been considerable interest in the relationship between female education and participation in the labour force, and fertility rates. This has been particularly so following the development of economic models of fertility behavior. In these models, price and income variables are postulated to affect fertility decisions. Accordingly, childbearing and early nurturing of infants, which are of biological necessity a woman's role (Ellis, 1988), are seen as activities that intensively use a woman's time. With increased education, urbanization and modernization, the opportunity cost of women staying at home and taking care of children also rises. These activities also consume a lot of the woman's time, which can otherwise be used to earn income. Therefore, a woman's expected lifetime wage rate is an important variable that may affect the number of children she gives birth to. But since a woman's expected lifetime wage rate is not a directly observable variable, her educational attainment provides an important proxy for her expected lifetime wage rate.

A number of studies, using data from both developed and developing countries, show that female education is associated with a decrease in fertility (Sackey, 2005; Lam & Duryea, 1999; Ainsworth et al., 1996; Vavrus & Larsen, 2003; Guilkey et al., 1998; Ben-Porath, 1973; Gardner, 1973). While studies from various countries show fertility declines to follow periods of active family planning programmes, Brazil provides an example of a country where, despite the limited family planning programmes and volatile economic growth, fertility has steadily declined since the 1960s, underscoring the importance of women's education in this trend, even in the absence of other factors (Lam & Duryea, 1999). In addition to the importance of women's education, higher levels of education of people in the community have a strong negative impact on fertility. Using demographic and health surveys data for 22 Sub-Saharan African countries, Kravdal (2002) finds a strong negative impact of the level of education at community level on fertility rates. These findings confirm the neoclassical theory, which suggests that as investment in human capital increases and as more women participate in the labour market, the fertility behaviour of households is bound to change in favour of fewer children. However, the quantitative impact had not been explicitly estimated for Malawi. This study aimed to test this theory using data from the 2015/16 MDHS. Given Malawi's high fertility rates, it is important to gain more understanding into the factors that affect household fertility decisions.

The study seeks to provide answers to the following questions: Does the level of education acquired by a woman affect her decision in terms of the number of children born, and if so, how many years of a woman's schooling have a significant negative impact on fertility in Malawi? What are the factors that are more likely to influence a woman's decision to participate in the labour force?

This study provides evidence on the impact of female education and labour force participation on fertility in Malawi and makes recommendations on how to achieve the optimal fertility targets. The study also adds to the stock of knowledge on female education, fertility and labour force participation.

4.2 Importance of education in fertility reduction

Empirical evidence from both developed and developing countries unambiguously reveals that female education is associated with a decrease in fertility (Sackey, 2005; Lam & Duryea, 1999; Ainsworth et al., 1996; Vavrus & Larsen, 2003; Singh, 1994; Ben-Porath, 1973; Gardner, 1973). Increased participation of women in schooling and the labour market raises the economic value of their time, which increases the opportunity cost of raising children (Guilkey et al., 1998; Singh, 1994; Ben-Porath, 1973; Gardner, 1973).

Studies on female education and fertility conclude that female education leads to a decrease in fertility; that is, with higher levels of education, the number of children born per woman reduces (Guilkey et al., 1998; Ben-Porath, 1973; Gardner, 1973). Schultz (1993) confirms that women's education is associated with smaller desired family sizes across the world. This negative relationship between women's education, fertility and desired family size is explained by several factors that have been explored by both economists and sociologists. First, with higher levels of education, a woman's expectations of future earnings are higher, increasing the opportunity cost of giving birth to, and raising children. Second, the longer a woman stays in school, the lower the chances of giving birth to many children. Related to this is the fact that with more education and exposure, women acquire more information about their bodies and are more able to process that information to their advantage (Vavrus & Larsen, 2003; Singh, 1994).

The positive impact of women's education on their autonomy leads to later marriages, increased use of contraceptives, and lower fertility as discussed by Mason (1986). More importantly, higher levels of women's education are associated with lower child mortality rates, in the order of 5-10% for each additional year of the mother's schooling (Schultz, 1993; Mensch et al., 1985; Cochrane et al., 1980). This is because higher levels of women's education lead to improved childcare, nutrition, and basic health and better child outcomes – health and school attainment (Strauss & Thomas, 1995).

In general, there are two major determinants of fertility in Malawi. First, are the underlying or indirect factors known as socio-cultural and economic (intermediate) determinants, including education, the desire for large families, extended family influence, economic value of children, occupation, property ownership, and residence. Second, is the immediate or direct (proximate) determinants, including marriage patterns, sexual customs, and frequency of sexual activity, access to and use of contraceptives, length of post-partum amenorrhea, sterility, and abortion. In this study, we focus on education, a factor that policy makers can influence. It is also a factor that has other important implications, including participation in labour force, poverty reduction and improved standards of living.

Table 4.1: Trends in total fertility rates in Malawi between 2010 and 2016

Background characteristics	Total fertility rate (TFR)	
	2010	2016
Education		
No education	6.9	5.5
Primary	5.9	4.8
Secondary	3.8	3.3
More than secondary	2.1	2.3
Residence		
Urban	4	3
Rural	6.1	4.7
Wealth quintile		
Lowest	6.8	5.7
Second	6.8	5.2
Middle	6.3	4.6
Fourth	5.3	4.1
Highest	3.7	2.9
Total	5.7	4.4

Source: Malawi DHS 2010 and 2015/16

In Malawi, women start giving birth at an average age of about 15 years and in some cases, girls have given birth at ages as low as 12 years (NSO, 2017). The peak age group for childbearing is 20-29 years (NSO, 2017), such that if between these ages the women are still at school it would tremendously reduce their chances of having many children. Table 4.1 illustrates how the TFR in Malawi has improved over time and that the level of education has been found to significantly reduce the ideal number of children both women and men would choose to have.

The Malawi DHS 2010 and 2016 show that women with more than secondary education have fewer children (approximately 2) compared to those with no education at all (an

average of 6). It is also noteworthy that TFR is significantly lower in urban areas (between 3 and 4) than in rural areas (between 5 and 6). One reason for the urban-rural differential is the concentration of women with secondary and higher levels of schooling in urban areas, and also the greater access to contraceptives and other medical facilities in urban areas. Women who have completed primary schooling or those with some secondary schooling have a lower TFR than women without schooling. Overall, Table 4.1 shows that there is a strong negative relationship between female education and fertility. The intention of this study is to explicitly estimate the quantitative impact for Malawi and provide empirical evidence on this assertion, and thereafter draw policy recommendations.

4.3 Female employment and fertility

The participation of women in the economic market is presumed to compete with their family obligations, since mothers are usually primarily responsible for household duties in many cultures. Accordingly, a negative relationship is generally expected between female labour force participation and fertility at the micro level, although there is controversy about the casual direction of the relationship between the two phenomena (Felmlee, 1993; Cramer, 1980; Stolzenberg & Waite, 1977). Beguy (2009) observes that while a consistent negative relationship between women's paid work and fertility has been found at the micro level in developed countries, no clear pattern has emerged in developing countries. In particular, in Sub-Saharan Africa it has been suggested that no relationship should exist between labour force status and fertility because of limited wage employment, extended family networking, and cheap domestic labour, as well as traditional social norms regarding gender roles and the division of household duties between men and women. However, it is likely that these mediating factors vary across different settings in sub-Saharan Africa, thereby resulting in the discrepancy in the female employment-fertility relationship in this region (Beguy, 2009).

The maternal role incompatibility hypothesis in socio-demographic literature attempts to explain the work-fertility relationship. Unlike the economic approach, the socio-demographic approach does not focus on female wages, which represent the opportunity

cost of childbearing, as a determinant of fertility (Beguy, 2009). Rather, this approach argues that an inverse relationship exists between female employment and fertility owing to the assumed conflict between women's work and their reproductive roles (Standing, 1983). Conflict between the roles of mother and worker is understood to originate from concurrent demands of the home and workplace, the nature of employment and social norms regarding the roles of men and women (Beguy, 2009; Mason & Palan, 1981). There are certain circumstances under which this conflict can be attenuated. For instance, some jobs have characteristics that allow for simultaneous fulfilment of worker and mother roles, hence reducing incompatibility between the two. For example, women occupied in agriculture and working at home are largely able to combine their working and mothering roles. These women are more likely to have higher fertility. For women working predominantly outside the home, particularly in the modern sector, it is more difficult to combine parenting and worker roles (Beguy, 2009). These types of jobs are therefore conducive to small family size.

The availability and low cost of domestic help or parental surrogates (grandparents, cousins, older children) is another factor that could attenuate the conflict between work and childbearing, allowing women to fulfill both roles and thereby resulting in higher fertility (Blau & Robins, 1989; Rindfuss & Brewster, 1996). The traditional social norms regarding gender roles and the division of household duties between men and women could also affect the relationship between female employment and fertility (Beguy, 2009). In many societies, such norms assign to women the role of rearing children, while men have the responsibility to take care of the household by working and providing revenue. When prevailing, these social norms can alter women's aspirations and attitudes towards work outside the home. Negative attitudes towards work outside the home could reduce a woman's employment chances or predispose her towards a job that is more compatible with her maternal responsibilities. Traditional women favour the mother-and-wife role, resulting in large family sizes, while modern women favour professional life and are therefore more likely to have lower fertility levels. These conditions, which prevail generally in developing countries have led to the assumption that no or weak relationship should exist between labour force status and fertility. This could be true in rural settings in

developing countries only, where such conditions are more likely to prevail. By contrast, urban areas offer opportunities to women to be involved in paid, non-agricultural work outside the home and to have aspirations more favourable to paid work.

4.4 Data

This analysis used data from the Malawi Demographic and Health Survey (MDHS) conducted from October 2015 to February 2016 by the Malawi National Statistics Office (NSO). At the time of conducting this study, the 2015/16 MDHS was the most recent nationally representative household survey covering a sample of 26,361 households; 24,562 female and 7,478 male respondents. The survey collected detailed information on topics including demographic characteristics of the population, education, health, occupation of household members, household income and marital status among others. Similar to Bbaale (2014), a wealth index was constructed by combining information on household assets, such as ownership of consumer items, type of dwelling, source of water, and availability of electricity into a single asset index. The sample is divided into five equal quintiles from 1 representing the lowest or poorest segment to 5 representing the highest or richest segment. The poorest quintile is used as the base category in the estimations where the wealth index is used.

4.5 Trends in Malawi's fertility rates

In the 36-year period between 1980 and 2016, Malawi's TFR declined from 7.6 children per woman to 4.4 and was marginally below the Sub-Saharan Africa average of 4.8 children per woman but still significantly higher than the world average of 2.4 (World Bank, 2017). In the period between 2006 and 2016, Malawi's population grew rapidly at an average of 2.8% per annum reaching 17.2 million people in 2016 (World Bank, 2017). The country's population is youthful and predominantly rural based; 45% of the population is below the age of 15 and 81% of the population lives in rural areas (NSO 2017). The youthfulness of Malawi's population carries a demographic momentum toward further

population growth. Teenage childbearing generally declined between 1992 (35%) and 2010 (26%) before increasing slightly in 2016 (29%). In rural areas, 31% of women age 15-19 have begun childbearing, compared with 21% in urban areas (NSO, 2017). This descriptive evidence that Malawian women start giving birth at early ages is important for policy and actions to reduce fertility. It implies that female education and campaigns that are intended to keep girls in school could play an important role in reducing fertility. Malawi instituted a Universal (Free) Primary Education (UPE) programme, which aimed to provide an avenue to keep girls in school.

Until the 1980s, family planning in Malawi was banned under the one-party system regime. The idea of limiting births was slow to catch on, in a traditionally conservative society that saw promotion of family planning as foreign influence and opted to defend cultural values of large families (Chimbwete et al. 2005; Solo et al., 2005). Family planning was forbidden and “child-spacing” was preferred as an integral part of the maternal and child health program in the 1980s, which acknowledged the health problems a woman faced when pregnancies were too early, too many, too late, and too frequent (Solo et al., 2005; Chintsanya, 2013).

The advent of a multiparty system in Malawi in 1994 ushered in a new environment in which family planning programs could be implemented. While levels of use of modern contraceptive methods (oral pills, condoms, intrauterine devices, sterilization, implants, and injectables) have traditionally been low in sub-Saharan Africa, modern contraceptive use increased dramatically in Malawi in the 24 year period between 1992 and 2016 rising from 7% to 58%. (NSO, 2017).

While access to family planning is critical for keeping population growth at sustainable levels and also important to the reduction of poverty, several barriers hinder contraceptive access in Malawi. Most people live in rural areas, and these are the least served by health centres. Gender inequity remains pervasive, especially in the rural areas, where traditional values are strong and gender inequality practices such as support for early marriage of girls, polygamy, and widow inheritance make women less autonomous (Matinga and

McConville 2002; Chintsanya, 2013). Such an environment impedes women's greater say in decision-making in general, and particularly concerning their own reproductive health.

4.6 Theoretical framework

This study adopts the one-period static life cycle model previously applied by McCabe and Rozenzweig (1976), Ben-Porath (1973), Willis (1973) and Sackey (2005) when examining the various dimensions of fertility and labour force participation. The model defines a woman's utility as a function of the number of children (c), which has been adjusted for quality, consumption of market goods (x), leisure (v) and taste (t) (i.e. $U = U[c, x, v, t]$). The woman is assumed to maximize a well-behaved twice-differentiable utility function subject to a time allocation constraint and an income budget constraint.

Theory indicates that lifetime demand for births is predicated on various socioeconomic factors. Notable among the factors affecting fertility are the woman's productive opportunities (which could be perceived as being primarily determined by her educational attainment), her household's non-human capital assets, the survival rate of her children and her social environment (i.e. locality, and religion) (Sackey, 2005). Increases in the schooling of women enhances their probability of participating in the labour market only if the schooling causes a larger increase in their market wage than in their reservation wage (Lam & Duryea, 1999). The decision to participate reflects a comparison between gains from the market earnings and the opportunity costs in terms of forgone household production in childcare and in other activities for a given level of household income from all other sources.

4.7 Methodology and models for estimation

The analysis and models used in this study are based on the neoclassical labour supply model of labour-leisure choice (Abbott & Ashenfelter, 1976) and household production theory (Becker, 1965). The neoclassical model, which is an extension of the fertility maximization problem of consumer theory, analyses how individuals make choices in

deciding how they will spend a fixed amount of time. In the model, an individual has two uses of their time; either working in the labour market at a real wage rate of W per hour or enjoying leisure (Baah-Boateng et al., 2013). According to this model, individuals wish to maximize their utility by purchasing consumption goods in the marketplace and by consuming time in leisure activities, conditional on individual's market wage, personal preferences and non-labour income. This study uses this model to explain family-size decisions. Households could be perceived to maximize their welfare by making choices between having children and other consumption goods. In this case, children are treated as a special type of good from which utility is derived and the cost of which is the time required to raise them.

To achieve the objectives of this study, we follow approaches by Sackey (2005) and Bbaale (2009) and estimate the reduced form specifications for female labour force participation and fertility. We assume that the covariates are exogenous and also that the error term, which captures all unobserved variables, is uncorrelated with any of the right-hand-side variables. Since the reduced form equations have no inherent simultaneity, they do not violate the classical assumption of non-correlation between explanatory variables and the stochastic term.

We first estimate a model of labour force participation using a probit model with the aim to establish what factors explain women's decisions to participate in the labour market. Of particular interest is the role played by educational attainment. The coefficients obtained in our probit estimation would only serve to provide a sense of the direction of the effects of the covariates on participation in the labour market and cannot be used for magnitude of impact analysis. To examine the magnitude of impact, we calculate the marginal impact of these right-hand-side variables on the probability of participation.

The model we estimate has the following form:

$$Y_i^* = X_i\beta + \mu_i, \quad \forall i = 1, \dots, n \quad \dots\dots\dots (1)$$

$$Y_i = \begin{cases} 1: \text{if } Y_i^* \\ 0: \text{otherwise} \end{cases} \quad \dots\dots\dots (2)$$

Where Y_i is a binary response variable of the i^{th} woman determined by the underlying latent variable Y_i^* . This takes on a value of 1 if the i^{th} woman participated in the labour force in the year of the survey and is equal to zero otherwise. X_i is a row vector of explanatory variables, while β is a vector of unknown parameters to be estimated and μ_i is the error term. In estimating the empirical probit model, labour force participation (*LFP*) will take the form:

$$LFP = f(MED, BIR, WEA, LOC, REL, FED) \quad \dots\dots\dots (3)$$

Where *LFP*, *MED*, *BIR*, *WEA*, *LOC*, *REL*, *FED* are the probability of female labour force participation, mothers level of schooling completed, birth cohort dummies, wealth status (measured by wealth quintiles), locality, religion and fathers education level respectively.

Following Bbaale (2009), Duryea and Lam (1999) and Ainsworth (1996) we then define fertility as a cumulative outcome and estimate a fertility choice model. We create variables for number of children born by age 20, 25 and 30 respectively using birth histories of live births before the woman reached 20, 25 and 30 from the DHS. Regressors in this model include mother's education, father's education and education dummies for the birth year cohort. Ordinary Least Squares is used to estimate the reduced form equation with the fertility model specification taking the form:

$$CMF = f(MED, BIR, LOC, REL, FED) \quad \dots\dots\dots (4)$$

where *CMF*, *MED*, *BIR*, *REG*, *REL*, *FED* are cumulative fertility, woman's level of schooling completed, birth cohort dummies, locality, religion and father's education level, respectively.

4.8 Results and interpretation

This section presents results of estimations of a probit model where we obtain output related to the marginal impact of a woman's education level, marital status, age, residence, wealth status, religion and husband's education on her participation in the labour force. The section also presents OLS estimation results for total and cumulative fertility regression models. These are detailed in the sections below.

4.8.1 Results from probit model on female labour force participation

The marginal impact of respective right-hand-side variables on the probability of participation by women is shown in Table 4.2. The results confirm that women's education plays an important role in their labour force participation, which from the literature has important implications for fertility. Women with a primary school level of education and those with a secondary level are about 5% and 7%, respectively, more likely to be working (significant at 5% level) compared to those with no education at all (Table 4.2). Among the married, women with a post-secondary school education are about 10% more likely to be working compared to the uneducated. This is in line with our theoretical expectations and attests to the fact that schooling in general and higher levels in particular increase the opportunity cost of women's time in household production. Through education, human capital of women becomes enhanced, thus increasing their employability.

Table 4.2: Female labour force participation

Variable	All women	Married women
<i>Dependent variable is currently working women</i>		
Woman's education		
Primary	0.053** [2.51]	0.036* [1.80]
Secondary	0.068** [2.63]	0.008 [0.42]
Post-secondary	0.029 [1.41]	0.098*** [3.01]
Partner's education		
Primary		0.077** [2.90]
Secondary		0.081*** [2.98]
Post-secondary		0.075* [1.94]
Age cohort		
20-24 years	0.104*** [10.81]	0.058** [2.42]
25-29 years	0.149*** [15.74]	0.105*** [4.31]
30-34 years	0.154*** [13.29]	0.109*** [4.55]
35-39 years	0.152*** [13.83]	0.121*** [5.27]
40-44 years	0.148*** [13.04]	0.113*** [4.72]

Variable	All women	Married women
45-49 years	0.144*** [11.22]	0.122*** [5.27]
Locality		
Rural resident	0.059*** [4.82]	0.129*** [5.44]
Religious affiliation		
Protestant	-0.009 [1.17]	0.004 [0.15]
Muslim	-0.011 [1.23]	-0.015 [0.27]
Other faith	0.012 [1.08]	-0.009 [0.22]
Wealth quintile		
Poorer	-0.054*** [3.62]	-0.041 [1.20]
Middle	-0.109*** [5.54]	-0.083** [2.33]
Rich	-0.137*** [7.41]	-0.117*** [3.41]
Richest	-0.172*** [8.44]	-0.155*** [4.36]
Observations	3,760	1,219
Pseudo R-squared	0.19	0.18

Absolute value of z statistics in parentheses: * Significant at 10%; ** Significant at 5%; * Significant at 1%.**

The results show the partner's education (at all levels) tends to have a significant positive effect on the probability of female labour force participation. Women whose partners have primary, secondary and post-secondary school education are about 8% more likely to be

working compared to those whose partners have no education. The impact of age cohort on women's participation in the labour force is generally the same, ranging between 14-15% (except for the age cohort 20-24 years, which is 10% - some of whom are expected to still be in school) compared to the age cohort 15-19 years.

Women residing in rural areas are 6% more likely to be currently working compared to those in urban areas. For married women, the probability is even higher (13%) than that of unmarried women.

Women in poor households are more likely to be working compared to those in relatively richer households. Women in the second to the fifth wealth quintiles are 5-17% less likely to be working compared to those in the poorest quintile. Apart from those in the poorer quintile, the scenario is almost the same when we compare the married with the unmarried women.

4.8.2 Determinants of total and cumulative fertility

To understand the fertility behaviour of younger (married and unmarried) women in Malawi, Table 4.3 present the OLS regression results from the reduced form fertility model for determinants of fertility using the number of children ever born as the dependent variable. Table 4.4 presents evidence on the determinants of cumulative fertility by age 20, 25 and 30. We see from table 4.3 that an inverse relationship is implied between education and fertility from the negative and significant coefficients on women's schooling levels. In particular, women's post-primary education reduces fertility in a significant manner. This suggests that efforts to improve access to education beyond the primary school level needs to be strengthened. Our model suggests that relative to no schooling, completion of post-primary level leads every 10 women to have on average between 4 to 11 fewer children (Table 4.3). For all women, by age 20, 25 and 30 (cumulative fertility), every 10 women with at least secondary education will, on average, have 2 to 13 fewer children than those with no education at all (Table 4.4).

For married women, the husband's post-primary schooling reinforces the tendency towards reduced fertility. Yet, partners' secondary and post-secondary school education has limited

impact on fertility given the statistical insignificance of the coefficients. The results indicate the male partners' primary education raises fertility compared to those without any education. This may be explained by those with at least primary education being able to earn higher incomes compared to those with no education and this may influence higher fertility.

Table 4.3: Determinants of fertility

Variable	All women	Married women	Married by age 20	Married by age 25
<i>Dependent variable is currently working women</i>				
Woman's education				
Primary	-0.136*** [2.64]	0.006 [0.007]	-0.341*** [5.03]	-0.470*** [5.59]
Secondary	-0.779*** [10.41]	-0.637*** [5.81]	-0.436*** [5.17]	-0.522*** [5.63]
Post-secondary	-1.044*** [16.54]	-1.030*** [10.43]	-1.127*** [8.98]	-0.775*** [6.92]
Partner's education				
Primary		0.286*** [4.03]		
Secondary		-0.041 [0.36]		
Post-secondary		-0.044 [0.38]		
Age cohort				
20-24 years	1.340*** [21.09]	1.205*** [9.90]		
25-29 years	2.815*** [46.18]	2.054*** [19.59]	1.749*** [22.77]	

Variable	All women	Married women	Married by age 20	Married by age 25
30-34 years	3.679*** [61.04]	3.381*** [29.78]	2.460*** [29.51]	2.181*** [19.67]
35-39 years	4.228*** [65.19]	4.316*** [37.11]	3.482*** [37.85]	3.263*** [25.49]
40-44 years	4.860*** [70.01]	4.418*** [38.14]	4.036*** [47.92]	3.669*** [28.75]
45-49 years	5.402*** [73.68]	5.313*** [44.87]	4.114*** [40.70]	3.803*** [26.34]
Locality				
Rural resident	0.547*** [8.33]	0.404*** [5.30]	0.245*** [4.33]	0.120** [2.18]
Religious affiliation				
Protestant	0.040 [1.19]	0.034 [0.84]	0.019 [0.37]	0.038 [0.92]
Muslim	0.061 [1.32]	0.063 [1.28]	0.049 [0.50]	0.004 [0.03]
Other faith	0.027 [0.31]	0.002 [0.02]	0.019 [0.024]	0.046 [0.78]
Observations	3,760	2,358	1,512	1,015
Pseudo R-squared	0.65	0.57	0.70	0.63

Absolute value of t statistics in parentheses: * Significant at 10%; ** Significant at 5%; * Significant at 1%.**

Table 4.4: Determinants of cumulative fertility by ages 20, 25 and 30.

	All women			Married women		
	By age 20	By age 25	By age 30	By age 20	By age 25	By age 30
<i>Dependent variable is currently working women</i>						
Woman's education						
Primary	0.058** [2.30]	0.180*** [5.03]	0.219*** [3.73]	0.054 [1.32]	0.192** [2.67]	0.218** [2.31]
Secondary	-0.383*** [8.81]	-0.317** [2.92]	-0.205* [1.90]	-0.266** [2.87]	-0.317** [2.72]	-0.195 [1.09]
Post-secondary	-0.785*** [12.17]	-1.303*** [10.34]	-1.299*** [6.83]	-0.884*** [7.80]	-1.309** [6.75]	-1.255** [3.09]
Partner's education						
Primary				0.133*** [2.90]	0.199 [2.23]**	0.202* [1.90]
Secondary				0.124** [2.13]	0.289** [2.06]	0.235 [1.49]
Post-secondary				0.136 [1.42]	0.196 [1.38]	0.271 [1.55]

	All women			Married women		
	By age 20	By age 25	By age 30	By age 20	By age 25	By age 30
Age cohort						
25-29 years	0.028 [0.97]			-0.127** [3.14]		
30-34 years	0.071** [1.97]	0.008 [0.19]		-0.067 [1.02]	0.004 [0.07]	
35-39 years	-0.055 [1.48]	-1.529*** [3.72]	-0.187*** [2.70]	-0.206*** [3.66]	-0.157** [2.11]	-0.209* [1.89]
40-44 years	-0.149*** [4.01]	-0.364*** [5.99]	-0.377*** [4.11]	-0.309*** [5.02]	-0.425*** [4.60]	-0.399*** [3.40]
45-49 years	-0.133*** [3.05]	-0.401*** [6.08]	-0.492*** [5.12]	-0.345*** [5.22]	-0.471*** [4.79]	-0.555*** [4.88]
Locality						
Rural resident	0.086*** [2.89]	0.235*** [3.93]	0.362*** [3.99]	0.131*** [3.00]	0.244*** [2.72]	0.388*** [3.07]
Religious affiliation						
Protestant	0.030 [1.11]	0.056 [0.80]	0.077 [0.96]	0.068 [0.84]	0.085 [1.29]	0.089 [1.35]

	All women			Married women		
	By age 20	By age 25	By age 30	By age 20	By age 25	By age 30
Muslim	0.112 [1.22]	0.104 [1.01]	0.109 [1.13]	0.117 [1.25]	0.133 [1.27]	0.128 [1.16]
Other faith	-0.003 [0.12]	0.007 [0.11]	0.010 [0.12]	0.034 [0.70]	0.94 [1.02]	0.108 [1.00]
Constant	1.121*** [23.02]	2.503*** [31.24]	4.110*** [30.19]	1.076*** [13.44]	2.191*** [16.62]	4.002*** [16.71]
Observations	2,901	2,170	1,548	1,154	916	650
Pseudo R-squared	0.11	0.13	0.10	0.12	0.16	0.12

Absolute value of t statistics in parentheses: * Significant at 10%; ** Significant at 5%; * Significant at 1%.**

As expected, the average number of children ever born, is positively related to age, so that as one moves from younger age cohorts to older ones, the number of children born increases accordingly. We note that fertility among all women in the age cohort 20-24 years is, on average, about 1.3 children higher than those in the age cohort 15-19 years, while fertility in the age cohort 45-49 is approximately 5 children higher compared to the base age cohort category. We notice that the same trend is portrayed for married women (Table 4.3).

The estimation results show that on average, women living in rural areas are likelier to have more children than those in urban areas. Other factors held constant, every 10 women, married and unmarried, residing in rural areas has on average 5 children more than women residing in urban areas. Regarding cumulative fertility by age 20, 25 and 30, every 10 women, married and unmarried, on average has 1, 2 and 4 children respectively more than those in urban areas. This finding is similar to that of married women (Table 4.4). In rural areas there seems to be relatively less conflict between women's role as a caregiver and that of labour market participant because some forms of rural work allow supervision of children. For example, it is not uncommon to find rural women taking their children to the farm (Sackey, 2005).

4.9 Conclusion

Women play a crucial role in the development of the Malawian economy. Their ability to blend household demands with labour market activities has been a remarkable phenomenon, one that has attracted the attention of an emerging literature on gender dynamics. This paper, in an attempt to add to this growing literature, sought to model female labour force participation and fertility in Malawi with a focus on the role of education using demographically enriched household survey data from the 2015/16 MDHS.

We reconfirm that female education attainments matter. Based on the probit model on female labour force participation, our study shows that education of women exerts a

positive impact on their participation in the labour market. The opposite obtains in the fertility models, where education results in a reduction in the number of children ever born to a woman. These results have important policy implications. It can be argued that providing women with education would be a useful investment and a good mechanism for the realization of their empowerment. With enhancement in their human capital, they will be better equipped to participate in a more productive way in the labour market. The implication of this is that as more females get educated and acquire more skills, they will increase their employability in the formal labour market, with favourable impacts on their perceptions of ideal family size and fertility preference. It is important, however, to ensure that the educational gains are sustained.

The findings from this study also have important implications for improving the quality of life of Malawian women and their children through a number of policy actions. Policies to reduce fertility can play both direct and indirect roles in enhancing maternal and child mortality reductions. When women give birth to fewer children, it reduces their exposure to the risks of childbirth, particularly in rural areas where health and maternal care services are poor or non-existent. Having fewer children also implies that family income is shared among a few heads. With fewer children born, parents are likelier to provide adequate care, thus ensuring better chances of child survival and greater attention to early childhood development requirements.

The findings of the study suggest that efforts to reduce fertility need to target measures that aim to educate women beyond primary school level. A well-planned and adequately resourced Government programme to extend free education to the secondary school level could therefore potentially be an important measure that may help to reduce fertility. To succeed, this would need to be embraced by all stakeholders and actively campaigned to encourage girls to remain in school beyond the primary school level. Measures should be strengthened to remove or at least to minimize factors that influence high dropout rates among girls in school. This could include improving the quality of schools and teaching and ensuring that all schools have separate sanitary facilities for girls and boys.

CHAPTER 5

CONCLUSION

Recognizing the important role that human capital plays in economic growth and poverty reduction, the dissertation has explored three interrelated topics. These concerned external financing to education, gender productivity differences in farming and how education influences women's labour force participation and fertility. Specifically, we looked at how economic growth is impacted by disaggregated education sector foreign aid in recipient countries which were treated heterogeneously with respect to income levels and political regimes. Mindful of the important role that women can play in generating economic growth through farming, we investigated factors that contribute to gender productivity differences. Women's empowerment is recognized as an important consideration for poverty reduction and economic growth and so the relationships between education, women's labour force participation and fertility were also examined. The dissertation has made contributions on these interwoven issues.

Key messages from the dissertation include the finding that primary education aid has positive and significant effects on growth in low-income African countries. With regards to policy, the results suggest that increasing aid in primary education will benefit low-income African countries in two important ways: promote economic growth and also help with the attainment of universal primary education. Furthermore, policymakers need to address the factors that prevent aid in post-primary education from contributing significantly to growth in low-income African countries. This includes making available complementary inputs that will enhance the productivity of the populations that have a higher education and enacting policies to reduce unemployment among secondary school graduates.

The dissertation also sheds light on the fact that addressing constraints to women's empowerment especially in agricultural productivity and reproductive health is fundamental to inclusive and sustainable economic growth, poverty reduction, food security and achievement of gender equality. Attainment of significant human capital development facilitated by empowerment of women requires changes within individuals (capability, knowledge and self-esteem); in communities and institutions (including norms and behaviour); in markets and value chains; and in the wider political and legal environment. Ultimately, no single intervention can address all these aspects and be effective for all women. The challenge, therefore, is to identify key entry points where a range of 'enablers' or 'building blocks' could have a pivotal, positive effect. In this regard, greater attention should be directed towards improving education quantity, quality and access especially at the primary level where returns were shown to be greatest in low-income African countries such as Malawi as well as secondary level, which helps improve prospects for labour force participation.

The findings from this research place emphasis on the importance of eliminating gender-specific barriers to education. Investment in education can have important spill-over effects in breaking intergenerational poverty cycles as women are empowered to become more productive in agriculture to close gender productivity gaps particularly in cash crop production. Expanding education, particularly for women, to enable progression to secondary education and beyond increases the likelihood of engaging in the labour force. This also implies that education has the potential to contribute to higher incomes. This has important implications for female farmers as this would place them in a stronger position to purchase critical agricultural inputs such as male labour and fertilizer, which were observed to be among the factors widening the gender productivity gap in Malawi. Thus, education is important for human capital development and female empowerment, leading to reduction in poverty levels and contributing to economic growth.

The research showed that empowered women who are educated and engaged in the labour market will have less time for many children as the opportunity cost of staying at home and taking care of children becomes very high. In this regard, extending free education

beyond primary school level to include secondary education could be an important measure that could help further reduce the fertility rate in Malawi. However, in order to be effective in achieving its goals, the introduction of a free secondary education reform would need to be preceded by considerable planning and investments in infrastructure, teachers and teaching and learning materials. This would prevent the resultant explosion in student enrolment in secondary schools following introduction of the reform from straining the entire system and lowering the quality of education.

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APPENDICES

Appendix A

The EAid-investment model used in the first step to tackle the EAid/investment double counting in the EAid-growth model (Chapter 2):

$$Inv_{it} = \delta_0 + \delta_1 Inv_{i,t-1} + \delta_2 Inf_{it} + \delta_3 Fre_{it} + \delta_4 lnCre_{it} + \delta_5 Aid_{it} + \varepsilon_{it}$$

Table A1: Pooled OLS investment regression

Dependent variable: INV			
Variable	Coefficient	t-Statistic	P-value
<i>Inv</i> (−1)	0.748	3.79	0.001***
<i>Inf</i>	-0.058	-2.53	0.062*
<i>Fre</i>	-0.611	-2.14	0.088*
<i>Cre</i>	0.0246	0.046	0.657
<i>Aid</i>	0.358	1.997	0.044**
<i>Constant</i>	-3.017	1.029	0.516
Observations	416		
R-squared	0.77		
F-Stat	24.31		
Prob. (F-stat)	0.00		

* denotes significance at 10%; ** significance at 5%; *** significance at 1%.

where Inv_{it} denotes investment as a percentage of GDP. $Inv_{i,t-1}$ denotes one period lagged investment to account for dependence of current investment levels on physical capital. Inf_{it} denotes the inflation rate. Fre_{it} denotes the Freedom House Index, which takes values between 1 and 7, where higher values indicate less freedom and accounts for the political environment. $lnCre_{it}$ denotes the logarithm of credit to the private sector as a percentage of total domestic credit to account for the widely acknowledged view that finance is the key to private sector investment. Aid_{it} denotes foreign education aid.

Table A1 displays the pooled OLS regression output for the investment regression for the 32 African countries included in this study for the 13-year period from 2005 to 2017. There

is evidence of a significant positive effect of education aid on investment. This suggests that aid significantly influences investment and therefore it is necessary to consider the double counting problem in the vector k of equation 2 and avoid biased results.

Appendix B

Effect of aid in education on GDP per capita growth Systems GMM estimations (Chapter 2)

Table B1: Pooled sample

Variable	Regression No.1 [Aggregate]	Regression No.2 [Primary]	Regression No.3 [Secondary]	Regression No.4 [Higher]
Education aid variables				
Aggregate aid	0.141 [0.133]			
Primary		0.109 [0.137]		
Secondary aid			-0.088 [0.225]	
Higher aid				0.151 [0.285]
Control variables				
Log (Initial GDP per capita)	0.085 [0.682]	0.079 [0.736]	-0.092 [0.621]	0.089 [0.749]
Investment (% of GDP)	0.114** [0.013]	0.140** [0.022]	0.131* [0.076]	0.154** [0.036]
Government consumption (% of GDP)	-0.121* [0.081]	-0.113** [0.003]	-0.102* [0.093]	-0.142** [0.044]
Log (1+ Inflation rate)	-1.380*** [0.000]	-1.243*** [0.000]	-1.319*** [0.000]	-1.277*** [0.000]
Trade (% of GDP)	-0.017 [0.101]	-0.018 [0.119]	-0.013 [0.117]	-0.0010 [0.108]
Constant	4.205** [0.019]	3.789** [0.013]	2.033 [0.196]	4.490 [0.774]
Number of observations	384	384	384	384
Number of countries	32	32	32	32
Number of lags of variables used as instruments.	2	2	2	2
Number of instruments	26	26	26	26
Hansen test of joint validity of	0.427	0.291	0.305	0.247

instruments ⁴ (P-value)				
Arellano-Bond test for autocorrelation ⁵ (P-value)	0.353	0.261	0.304	0.292

P values are in parentheses. * Significant at 10%; ** Significant at 5%; * Significant at 1%.**

Table B2: Low-income democracies

Variable	Regression No.1 [Aggregate]	Regression No.2 [Primary]	Regression No.3 [Secondary]	Regression No.4 [Higher]
Education aid variables				
Aggregate aid	0.413** [0.014]			
Primary		1.367** [0.004]		
Secondary aid			-1.055 [0.248]	
Higher aid				0.569 [0.291]
Control variables				
Log (Initial GDP per capita)	-0.703 [0.442]	-1.221 [0.503]	-1.375 [0.549]	-1.324 [0.378]
Investment (% of GDP)	0.158*** [0.000]	0.183*** [0.000]	0.161*** [0.000]	0.190*** [0.000]
Government consumption (% of GDP)	-0.134** [0.008]	-0.142** [0.004]	-0.149** [0.009]	-0.151** [0.006]
Log (1+ Inflation rate)	-1.233*** [0.000]	-1.301*** [0.000]	-1.287** [0.003]	-1.326*** [0.000]

⁴ The null hypothesis is that the instrumental variables are uncorrelated with the residuals (i.e. the instruments as a group are exogenous).

⁵ The null hypothesis is that the error terms in the first difference regression exhibit no second order serial correlation.

Trade (% of GDP)	-0.021 [0.122]	-0.032 [0.131]	-0.039 [0.125]	-0.028 [0.136]
Constant	5.221** [0.009]	4.008** [0.010]	5.322* [0.087]	3.710* [0.064]
Number of observations	96	96	96	96
Number of countries	8	8	8	8
Number of lags of variables used as instruments.	2	2	2	2
Number of instruments	7	7	7	7
Hansen test of joint validity of instruments (P-value)	0.334	0.402	0.379	0.362
Arellano-Bond test for autocorrelation (P-value)	0.221	0.341	0.274	0.35

P values are in parentheses. * Significant at 10%; ** Significant at 5%; * Significant at 1%.**

Table B3: Low-income autocracies

Variable	Regression No.1 [Aggregate]	Regression No.2 [Primary]	Regression No.3 [Secondary]	Regression No.4 [Higher]
Education aid variables				
Aggregate aid	0.384* [0.065]			
Primary		1.181** [0.040]		
Secondary aid			-1.963 [0.192]	
Higher aid				0.671 [0.115]

Control variables				
Log (Initial GDP per capita)	-0.639 [0.318]	-0.833 [0.702]	-1.042 [0.695]	-0.781 [0.545]
Investment (% of GDP)	0.203** [0.002]	0.199** [0.007]	0.251** [0.006]	0.221*** [0.000]
Government consumption (% of GDP)	-0.256*** [0.000]	-0.196** [0.002]	-0.177** [0.009]	-0.240*** [0.001]
Log (1+ Inflation rate)	-1.448** [0.007]	-1.507*** [0.000]	-1.579*** [0.000]	-1.628*** [0.000]
Trade (% of GDP)	-0.031 [0.209]	-0.047 [0.189]	-0.019 [0.210]	-0.039 [0.229]
Constant	6.099** [0.022]	7.403* [0.092]	3.597 [0.103]	6.335* [0.086]
Number of observations	96	96	96	96
Number of countries	8	8	8	8
Number of lags of variables used as instruments.	2	2	2	2
Number of instruments	7	7	7	7
Hansen test of joint validity of instruments (P-value)	0.409	0.512	0.382	0.518
Arellano-Bond test for autocorrelation (P-value)	0.319	0.371	0.414	0.338

P values are in parentheses. * Significant at 10%; ** Significant at 5%; * Significant at 1%.**

Table B4: Middle-income democracies

Variable	Regression No.1 [Aggregate]	Regression No.2 [Primary]	Regression No.3 [Secondary]	Regression No.4 [Higher]
Education aid variables				
Aggregate aid	0.103 [0.528]			
Primary		-0.724* [0.079]		
Secondary aid			-0.655** [0.036]	
Higher aid				1.341** [0.005]
Control variables				
Log (Initial GDP per capita)	0.781 [0.242]	0.873 [0.306]	0.939 [0.274]	0.891 [0.401]
Investment (% of GDP)	0.143*** [0.000]	0.173*** [0.000]	0.182*** [0.000]	0.175*** [0.000]
Government consumption (% of GDP)	-0.076** [0.019]	-0.081** [0.044]	-0.079** [0.008]	-0.089** [0.015]
Log (1+ Inflation rate)	-2.009*** [0.000]	-1.985*** [0.000]	-1.880** [0.005]	-2.039*** [0.000]
Trade (% of GDP)	-0.037* [0.061]	-0.049 [0.190]	-0.031 [0.115]	-0.043 [0.120]
Constant	5.021** [0.020]	6.219*** [0.000]	4.517* [0.055]	7.310* [0.079]
Number of observations	96	96	96	96
Number of countries	8	8	8	8
Number of lags of variables used as instruments.	2	2	2	2
Number of instruments	7	7	7	7

Hansen test of joint validity of instruments (P-value)	0.401	0.35	0.592	0.526
Arellano-Bond test for autocorrelation (P-value)	0.329	0.446	0.413	0.391

P values are in parentheses. * Significant at 10%; ** Significant at 5%; * Significant at 1%.**

Table B5: Middle-income autocracies

Variable	Regression No.1 [Aggregate]	Regression No.2 [Primary]	Regression No.3 [Secondary]	Regression No.4 [Higher]
Education aid variables				
Aggregate aid	0.172 [0.339]			
Primary		-0.831** [0.048]		
Secondary aid			-0.749** [0.019]	
Higher aid				1.539** [0.004]
Control variables				
Log (Initial GDP per capita)	0.349 [0.162]	0.449 [0.184]	0.409 [0.176]	0.371 [0.201]
Investment (% of GDP)	0.227*** [0.000]	0.216*** [0.000]	0.294*** [0.000]	0.258*** [0.000]
Government consumption (% of GDP)	-0.054 [0.102]	-0.077* [0.092]	-0.063* [0.089]	-0.093** [0.048]
Log (1+ Inflation rate)	-1.772** [0.007]	-1.808*** [0.000]	-1.683** [0.011]	-1.885*** [0.001]
Trade (% of GDP)	-0.038* [0.078]	-0.062 [0.207]	-0.059 [0.194]	-0.07 [0.211]
Constant	7.295** [0.034]	8.172** [0.042]	5.891* [0.069]	6.208** [0.009]
Number of observations	96	96	96	96

Number of countries	8	8	8	8
Number of lags of variables used as instruments.	2	2	2	2
Number of instruments	7	7	7	7
Hansen test of joint validity of instruments (P-value)	0.547	0.42	0.619	0.553
Arellano-Bond test for autocorrelation (P-value)	0.409	0.515	0.426	0.539

P values are in parentheses. * Significant at 10%; ** Significant at 5%; * Significant at 1%**

Education sector foreign aid and economic growth in AfricaLamulo Nsanja,[†] Ben M. Kaluwa[§] and Winford H. Masanjala[‡]**Abstract**

This paper explores whether education sector foreign aid influences economic growth in Africa based on a panel of 32 countries over the period 2005 – 2017. The major novelty of the study is that on the supply side the major dependent variable, education aid flows, are disaggregated by education level. On the demand side, the recipient economies are accorded their income groups to account for capacities that complement the effects of human capital development on economic growth as well as the benevolent complementary or destabilizing effects of different political systems of government. The key findings are that: (i) education aid in aggregate form and primary education aid both enhance economic growth in low income countries; (ii) in middle income countries higher education aid is more important for economic growth than primary and secondary education foreign aid; (iii) democracies have a stronger tendency to allocate more education sector foreign aid to primary education, while in autocracies the orientation is towards higher education. The findings imply that low-income autocracies that allocate more education sector foreign aid to higher education than to primary education do so at the expense of economic growth. The same applies to middle-income democracies whose allocation orientation is more towards primary education compared to higher education.

Key words: Africa, Education, Foreign Aid, Growth, Political System.

JEL Classification Codes: I22, C12

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1. Introduction

Much of the contention surrounding international aid from donors to recipients has emanated from the motives of the supply side as well as the expected net benefits on the demand side. Military aid would perhaps be the most brazen where the benefits to both sides are seen in clear short and long-term perspectives including sales of military technology, political and military leverage, dependence and related economic ties. This implies some cost to the recipient at some point in time, which is why after a recent Tsunami, India declined international humanitarian assistance because payback would be in the form of lowered international creditworthiness. Outside the military and within the so-called Overseas Development Assistance (ODA), education aid is among the most enigmatic as far as motivation is concerned – at least to ordinary citizens and taxpayers in donor countries. But donor governments can see strong and long-term economic motivations brokered via political influence or even cultural ties with costs to the recipients and so the benefits to them would also need to be assessed.

A direct objective of education sector foreign aid to developing countries would be to contribute towards the accumulation of their human capital as an investment which should spur economic growth for them and demand for imports from the donating countries. This transmission mechanism would be implied and incorporated in endogenous growth models of Lucas (1988) and Romer (1990) as well as the augmented Solow exogenous growth model of Mankiw et al. (1992), which postulate a positive relationship between education and economic growth. Several empirical studies have also found that the stock of human capital and the level of investment in education are positively associated with economic growth (see McMahon, 1998; Keller, 2006; Asiedu, 2014).

Education aid in recipient countries in sub-Sahara Africa would mainly be utilized for school infrastructure, training and recruitment of teachers, and procurement of teaching and learning materials, all of which tend to be in short supply. These expenditures can influence the quality and quantity of education outputs. They also have the potential to impact GDP growth through increases in investment in education and the enhancement of the stock of human capital. From the perspective of endogenous growth models, more and better education improves the quality, innovativeness, adaptability and productivity of labour as a factor of production.

The effects of education on economic growth are expected to be different for the three levels of education, namely primary, secondary, and higher education. For the longer term, the decline in fertility and mortality rates would likely be more influenced by primary education whereas technological spill-overs would be a more relevant and direct transmission route to growth via higher education especially when complementary inputs such as physical capital and technological know-how are also available. This suggests that the growth effects of education can be mediated by the level of economic development and can therefore differ between low and middle income countries.

Previous studies have tended to overlook the fact and importance of the heterogeneous nature of education aid as well as that of aid recipients both of which could influence economic growth. The oversight may explain the lack of robustness of the effect of aid on growth found in some of the previous empirical studies. Clemens et al. (2004) show that different components of aid, as opposed to aggregate aid, are important when assessing the effect of aid on growth-related

macroeconomic variables such as developing countries' creditworthiness. In their study Harms and Rauber (2004) found that aid improves countries' standings vis-a-vis international capital markets. Importantly, the strength of this effect of aid differs across types of aid and country income groups. The relevance of recipient heterogeneity can be extended beyond income levels to whether any aid effectiveness is neutral to political governance: could (and how) democratic as opposed to autocratic political regimes mediate aid effectiveness?

The present study uses panel data from 32 African countries covering the 13-year period from 2005 to 2017 to examine whether foreign aid in the education sector has a significant effect on economic growth. The significant contributions are that on the supply side the major dependent variable, education aid flows are disaggregated by education level. On the demand side the recipient economies are accorded their income groups (to account for capacities for human capital development complementarities) as well as different political systems of government (to account for the benevolent/destabilizing complementarity for economic growth). In order to concretely ascertain the importance of heterogeneity of aid and of recipients, the estimated results from these disaggregations are benchmarked against those based on pooled or aggregated aid and recipient data (i.e. where heterogeneity is ignored).

The remainder of the paper is organized as follows: Section 2 reviews theoretical and empirical literature. Section 3 discusses the data, model and methodology. Section 4 presents the results and enters into preliminary interpretations. Section 5 offers an in-depth discussion of the results and section 6 concludes.

2. Literature review

2.1. Theoretical perspective

Theory suggests that foreign aid promotes economic growth by supplementing limited domestic savings of recipient developing countries. Early influential literature based on the Harrod-Domar model of economic growth includes the work of Chenery and Strout (1966). The three elements of the Harrod-Domar model are income (growth), investment (savings) and the capital-output ratio, which links the former two and representing the marginal amount of investment necessary to produce an additional unit of output. With the capital-output ratio remaining constant, the rate of economic growth will be directly determined by the rate of investment. With investment assumed to be equal to savings, this implies that a poor country, with low savings, will have low investment and low growth potential. It is thus expected that a supplementation of domestic savings by foreign aid would support an increase in investment, and hence economic growth. Chenery and Strout base their analysis on the case where resource limits on skills and savings are important, and describe this scenario as 'investment limited growth,' where the Harrod-Domar model is taken as the limiting case of no foreign assistance. Calculation of the savings gap is made possible from the Harrod-Domar equations. A savings gap occurs when the quantum of domestic savings available is less than the amount of investment required to attain the target growth rate, and this gap can be filled by foreign aid.

Over time, further growth theories have emerged contesting some of the postulations of the Harrod-Domar model such as the models employed in the assessment of the impact of aid on economic growth. The crucial ones have been the neoclassical and endogenous growth theories. The neoclassical model is largely inspired by the Solow model of long-run growth, which assumes

a continuous production function relating output to the inputs of capital and labour which (as opposed to the Harrod-Domar model) are substitutable and exhibit diminishing returns to scale.

The endogenous growth theory whose key proponents are Arrow (1962), Romer (1986) and Lucas (1988) acknowledges the importance of endogeneity of capital in the growth process with the prospects of increasing as opposed to diminishing returns to capital typical in the neoclassical growth theory.

In all the above, savings and investment (in capital and labour) are fundamental to economic growth. In the endogenous growth theory the assumption of increasing returns to capital implies that effects of foreign aid on growth can be long-run.

2.2. Empirical perspective

A fairly large number of empirical studies have been conducted to ascertain the theoretical construct of the aid-growth relationship at individual country (over time) and cross-country levels. Close variations of the following regression specification have been estimated at cross-country level by Hansen and Tarp (2001), Dalgaard et al. (2004) and Gomanee et al. (2005):

$$\Delta y_i = \beta_0 + \beta_y \ln y_{0i} + \sum_{j=1}^n \beta_j Z_{i,j} + \varepsilon_i \quad (1)$$

where Δy_i is the average growth rate of per capita output for country i , between some initial date t_0 and a second date t_1 , $\ln y_{0i}$ is the log of per capita output of country i , at time t_0 , and ε_i is an error term. $Z_{i,j}$ represents a number of other variables deemed relevant by the researcher and can include some measure of the initial level of human capital or its rate of change. It could also include a variety of variables related to government policies and institutions, such as the share of government spending in GDP, the inflation rate, an index of the rule of law, to name just a few.

To examine the relationship between foreign aid and growth in real GDP per capita, Hansen and Tarp studied a panel data set comprising 56 countries across Africa, Asia and South America for the 20 year period 1974 – 1993. They found that foreign aid increased the growth rate of real per capita GDP and this result was not conditional on ‘good’ policy. Their findings contradicted observations by Burnside and Dollar, who proposed that aid has a positive impact on growth in developing countries conditional on a policy index (i.e. aid has a positive impact in countries with good fiscal, monetary, and trade policies). Burnside and Dollar’s study comprised a panel dataset with 56 countries from Sub-Saharan Africa, Latin America and South Asia for the 24 year period 1970 – 1993. Hansen and Tarp further observed that the estimated effectiveness of aid is highly sensitive to the choice of estimator and the set of control variables included in the regression. Their study also reconfirmed the empirical support for the hypothesis that aid influences growth via the investment transmission mechanism. Dalgaard et al. reached a similar conclusion to Hansen and Tarp that aid is generally effective even in ‘bad policy’ environments. Their study comprised a panel dataset with 65 countries across Sub-Saharan Africa, Central America and East Asia for the 24 year period from 1974 – 1997.

Gomanee investigated aid effectiveness in a panel of 25 Sub-Saharan African countries in the 28 year period 1970 - 1997 by focusing on hypothesized transmission mechanisms through which aid

impacts growth. The results indicated a highly significant positive effect of aid on growth and that investment was the most important transmission mechanism suggesting that Africa's poor growth record should not be attributed to aid ineffectiveness.

The studies mentioned above have a number of features in common. First, they all conclude that aid positively and significantly influences economic growth. Second, they each studied foreign aid in aggregate form, hence ignoring the possibility that different sectoral orientations of foreign aid could influence economic growth with varying degrees of efficacy. Third, all the studies did not consider the heterogeneity of the governance regimes of the countries, which could affect aid effectiveness and impact on growth. The main contribution of the present study is to address omissions of earlier studies of the aid-growth nexus by accounting for the orientation of aid and the governance regimes of recipient countries.

2.3. The education aid-growth nexus and political governance systems

Researchers have debated whether foreign aid is good for economic growth, has no effect, or even a hindrance to progress (see Hansen and Tarp (2001); Burnside and Dollar (2000); Easterly (2003)). Some agreement has formed around the argument that aid works more effectively under specific political and economic conditions that enable foreign aid to have the greatest impact on poverty reduction and promotion of growth.

The arguments against democratic political systems were earlier proposed by Galenson (1959) and Huntington (1968) who argued that democracy generates an explosion of demands, which unleash pressures for immediate consumption. These demands, through union-driven wage demands, threaten profits, negatively impact investment and retard growth, implying that democracy is seen as inimical to economic growth. On the other hand, dictatorships would be better able to force savings for the huge investments in personnel and material required to launch economic growth (Rao, 1984). Such investment programs imply cuts or foregoing current consumption that would be painful for the low-income in developing societies and require strong measures to enforce them. Such a course would not likely survive a popular vote.

Scholars have attributed state autonomy for the superior economic performance of the four Asian Tigers since the 1960s in comparisons to Latin America. State autonomy has been defined as the capacity of the state to pursue developmentalist policies while being insulated from particularistic pressures e.g. originating from large firms or unions which could result in collective suboptimal behaviour and demands leading to underinvestment (Przeworski and Limongi, 1993).

On the other side of the argument, Wittman (1989) and North (1990) view state autonomy as harmful for economic performance because, through the phenomenon of "state capture" the state is always ready to prey on the society and only democratic institutions can constrain it to act in the general interest. From this view, dictatorships would be a source of inefficiency.

Selectorate Theory presented by de Mesquita (2003) supports the notion that democracy is ideal for promoting economic growth through the provision of more public goods to the population than autocracies. In the context of foreign aid, it would be logical to assume that compared to autocracies, democratic leaders in less developed countries would allocate more foreign aid and domestic resources to public and merit goods for the needs of the wider population. This would be more effective in alleviating poverty and engendering sustainable economic growth.

From the foregoing it would be instructive to assess whether disaggregated foreign aid in the education sector would have a greater positive and significant impact in promoting growth in democratic regimes in Africa than in autocratic states.

3. Data, model and methodology

3.1. Characteristics of the sampled countries and data sources

This study includes 32 African countries and spans 13 years from 2005 to 2017. The countries have been divided into four groups as follows: Group 1: Low-income democratic countries; Group 2: Low-income autocratic countries; Group 3: Middle-income democratic countries; and Group 4: Middle-income autocratic countries. Table 1 summarizes the composition of the groups.

Table 1 Categorization of Countries Included in the Study

	GDP per capita (USD)	GDP per capita growth (%)	Total ODA (% GDP)	Primary net enrolment rate (%)	Primary net enrolment rate growth (%)	Tertiary gross enrolment ratio (%)	Tertiary gross enrolment ratio growth (%)
Group 1: Low-income democracy							
Benin	646	1.3	9.0	88	0.7	10.3	5
Liberia	312	0.5	66.9	36	0.9	8.4	6.7
Madagascar	381	-0.3	11.3	70	0.6	4.8	3.3
Malawi	342	2.0	14.9	91	0.1	0.5	4.6
Mali	593	1.1	11.7	60	1.2	6.3	7.5
Mozambique	451	4.2	21.8	81	3.3	3.5	12.1
Tanzania	657	2.9	11.1	85	1.7	4.7	12.7
Uganda	512	3.2	10.6	92	0.4	4.1	3.9
Group average	486.8	1.9	19.7	75.4	1.1	5.3	7.0
Group 2: Low-income autocratic							
Chad	876	5.7	5.9	66	1.6	3.8	9.3
DRC	265	2.6	16.4	n.a.	3.6	8.2	9.8
Comoros	742	-0.2	10.3	77	1.1	9.3	7.1
Gambia	469	0.3	13.3	73	0.3	3.1	8.6
Guinea	427	0.1	7.8	67	1.3	7.7	12.4
Rwanda	468	4.7	17.1	93	1.1	5.7	9.7
Togo	473	0.8	8.6	88	0.2	6.1	6.4
Zimbabwe	754	-2.4	6.3	86	0.1	5.4	4.2
Group average	559.3	1.5	10.7	78.6	1.2	6.2	8.4
Group 3: Middle-income democracy							
Ghana	1167	3.9	7.4	75	1.8	10.3	5.2
Kenya	1072	2.4	4.2	82	2.4	5.5	4.4
Lesotho	1069	3.7	6.3	84	-0.3	7.4	9.3
Mauritius	7002	3.6	1.2	95	0.3	27.3	5.6
Namibia	4473	3.3	2.3	88	-0.4	10.4	4.1
Senegal	1052	2.2	8.7	70	0.4	8.6	5.9
South Africa	5905	1.8	0.5	87	-0.2	16.9	4.8
Zambia	1210	4.8	10.1	86	1.9	n.a.	n.a.
Group average	2868.8	3.3	5.1	83.4	0.7	12.3	5.6
Group 4: Middle-income autocratic							
Algeria	4044	2.3	0.4	96	0.3	25.3	5.2
Angola	3166	0.3	1.7	83	0.4	4.2	2.7
Cameroon	1101	0.9	4.6	85	0.8	8.9	5.2
Egypt	2171	2.2	1.3	96	0.6	28.8	0.4
Gabon	8645	0.7	0.8	n.a.	n.a.	12.6	4.8
Ivory Coast	1118	0.5	4.7	63	0.5	7.1	8.8
Morocco	2602	3	1.6	92	0.4	15.2	4.3
Swaziland	3342	1.2	2	80	0.8	4.8	3.1
Group average	3273.6	1.4	2.1	85.0	0.5	13.4	4.3

Source: World Bank World Development Indicators Database

Note: Figures appear as averages for the 13-year period from 2005 – 2017

The study has adopted World Bank's categorization of economies according to GDP per capita as of 2015 as follows: low income – US\$ 1,045 or less; middle income – US\$ 1,046 to US\$ 12, 735, and; high income – US\$ 12,736 or more. Summary features are as follows:

Low-income countries:

- Combined average GDP per capita of US\$ 523 in the 13-year sample period.
- Average GDP per capita growth for democracies at 1.9% was slightly higher than for autocracies at 1.5% for the 13-year period.
- The ODA as a proportion of GDP received by democracies was nearly double that received by autocracies.
- Primary net enrolment and tertiary gross enrolment ratios were lower for democracies compared to autocracies.

Middle-income countries:

- Combined average GDP per capita of US\$ 3,071 in the 13-year sample period.
- Average GDP per capita growth for democracies was more than double that of middle-income autocracies.
- Average ODA as a proportion of GDP received by democracies was more than double that received by autocracies
- Primary net enrolment and tertiary gross enrolment ratio were higher for autocracies.

For categorization of countries between democratic or autocratic systems of government, this study has employed definitions from three different sources: (i) Polity IV Project: Political Regime Characteristics and Transitions, 1800 – 2013 database by Marshall and Jaggers (2014); (ii) database of the index of democracy and dictatorship by Cheibub et al. (2010) and (iii) the democracy index constructed by publications of the Economist Intelligence Unit. It was rigorously verified that none of the countries included transitioned from one type of political system of government to another between 2005 and 2017 based on the definitions from these three sources. Definitions that have been used for categorization of countries between democracy and autocracy use indicators grouped in different categories measuring competitiveness and openness of elections, pluralism, civil liberties, and political culture.

For the rest of the study, data sources were as follows: World Economic Outlook database of the International Monetary Fund (IMF), International Development Statistics database of the Organization of Economic Cooperation and Development (OECD), and World Development Indicators database of the World Bank.

3.2. Model and methodology

Burnside and Dollar (2000), Hansen and Tarp (2004), Dalgaard et al. (2004) and Gomanee (2005) in their studies based on panel datasets, used a regression specification similar to the one in equation (1) and entered aid in their models endogenously. The main reason for this is that it is difficult to perceive aid as being independent of the level of income. Empirically, a negative relationship between aid and income per capita is well established (see Trumbull and Wall (1994) and Alesina and Dollar (2000)). However, Endogeneity of aid with respect to income per capita can contribute to simultaneity bias in aid-growth regressions, and thus lead to misleading conclusions about the impact of aid. In addition to this, unobserved country specific factors can cause estimates from aid-growth regressions to be biased. The linear dynamic panel General Method of Moments (GMM) estimator proposed by Arellano and Bond (1991) to overcome these

problems uses lagged levels of the first difference of the variables as instruments. However, as pointed out by Arellano and Bover (1995), lagged levels are often poor instruments for first differences, thus the difference GMM is said to suffer from the “weak instruments” problem (Kazuhiko, 2007; Asiedu, 2014). Blundell and Bond (1998) proposed a more efficient estimator, the system GMM estimator, which mitigates the weak instruments problem. Simulation results by Kazuhiko (2007) show that the system GMM is less biased than the difference GMM. Consequently, the preferred estimation procedure for this study is the more efficient and less biased estimator, the system GMM.

The dynamic panel data model of economic growth used in this study is based on the Lucas (1988) human capital accumulation endogenous growth model, which stipulates a positive relationship between education and economic growth. Similar to the model specifications used by Burnside and Dollar (2000), Hansen and Tarp (2004), Dalgaard et al. (2004) and Gomanee (2005), the regression specification of this study enters aid endogenously as an enhancer of capital accumulation which affects economic growth. The general specification is as follows:

$$\Delta y_{it} = \gamma \ln y_{it-1} + \phi Aid_{it} + \sum_{j=1}^k \beta_j x_{jit} + \alpha_t + \mu_{it} \quad (2)$$

Where Δy_{it} denotes the average growth rate of GDP per capita, being a proxy for economic growth; $\ln y_{it-1}$ denotes initial level of per capita GDP in log form, which is lagged, capturing conditional convergence effects; Aid_{it} denotes official development assistance to education expressed as a percentage of GDP, representing education foreign aid; x_{jit} are the k additional or control variables that are also determinants of growth; α_t is a constant term, and μ_{it} is the error term.

The aid effectiveness literature has generally relied on the key assumption that aid has a solely contemporaneous effect on growth because of endogeneity of aid flows (Minoiu and Reddy, 2010). Bobba and Powell (2007) uncover strong and robust evidence that aid can have a positive contemporaneous effect on recipient countries’ average growth.

Masanjala and Papageorgiou (2003) have come to the conclusion that the critical explanatory variables for African economic growth are different from the rest of the world. Among the six critical explanatory variables were: initial per capita GDP and investment as a percentage of GDP. Barro (1996) found that the growth rate of real per capita GDP is enhanced by maintenance of the rule of law, smaller government consumption, lower inflation, improvements in terms of trade, and lower initial levels of real per capita GDP. Sala-i-Martin et al. (2004) examined the robustness of explanatory variables in cross-country economic growth regressions in 98 countries spread across all seven continents. They found that the initial level of real GDP per capita, investment, and primary school enrolment had the most important effect on real GDP per capita growth. In the present study the following variables were included as control variables in the general equation (2): initial GDP per capita in log form, inflation as measured by the consumer price index in log form, general government consumption as a percentage of GDP, the sum of exports and imports as a percentage of GDP (i.e. trade as a percentage of GDP) and investment as a percentage of GDP (i.e. total spending on fixed assets and inventories of raw materials which provide the basis for future production, expressed as a percentage of GDP). Following indications that the aid-

investment transmission mechanism exists (see Appendix), INVRES was constructed to replace investment and represent that part of investment that is not attributed to education foreign aid.

An important question that arises is how to measure and compare the enhancement of the stock of human capital over time and between countries? The best measure would be in terms of the output of education. However, due to the difficulties of obtaining such consistent and comparable education output measures over time and among countries, input measures have instead been used as proxies (see Keller (2006) and Asiedu (2014)). In this study, education aid financing (which in many cases can be considered as investment in education) will be used as a proxy for education output.

By design, estimated growth models in previous studies such as those by Burnside and Dollar (2000), Hansen and Tarp (2001), Dalgaard et al. (2004) and Gomanee (2005) used foreign aid in aggregated form. This study seeks to isolate education aid, which is understood to contribute to human capital accumulation. This education aid is then further disaggregated by educational level for countries that are themselves disaggregated by level of income and political systems of government.

In a first step, the study will analyze a scenario in which education aid is aggregated and countries are pooled, thus disregarding income or political regime categories. The results of this pooled regression will be used as a benchmark for models in which education aid is disaggregated by levels (primary, secondary and tertiary) and countries are disaggregated by income group and political regime as in Table 1.

The three sub-sector levels of education aid will not be entered simultaneously in a single regression in order to avoid running into multicollinearity. By including only one measure of education aid at a time in the regressions there was the risk that estimations may suffer from the omitted variable bias problem. Indeed, in order to accurately capture the effects of each of the individual education aid variables on growth, the estimations should include all the three measures at one time. However, this approach also faces the risk of producing inaccurate estimates if there is multicollinearity, which was detected among the education aid variables used in this study. Pairwise correlation coefficients between the aid variables were all significant for each of the country categories. This justified the inclusion of a single measure of education aid at a time in the regressions. The system GMM estimator used for this analysis mitigates the potential omitted variable bias problem through the use of instrumental variables.

Based on the general growth equation (2), Table 2 summarizes the specific models to be estimated as separate regressions.

Table 2: Summary of regression models and variables used*

Variables	Regression 1: Pooled	Regression 2: Primary	Regression 3: Secondary	Regression 4: Higher
Dependent variable:				
GDP per capita growth	Δy_{it}	Δy_{it}	Δy_{it}	Δy_{it}
Aid variables (% of GDP):				
Aggregate education aid	A_Aid_{it}			
Primary education aid		P_Aid_{it}		
Secondary education aid			S_Aid_{it}	
Higher education aid				H_Aid_{it}
Control variables:				
Log of initial GDP per capita	$\log(y_{it-1})$	$\log(y_{it-1})$	$\log(y_{it-1})$	$\log(y_{it-1})$
Log (1+ inflation rate)	INF_{it}	INF_{it}	INF_{it}	INF_{it}
Investment (% of GDP)	INV_{it}	INV_{it}	INV_{it}	INV_{it}
Government consumption (% of GDP)	GVT_{it}	GVT_{it}	GVT_{it}	GVT_{it}
Trade (% GDP)	TRD_{it}	TRD_{it}	TRD_{it}	TRD_{it}

Note:* all the four models are estimated for each of the four country categories.

3.2.1. Estimation issues

With panel data, country matrices of time-series are stacked so that models of the kind specified in equation (2) are characterized by an error term decomposed into $\mu_{it} = \vartheta_i + \varepsilon_{it}$ where ϑ_i represents time invariant, country specific characteristics (fixed effects), and disturbances, ε_{it} , which change across time and across countries. Use of ordinary estimation techniques such as Ordinary Least Squares (OLS) and the Instrumental Variable (IV) approach cannot handle these characteristics. Moreover, there are other issues in the dynamic specification of equation (2) and its specification application to the aid-growth context. Firstly, there is correlation between the lagged dependent variable y_{it-1} and the disturbance term for the fixed effects (ϑ_i). Secondly, a negative relationship between aid and income per capita has been noted (see Trumbull and Wall (1994) and Alesina and Dollar (2000)) implying endogeneity running from the dependent variable to aid in equation (2).

The two ways to work around the endogeneity problems are the Arellano – Bond (1991) Difference GMM estimator, and the Arellano-Bover (1995) and Blundell and Bond (1998) System GMM estimator. The problem with the Difference GMM is that it is inefficient in that it relies on transforming the variables through first differencing which removes the fixed country-specific effects as they do not vary with time. It also does not address the endogeneity problem and

differencing can introduce serial correlation where disturbance terms $\Delta\varepsilon_{it}$ may no longer be independent and could thus reduce accuracy ($\Delta\varepsilon_{it} = \varepsilon_{it} - \varepsilon_{it-1}$ can be correlated with $\Delta\varepsilon_{it-1} = \varepsilon_{it-1} - \varepsilon_{it-2}$ through the shared ε_{it-1} term).

To overcome the shortcomings of the difference GMM estimator, Arellano-Bover and Blundell and Bond proposed the use of extra moment conditions that rely on certain stationarity conditions of the initial observation. The resulting system GMM estimator has been shown to have much better finite sample properties in terms of bias and root mean squared error than that of the difference GMM estimator. The system GMM estimator for dynamic panel data models combines moment conditions for the model in first differences with moment conditions for the model in levels. It augments difference GMM by estimating simultaneously in differences and levels, the two equations being distinctly instrumented. Blundell and Bond argued that the system GMM estimator performs better than the difference GMM estimator because the instruments in the levels model remain good predictors for the endogenous variables in this model. They showed that for an autoregressive panel data model of order 1, the reduced form parameters in the levels model do not approach zero when the autoregressive parameter approaches one, whereas the reduced form parameters in the difference model do. Furthermore, this estimator is designed for panel datasets comprising many cross sectional units and few time periods (i.e. large N and small T), which is particularly suitable for this study.

3.2.2. Accounting for double counting in the EAid and investment variables

Before attempting to tackle the education aid - growth nexus, there is need to tackle the issue of double counting involving EAid (education aid) which is likely to be incorporated in the investment variable in the vector k in equation (2). Any double counting would lead to a biased coefficient for the EAid variable. To circumvent this by attempting to omit the investment variable would also lead to model specification error (see Feeny, (2005) and Gomanee (2005)). The Appendix provides results of a model linking EAid to aggregate investment, which suggests that there is a link whereby an increase in education aid by one percentage point raises the investment share in GDP by about 0.36 percentage points. The next step would then be to isolate and purge this effect from the investment variable in equation (2). This is done by creating another investment variable, INVRES which is estimated by using the residuals from an aid-investment bivariate regression, whereby investment is regressed on aid using the Residual Generated Regressors technique proposed by Gomanee (2005) and Feeny (2005). Finally, the investment variable used, INV_{it} , is assumed to be net of the EAid component.

4. Results

4.1. Orientation of disaggregated education aid in democratic and autocratic countries

Figure 1 shows average primary education aid as a percentage of total education aid for low and middle-income countries for the thirteen-year period from 2005 to 2017. Section A shows how low income democracies allocated more education aid to primary education compared to low income autocracies. Throughout the sample period, low-income democracies allocated an average of 38% of total education aid to primary education compared to an average of 28% by low-income autocracies but the trend in the former has been declining over time. Similarly, in Section B, throughout the sample period middle-income democracies allocated a higher proportion (an average of 32%) of total education aid to primary education compared to middle-income autocracies (an average of 20%).

Figure 1: Average primary education aid (as % of total education aid)

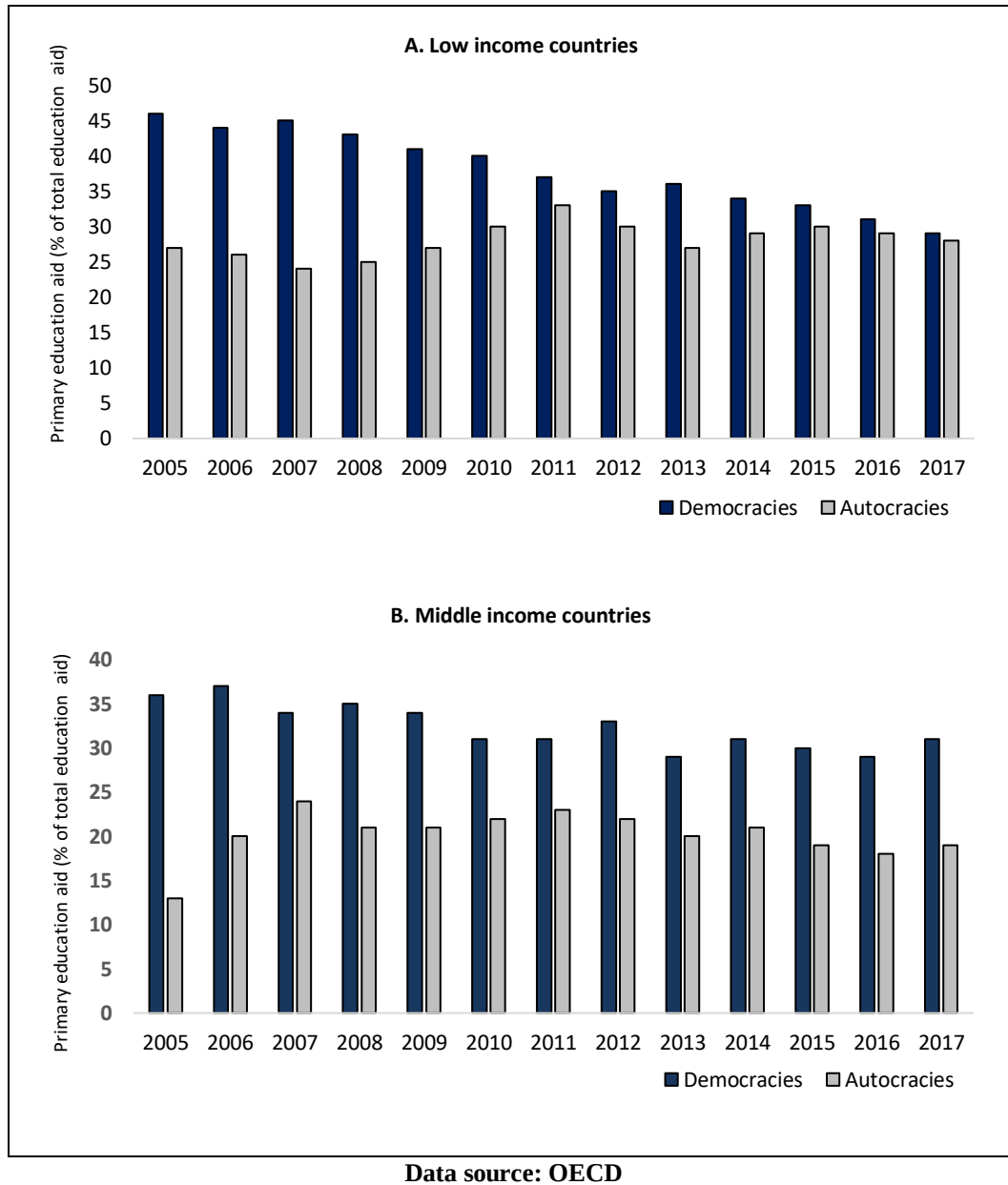
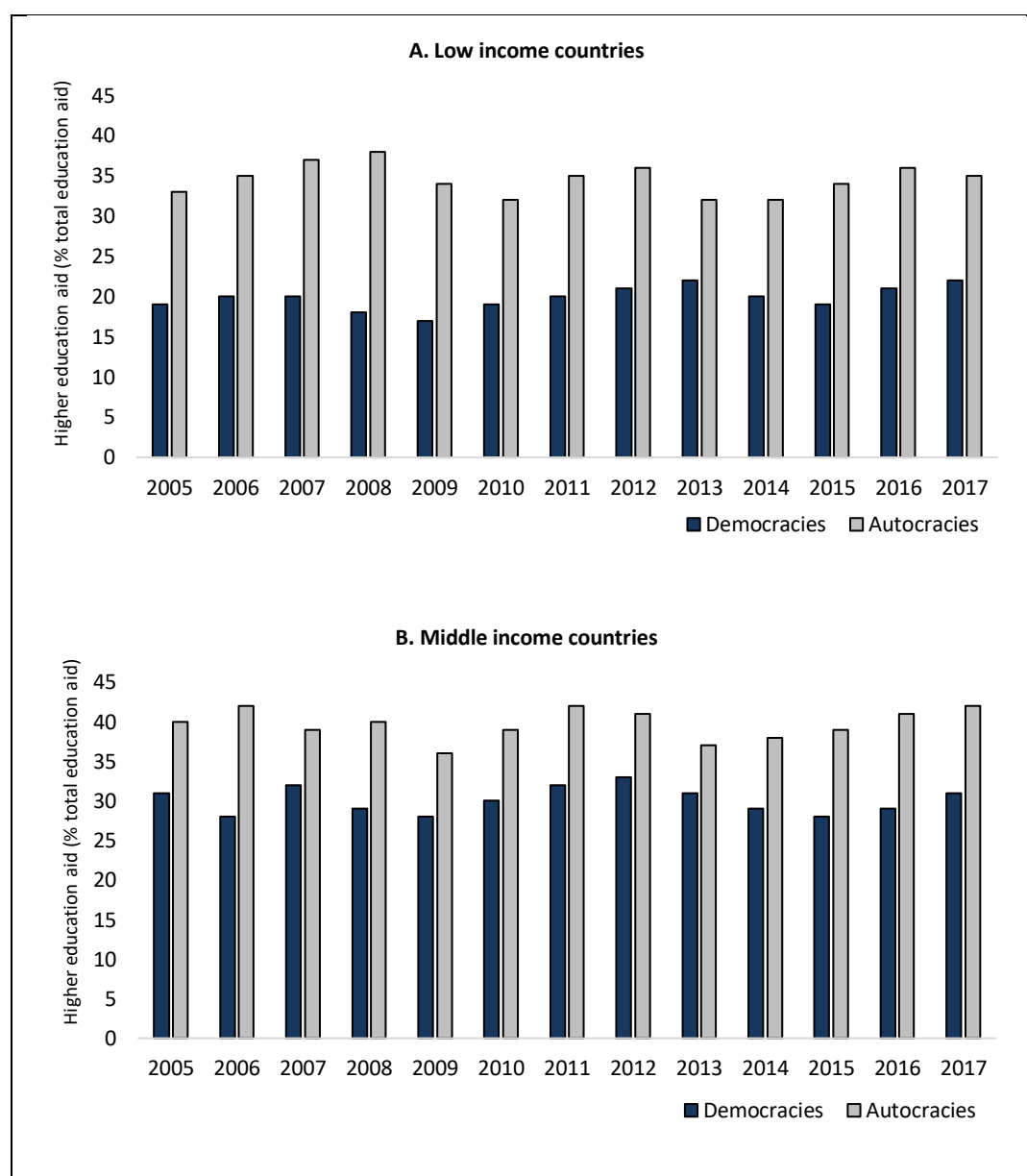


Figure 2 shows average higher education aid as a percentage of total education aid for low and middle-income countries for the study period. Here, autocracies consistently allocated a higher proportion of total education aid to higher education compared to democracies. Between 2005 and 2017 low-income autocracies allocated a group average of 35% of total education aid to higher education compared to 20% by low-income countries. Middle-income autocracies allocated a group average of 40% of total education aid to higher education compared to 30% by middle-income democracies.

Figure 2: Average higher education aid (as % of total education aid)



Data source: OECD

The data shows that democracies included in this study have a tendency to prioritize aid allocation to primary education while autocracies have a tendency to prioritize aid allocation to higher education.

4.2. The education aid-growth relation

Table 3 provides the education aid-growth regression output from the 20 system GMM growth regressions that were estimated. The table shows the estimated coefficients for the education aid variables and their P-values. In a first step to ascertain the importance of heterogeneity of aid flows and heterogeneity of aid recipients, the system GMM regression results from the pooled sample of countries are presented. This analysis uses aggregated data for education aid, country income

group, and system of government. These results are next compared with regression results from a second step using disaggregated data for education aid, country income group and political system of government (columns B, C and D). Table 4 summarizes the results from table 3 by showing the emerging patterns with the coefficient signs and significance levels.

Table 3: System GMM regression results

Country Category	A.	B.	C.	D.
	Aggregate aid	Primary aid	Secondary aid	Higher aid
Pooled sample	0.141 [0.133]	0.109 [0.137]	-0.088 [0.225]	0.151 [0.285]
Low income democracies	0.413** [0.014]	1.367** [0.004]	-1.055 [0.248]	0.569 [0.291]
Low income autocracies	0.384* [0.065]	1.181** [0.040]	-1.963 [0.192]	0.670 [0.115]
Middle income democracies	0.103 [0.528]	-0.724* [0.079]	-0.655** [0.036]	1.341** [0.005]
Middle income autocracies	0.170 [0.339]	-0.831** [0.048]	-0.749** [0.019]	1.539** [0.004]

Notes: P-values in parentheses. * denotes significance at 10%; ** significance at 5%; *** significance at 1%.

Table 4: Education aid-growth regression results: Signs and statistical significance

Income group	Governance	Aggregate	Primary	Secondary	Higher	Comment
Pooled	Pooled					No impact, all countries, all aid
Low-income	Democracies	***	+			(+) for aggregate and primary
	Autocracies	+	***			
Middle-income	Democracies		-	-	***	(-) for primary and secondary; (+) for higher
	Autocracies		-	-	***	

Notes: * denotes significance at 10%; ** significance at 5%; *** significance at 1%.

4.2.1. The pooled sample

The pooled sample ignores the heterogeneity of aid recipients and the heterogeneity of education aid flows. The estimated coefficient of aggregate aid in row 1, column A of table 3 for the pooled sample is not significant suggesting that aggregate education aid does not have a significant effect on growth for the 32 countries pooled together whatever their income or governance status. The heterogeneity of education aid flows by disaggregating education aid data into primary, secondary and higher education aid but without considering the heterogeneity of aid recipients is reported in

row 1 under columns B, C, and D of table 3. None of the estimated coefficients are statistically significant. In short, no type of education aid has any significant effect on growth in African countries if recipients' heterogeneity is not taken into account. In the next step we examine the issue of recipient heterogeneity.

4.2.2. Low-income democracies vs. Low-income autocracies

For low-income countries both aggregate aid and primary level aid have a positive and significant effect on GDP per capita growth regardless of governance system. When the effects of other variables are held constant, a 1% increase in aggregate education aid increases GDP per capita growth by approximately 0.41% in low-income democracies and by 0.38% in low-income autocracies. A 1% increase in primary education aid will increase GDP per capita growth by approximately 1.4% in low-income democracies and by 1.2% in low-income autocracies on average. Higher and secondary education aid have no significant effect.

4.2.3. Middle-income democracies vs. Middle-income autocracies

For middle-income countries, democracies and autocracies alike, aggregate education aid has no significant effect on growth while primary and secondary aid have negative and significant effects. Other variables held constant, a 1% increase in primary education aid leads to approximately a 0.72% and 0.83% decline in growth in middle-income democracies and autocracies on average respectively, while for secondary level aid the declines would be 0.66% and 0.75% respectively. In both middle-income democracies and autocracies, higher education aid has a positive, significant and strong effect on GDP per capita growth. Holding other variables constant, a 1% increase in higher education aid leads to a 1.3% and 1.5% increase in growth on average in democracies and autocracies respectively.

4.2.4. Aid orientation and implications for growth in different political systems

Contrary to a priori expectation, aggregate education aid is seen to be important for growth in low-income countries. Conversely, middle-income countries conform to a priori expectation with respect to aggregate education aid not being statistically important for growth. Possible reasons for this will be discussed in the following section. For both low-income and middle-income countries, heterogeneity of education aid is seen to have important effects for growth. Specifically, primary education aid appears to be more important for increasing growth in low-income countries compared to secondary and higher education aid irrespective of the prevailing political system of government. Conversely, for middle-income countries, higher education aid appears to be more important for promoting growth than primary and secondary education aid irrespective of the prevailing political system of government. This suggests that it is in the interest of both low-income democracies and autocracies to skew their education sector financing (and education aid) to the primary education subsector. However, the data analysis in the section on orientation of disaggregated education aid in democratic and autocratic countries shows that low-income autocracies are less inclined to follow this path, to their detriment. On the other hand, low-income democracies have a preference for this type of prioritization, to their benefit (see figures 1 and 2). For middle-income countries in this study collectively, the empirical results show that it is more advantageous to skew education sector spending (and education aid) to higher education because that is where there are greater returns for economic growth. However, the data analysis shows that middle-income autocracies are more inclined to follow this path to their benefit compared to middle-income democracies (see figures 1 and 2).

4.2.5. Effect of control variables on GDP per capita growth

The sign of the estimated coefficient of initial GDP per capita in log form was not consistent across all estimations and the estimated coefficient was consistently statistically insignificant. This suggests that there was no evidence of convergence in the sample of countries in this study. Government consumption and inflation both had inverse and statistically significant relationships with per capita GDP growth across all estimations while investment consistently had a positive and statistically significant relationship with per capita GDP growth. Trade did not display a consistent relationship with growth. In conclusion, the results suggest that lower government consumption, lower inflation, and high investment promote economic growth in the sampled countries.

5. Discussion

On average, tax revenues covered approximately 84% of total public spending during the period 2005 to 2017 in the sample of low-income African countries in this study and 182% in the sample of middle-income countries (World Bank, 2017). ODA from bilateral and multilateral donors amounted to an average of 90% of total public spending for the sample of low-income countries between 2005 and 2017 compared to just 12% for the sample of middle-income countries (OECD, 2017; World Bank 2017). The greater reliance on ODA by the sample of low-income countries explains why the coefficient of aggregate education aid was positive and significant for low-income democracies and autocracies but insignificant for the middle-income counterparts.

A possible explanation for the significant and positive effect of primary education aid in low-income countries is that many of these countries have not achieved universal primary education due to inadequate capacity in terms of school infrastructure, teaching and learning materials, and teachers. These contribute to high repetition and dropout rates which mean that marginal productivity per dollar is high for primary education aid in low-income countries where the need for investment is high at primary level. Middle income countries would be closer to achieving universal primary and secondary education and therefore the marginal productivity per dollar is relatively lower for those levels of education. In addition, primary education is comparatively more relevant for economic activities characteristic of low-income economies such as the predominance of subsistence agriculture and informal enterprises.

Governments in low-income countries spent 169% more per pupil on average on higher education compared to middle-income countries (World Bank, 2017). This can largely be explained by average gross enrolment ratio of less than half that for middle-income countries over the sample period. Higher education is comparatively more important for middle-income countries than low-income countries. This is because as countries progress into middle-income status it is often the case that the share of agriculture in GDP declines while the shares of sectors that depend on higher education such as secondary and tertiary sectors expand. This incentivizes larger enrolments in higher education. This could explain the positive and significant effect of higher education aid for both categories of middle-income countries in this study.

6. Conclusion

In investigating the impact that foreign aid in the education sector has on economic growth in selected African countries, this study has made a distinction between low and middle-income countries as well as between democracies and autocracies. Furthermore, education sector foreign aid was treated heterogeneously. The results suggest that for low-income countries education aid

in aggregate form and primary education aid both enhance economic growth, while post-primary education aid has no significant effect. For middle-income countries, higher education aid was more important for promoting economic growth than foreign aid to primary and secondary levels.

In assessing whether foreign aid in the education sector has a greater impact in promoting growth in democratic regimes in Africa than in autocratic ones, the results suggest that democracies have a stronger tendency to allocate more education sector foreign aid to primary education. On the other hand, autocracies have a stronger orientation to allocate more education sector foreign aid to higher education. When low-income democracies have a stronger tendency to allocate more education sector foreign aid to primary education, this is generally beneficial to them because the returns to primary education are higher and this is confirmed in the econometric analysis. This also implies that low-income autocratic countries that allocate more education sector foreign aid to higher education than to primary education do so at their detriment with respect to economic growth. When autocracies have a stronger tendency to allocate more education foreign aid to higher education this is generally beneficial to middle-income countries where returns to higher education were seen to be higher. Middle-income democracies that allocate more education sector foreign aid to primary education compared to higher education also do so at their detriment.

The general counsel of wisdom from this study is that regardless of governance orientations and their implications, education aid in low-income countries is better oriented towards the primary level and towards higher levels for middle-income countries. An important and obvious weakness in this and related studies is the implicit assumption of efficiency: that an increase in aid expenditure implies the most education quantity and quality in time and across sample countries. These are dimensions that are not easy to measure and incorporate simultaneously.

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Appendix

The EAid-investment model used in the first step to tackle the EAid/investment double counting in the EAid-growth model

$$Inv_{it} = \delta_0 + \delta_1 Inv_{i,t-1} + \delta_2 Inf_{it} + \delta_3 Fre_{it} + \delta_4 lnCre_{it} + \delta_5 Aid_{it} + \varepsilon_{it}$$

Table 5: Pooled OLS investment regression

Variable	Dependent variable: INV		
	Coefficient	t-Statistic	P-value
<i>Inv</i> (-1)	0.748	3.79	0.001***
<i>Inf</i>	-0.058	-2.53	0.062*
<i>Fre</i>	-0.611	-2.14	0.088*
<i>Cre</i>	0.0246	0.046	0.657
<i>Aid</i>	0.358	1.997	0.044**
<i>Constant</i>	-3.017	1.029	0.516
Observations	416		
R-squared	0.77		
F-Stat	24.31		
Prob. (F-stat)	0.00		

Notes: * denotes significance at 10%; ** significance at 5%; *** significance at 1%.

where Inv_{it} denotes investment as a percentage of GDP. $Inv_{i,t-1}$ denotes one period lagged investment to account for dependence of current investment levels on physical capital. Inf_{it} denotes the inflation rate. Fre_{it} denotes the Freedom House Index, which takes values between 1 and 7, where higher values indicate less freedom and accounts for the political environment. $lnCre_{it}$ denotes the logarithm of credit to the private sector as a percentage of total domestic credit to account for the widely acknowledged view that finance is the key to private sector investment. Aid_{it} denotes foreign education aid.

Table 5 displays the pooled OLS regression output for the investment regression for the 32 African countries included in this study for the 13 year period from 2005 to 2017. There is evidence of a significant positive effect of education aid on investment. This suggests that aid significantly influences investment and therefore it is necessary to consider the double counting problem in the vector k of equation 2 and avoid biased results.

Systems GMM estimations: Effect of aid in education on GDP per capita growth

Table 6: Pooled sample

Variable	Regression No.1 [Aggregate]	Regression No.2 [Primary]	Regression No.3 [Secondary]	Regression No.4 [Higher]
Education aid variables				
Aggregate aid	0.141 [0.133]			
Primary		0.109 [0.137]		
Secondary aid			-0.088 [0.225]	
Higher aid				0.151 [0.285]
Control variables				
Log (Initial GDP per capita)	0.085 [0.682]	0.079 [0.736]	-0.092 [0.621]	0.089 [0.749]
Investment (% of GDP)	0.114** [0.013]	0.140** [0.022]	0.131* [0.076]	0.154** [0.036]
Government consumption (% of GDP)	-0.121* [0.081]	-0.113** [0.003]	-0.102* [0.093]	-0.142** [0.044]
Log (1+ Inflation rate)	-1.380*** [0.000]	-1.243*** [0.000]	-1.319*** [0.000]	-1.277*** [0.000]
Trade (% of GDP)	-0.017 [0.101]	-0.018 [0.119]	-0.013 [0.117]	-0.0010 [0.108]
Constant	4.205** [0.019]	3.789** [0.013]	2.033 [0.196]	4.490 [0.774]
Number of observations	384	384	384	384
Number of countries	32	32	32	32
Number of lags of variables used as instruments.	2	2	2	2
Number of instruments	26	26	26	26
Hansen test of joint validity of instruments ¹ (P-value)	0.427	0.291	0.305	0.247
Arellano-Bond test for autocorrelation ² (P-value)	0.353	0.261	0.304	0.292

Notes: * denotes significance at 10%; ** significance at 5%; *** significance at 1%.

¹ The null hypothesis is that the instrumental variables are uncorrelated with the residuals (i.e. the instruments as a group are exogenous).

² The null hypothesis is that the error terms in the first difference regression exhibit no second order serial correlation.

Table 7: Low-income democracies

Variable	Regression No.1 [Aggregate]	Regression No.2 [Primary]	Regression No.3 [Secondary]	Regression No.4 [Higher]
Education aid variables				
Aggregate aid	0.413** [0.014]			
Primary		1.367** [0.004]		
Secondary aid			-1.055 [0.248]	
Higher aid				0.569 [0.291]
Control variables				
Log (Initial GDP per capita)	-0.703 [0.442]	-1.221 [0.503]	-1.375 [0.549]	-1.324 [0.378]
Investment (% of GDP)	0.158*** [0.000]	0.183*** [0.000]	0.161*** [0.000]	0.190*** [0.000]
Government consumption (% of GDP)	-0.134** [0.008]	-0.142** [0.004]	-0.149** [0.009]	-0.151** [0.006]
Log (1+ Inflation rate)	-1.233*** [0.000]	-1.301*** [0.000]	-1.287** [0.003]	-1.326*** [0.000]
Trade (% of GDP)	-0.021 [0.122]	-0.032 [0.131]	-0.039 [0.125]	-0.028 [0.136]
Constant	5.221** [0.009]	4.008** [0.010]	5.322* [0.087]	3.710* [0.064]
Number of observations	96	96	96	96
Number of countries	8	8	8	8
Number of lags of variables used as instruments.	2	2	2	2
Number of instruments	7	7	7	7
Hansen test of joint validity of instruments (P-value)	0.334	0.402	0.379	0.362
Arellano-Bond test for autocorrelation (P-value)	0.221	0.341	0.274	0.35

Table 8: Low-income autocracies

Variable	Regression No.1 [Aggregate]	Regression No.2 [Primary]	Regression No.3 [Secondary]	Regression No.4 [Higher]
Education aid variables				
Aggregate aid	0.384* [0.065]			
Primary		1.181** [0.040]		
Secondary aid			-1.963 [0.192]	
Higher aid				0.671 [0.115]
Control variables				
Log (Initial GDP per capita)	-0.639 [0.318]	-0.833 [0.702]	-1.042 [0.695]	-0.781 [0.545]
Investment (% of GDP)	0.203** [0.002]	0.199** [0.007]	0.251** [0.006]	0.221*** [0.000]
Government consumption (% of GDP)	-0.256*** [0.000]	-0.196** [0.002]	-0.177** [0.009]	-0.240*** [0.001]
Log (1+ Inflation rate)	-1.448** [0.007]	-1.507*** [0.000]	-1.579*** [0.000]	-1.628*** [0.000]
Trade (% of GDP)	-0.031 [0.209]	-0.047 [0.189]	-0.019 [0.210]	-0.039 [0.229]
Constant	6.099** [0.022]	7.403* [0.092]	3.597 [0.103]	6.335* [0.086]
Number of observations	96	96	96	96
Number of countries	8	8	8	8
Number of lags of variables used as instruments.	2	2	2	2
Number of instruments	7	7	7	7
Hansen test of joint validity of instruments (P-value)	0.409	0.512	0.382	0.518
Arellano-Bond test for autocorrelation (P-value)	0.319	0.371	0.414	0.338

Table 9: Middle-income democracies

Variable	Regression No.1 [Aggregate]	Regression No.2 [Primary]	Regression No.3 [Secondary]	Regression No.4 [Higher]
Education aid variables				
Aggregate aid	0.103 [0.528]			
Primary		-0.724* [0.079]		
Secondary aid			-0.655** [0.036]	
Higher aid				1.341** [0.005]
Control variables				
Log (Initial GDP per capita)	0.781 [0.242]	0.873 [0.306]	0.939 [0.274]	0.891 [0.401]
Investment (% of GDP)	0.143*** [0.000]	0.173*** [0.000]	0.182*** [0.000]	0.175*** [0.000]
Government consumption (% of GDP)	-0.076** [0.019]	-0.081** [0.044]	-0.079** [0.008]	-0.089** [0.015]
Log (1+ Inflation rate)	-2.009*** [0.000]	-1.985*** [0.000]	-1.880** [0.005]	-2.039*** [0.000]
Trade (% of GDP)	-0.037* [0.061]	-0.049 [0.190]	-0.031 [0.115]	-0.043 [0.120]
Constant	5.021** [0.020]	6.219*** [0.000]	4.517* [0.055]	7.310* [0.079]
Number of observations	96	96	96	96
Number of countries	8	8	8	8
Number of lags of variables used as instruments.	2	2	2	2
Number of instruments	7	7	7	7
Hansen test of joint validity of instruments (P-value)	0.401	0.35	0.592	0.526
Arellano-Bond test for autocorrelation (P-value)	0.329	0.446	0.413	0.391

Table 10: Middle-income autocracies

Variable	Regression No.1 [Aggregate]	Regression No.2 [Primary]	Regression No.3 [Secondary]	Regression No.4 [Higher]
Education aid variables				
Aggregate aid	0.172 [0.339]			
Primary		-0.831** [0.048]		
Secondary aid			-0.749** [0.019]	
Higher aid				1.539** [0.004]
Control variables				
Log (Initial GDP per capita)	0.349 [0.162]	0.449 [0.184]	0.409 [0.176]	0.371 [0.201]
Investment (% of GDP)	0.227*** [0.000]	0.216*** [0.000]	0.294*** [0.000]	0.258*** [0.000]
Government consumption (% of GDP)	-0.054 [0.102]	-0.077* [0.092]	-0.063* [0.089]	-0.093** [0.048]
Log (1+ Inflation rate)	-1.772** [0.007]	-1.808*** [0.000]	-1.683** [0.011]	-1.885*** [0.001]
Trade (% of GDP)	-0.038* [0.078]	-0.062 [0.207]	-0.059 [0.194]	-0.07 [0.211]
Constant	7.295** [0.034]	8.172** [0.042]	5.891* [0.069]	6.208** [0.009]
Number of observations	96	96	96	96
Number of countries	8	8	8	8
Number of lags of variables used as instruments.	2	2	2	2
Number of instruments	7	7	7	7
Hansen test of joint validity of instruments (P-value)	0.547	0.42	0.619	0.553
Arellano-Bond test for autocorrelation (P-value)	0.409	0.515	0.426	0.539



Research Article

GENDER GAP IN AGRICULTURAL PRODUCTIVITY IN MALAWI

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Received 07th March 2021; Accepted 10th April 2021; Published online 24th May 2021

Abstract

This paper explores agricultural productivity differences in Malawi arising due to differences in the gender of the plot manager based on a gender disaggregated sample of 784 maize, 232 groundnut, 212 tobacco and 199 cotton plot managers. Decomposition techniques were used to identify the relative quantitative importance of factors explaining the gender gap at the mean of the agricultural productivity distribution. This was carried out using data from the fourth Malawi Integrated Household Survey (IHS 4), which was nationally representative and collected within a multi-topic framework with emphasis on gender disaggregation of crop farming preferences. The survey was conducted by the Malawi National Statistical Office from April 2016 to April 2017 and information was collected from a sample of 12,447 households. Empirical investigation based on the Oaxaca-Blinder regression-based mean decomposition showed that gender gaps exist where men are more productive in the cultivation of both male and female dominated crops. Large and significant gender disparities were seen not only in the use of inputs (particularly fertilizer and labour) but also in the returns to those inputs. Higher levels of household adult male labour on male-managed plots, in particular, widen the gender gap. The female structural disadvantage component of the gender gap is exacerbated by gender differences in the availability of time devoted to productive activities. This is because female managers, who are just as likely to be household heads or spouses, are more likely to combine farm management with household duties including child care in the Malawian social setting.

Keywords: Agriculture, Decomposition methods, Gender, Plot manager, Rural.

INTRODUCTION

Smallholder agriculture has been increasingly recognised as a means to address issues of poverty and nutrition insecurity in Malawi as the sector both feeds the population and employs the largest number of people in the country. There is near universal participation in agriculture by households throughout Malawi, with women responsible for a significant volume of the total labour. Approximately 97% of rural women in the country are engaged in subsistence farming (Koirala *et al.*, 2015). In terms of types of crops grown, it has been observed that female farmers in many instances grow lower value subsistence crops not necessarily because they prefer to do so but because they cannot access the resources that would permit them to do otherwise (Koirala *et al.*, 2015). Consequently, cash and export crops are frequently regarded as 'men's crops' and subsistence crops are regarded as 'women's crops'. In Malawi, female farmers are less likely to cultivate the country's primary cash crop, tobacco, compared to men. The crop is only planted on 1.3% of female-managed plots compared to 5.4% of male-managed plots (NSO, 2017). UN Women (2015) uncovered a 28% gender gap between women and men in the fraction of land devoted to export crops in Malawi. Gender differences in cash crop production create two key challenges: first, at the micro level, there is potential for widening income inequality arising from cash crops, grown mainly by men, which command higher market value than traditional staple crops, grown mainly by women. Second, at the macro level, failure to maximize the important contribution that women can make in cash crop production is costly to the national development agenda as it results in forgone aggregate agricultural output and incomes.

Previous research highlighting the gender gap in agricultural production focused largely on women's unequal access to key inputs, such as fertiliser, agricultural information and farm labour, concluding that if women had better access, they would be equally efficient (see Quisumbing, 1996; Udry, 1996; Quisumbing *et al.*, 2001; Horrell & Krishnan, 2007; Udry, 2008; Peterman *et al.*, 2011; and Vargas Hill & Vigneri, 2011). The methodology used in this paper looks not only at the quantity of resources that women use, but also assesses the returns that they receive from these resources, or how well these resources actually translate into increased agricultural productivity. It is possible that even if women had access to the same amount of inputs as men, this equal access would not automatically always achieve the same effect in terms of productivity. Such a paradox could result from broader norms, market failures or institutional constraints that alter the effectiveness of these resources for women. Furthermore, despite what could be perceived as a well-established base on the extent and proximate causes of the gender gap across sub-Saharan Africa, the overwhelming majority of empirical studies on the topic have used data from small-scale surveys that were limited in terms of geographic coverage, topic, or attention to intra-household dynamics (or in some cases, all three). The failure by previous studies to use nationally-representative, methodologically-sound data collected in heterogeneous settings has in turn inhibited the computation of rigorous estimates. This study seeks to fill this gap by providing a nationally-representative analysis of the gender gap in Malawi from the perspective of men's and women's crops using the Oaxaca-Blinder decomposition methodology. The substantively interesting question to be addressed is why productivity differences arise between men and women for a variety of crops, which have been designated as women's and men's crops.

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What are women's and men's crops?

A body of literature exists that has categorized certain crops to be either women's crops or men's crops depending on the gender that dominates production. Domination in production of a specific crop by a particular gender has been found to be influenced by a number of contextual factors as well as unique properties of the crops themselves. There is a strong association between cassava cultivation and women in Sub-Saharan Africa where cassava is often referred to as a 'women's crop' (Forsythe *et al.*, 2015). The association is derived from several factors including the low market value of cassava as a traditional food that is mainly grown and consumed at home, along with characteristics such as its low input requirements. Prevailing climate change increases the importance of the crop as it is drought tolerant and can do well in poor soils and requires less strenuous management. Chiwona-Karlton (2005) noted that cassava has gained popularity as an important crop in view of the HIV and AIDS pandemic in which labour-constrained households find it ideal as it has minimal labour requirements compared to crops such as maize.

thereby restricting the ability of low-income smallholders, many of whom are women farmers, to engage in the sector. Cotton is grown by approximately 300,000 smallholder farmers in Malawi and it is estimated that approximately 20% to 30% of these are female (i.e. those involved in decision-making in the production process on the farm) (Ussar, 2016). Many other women who are not involved in decision-making in the cotton production process work as labourers on their husband's cotton farms, or are employed as casual workers on other people's farms. Cotton is therefore also regarded as a men's crop. In Malawi, maize is the staple food crop cultivated on 73% of male-managed plots and 83% of female-managed plots (NSO, 2017). Orr *et al.* (2016) observed that both men and women viewed maize as a crop where over 60% of decisions were non-dominated and where control was shared. Therefore, maize occupies the middle ground, with control shared fairly evenly between women and men and thus can be viewed as a gender neutral crop. Based on data availability for the variables of interest, this study will analyse agricultural productivity differences between male-managed and female-managed plots for maize, groundnut, tobacco and cotton farming.

Table 1. summarizes the classification of women's and men's crops from the foregoing overview

Crop	Gender domination	Explanation	Reference
Cassava	Female	Low-risk; low input requirement; does not require strenuous management.	Forsythe <i>et al.</i> , (2015)
Groundnut	Female	Bulk of labour provided by women; women are involved to a large extent in management decisions in production.	Orr <i>et al.</i> (2016); Tsusaka <i>et al.</i> (2016)
Tobacco	Male	Men dominate decision-making process; considerable input requirements; strenuous management involved.	Makoka <i>et al.</i> (2016); NSO, (2017)
Cotton	Male	Men dominate decision-making process; considerable input requirements; strenuous management involved.	Ussar (2016); NSO, (2017)
Maize	Neutral	More than 60% of decision-making is non-dominated and control is generally shared.	NSO, (2017); Orr <i>et al.</i> (2016)

Practically, the low-risk and low-input requirements of cassava are particularly important for women who experience more severe constraints in accessing agricultural inputs in comparison to men, and also face more constraints in participating in alternative markets such as cash crops. Groundnut is also regarded as a women's crop primarily because much of the labour is provided by women, especially during the post-harvest handling such as stripping, and shelling (Tsusaka *et al.*, 2016). This has resulted in women perceiving greater control over groundnut production than men, where control extends to decision making at various steps in production (Orr *et al.*, 2016). This is consistent with Doss's (2001) argument that women's crops are defined not only by who controls the output but also by who makes the management decisions. As in many parts of Africa, men dominate the production and control of high-value cash crops in Malawi (Makoka *et al.* 2016). Malawi's primary cash crop is tobacco and the country is the world's most tobacco-dependent economy in the world (Otanezet *et al.*, 2009). The commodity contributed 52% of the total export value for the country in 2012. In the 2009/10 farming season tobacco was disproportionately cultivated on 10.4% of male-managed plots compared to 3.3% of female-managed plots (NSO, 2012). In the 2015/16 farming season, the crop was cultivated on 5.4% of male-managed plots and just 1.3% of female-managed plots (NSO, 2017). Although women are involved in a substantial amount of the labour associated with tobacco, they are less involved in decision-making in the production process (Makoka *et al.*, 2016). Cotton is a significant cash crop and the fourth largest agricultural export after tobacco, sugar, and tea in Malawi. Cotton requires considerable amount of inputs,

MATERIALS AND METHODS

Data

The economic, social and demographic data for this study are drawn from the fourth Malawi Integrated Household Survey (IHS 4). It is statistically designed to be representative at national, district, urban and rural levels. The survey was conducted by the Malawi National Statistical Office from April 2016 to April 2017. The survey collected information from a sample of 12,447 households; 2,272 (representing 18.3%) were urban households, and 10,175 (representing 81.7%) were rural households. The survey collected socio-economic data at the household level and on individuals within the households including highest education qualifications attained and gender of the plot manager. It also collected detailed data on farming activities including crop output, land usage, labour and other farming inputs. In rural Africa, plots are not necessarily managed at the household level but at individual level. It is not uncommon to have three generations living together and the person declared as the head of the household might just be the patriarch whose influence on productivity is in fact limited. The head of the household does not have identical observable and non-observable characteristics as the other household members. Therefore, the scope of the conclusions drawn from studies that aim to explain gender differences in agricultural productivity based on gender of the household head will likely be limited in terms of public policy. The method used in this study entails estimation of a production function with a gender dummy as an independent variable (in the pooled regression), with estimation at the plot level as opposed to the household

level. This plot level approach outperforms the household level approach in that it is better able to isolate the differences in productivity caused by gender among all the factors that influence productivity.

Oaxaca-Blinder mean decomposition method

The Oaxaca-Blinder decomposition developed by Oaxaca (1973) and Blinder (1973) gained prominence through its initial application involving decomposition of wage earning gaps and the estimation of discrimination in gender earning differentials. The decomposition method calculates the gap between means of an outcome variable of two groups and identifies the contribution of each variable to the differences between the groups of interest. The gap or the result of the mean differences of the two groups is then divided between the explained component, i.e. the endowment effect, and the unexplained component, i.e. the structural effect. The explained component is the part of the differential in group outcomes due to group differences in the explanatory variables while the unexplained component is due to discrimination or omitted predictors (Oaxaca, 1973). To document the extent and drivers of the gender gap in Malawi for maize, groundnut, tobacco and cotton farming, I use the Oaxaca-Blinder decomposition approach and assume the log of an agricultural productivity measure (Y), namely gross agricultural output per acre, for male (M) and female (F) managed plots estimated as:

$$Y_G = \beta_{G0} + \sum_{k=1}^K X_{Gk} \beta_{Gk} + \varepsilon_G \quad (1)$$

where G indicates the gender of the plot manager; X is a vector of the k observable, plot level explanatory variables; β is the associated vector of intercept and slope coefficients; and ε is the error term under the assumption that $E(\varepsilon_M) = E(\varepsilon_F) = 0$. The gender gap 'D' is expressed as the mean outcome difference:

$$D = E(Y_M) - E(Y_F) \quad (2)$$

Equations (1) and (2) imply that:

$$E(Y_M) = E(\beta_{M0} + \sum_{k=1}^K X_{Mk} \beta_{Mk} + \varepsilon_M) = \beta_{M0} + \sum_{k=1}^K E(X_{Mk}) \beta_{Mk} \quad (3)$$

$$E(Y_F) = E(\beta_{F0} + \sum_{k=1}^K X_{Fk} \beta_{Fk} + \varepsilon_F) = \beta_{F0} + \sum_{k=1}^K E(X_{Fk}) \beta_{Fk} \quad (4)$$

and equation (2) could be rewritten as:

$$D = \beta_{M0} + \sum_{k=1}^K E(X_{Mk}) \beta_{Mk} - \beta_{F0} - \sum_{k=1}^K E(X_{Fk}) \beta_{Fk} \quad (5)$$

Subsequently, I define β^* as the vector of coefficients that is obtained from a regression of Y that is based on the pooled plot sample and includes the group membership identifier, which is a dummy variable identifying female-managed plots. The inclusion of the group membership identifier in the pooled regression for the estimation of β^* takes into account the possibility that the mean difference in plot-level productivity measure is explained by gender of the plot manager, avoiding a possible distortion of the decomposition results due to the residual group difference reflected in β^* (Jann, 2008; Kilic, 2015). Rearranging Equation (5) by adding and subtracting (i) the slope coefficient of the pooled regression β_0^* , and (ii) the return to the observable covariates of each group valued at $\beta^*(X_{MK}\beta_k^* \text{ and } X_{FK}\beta_k^*)$, we obtain:

$$D = \underbrace{\sum_{k=1}^K [E(X_{Mk}) - E(X_{Fk})] \beta_k^*}_{\text{Component 1: Endowment effect}} + \underbrace{(\beta_{0M} - \beta_0^*) + \sum_{k=1}^K [E(X_{MK})(\beta_{MK} - \beta_k^*)] + (\beta_0^* - \beta_{0F}) + \sum_{k=1}^K [E(X_{FK})(\beta_{FK} - \beta_k^*)]}_{\substack{\text{Male structural advantage} \\ \text{Female structural disadvantage} \\ \text{Component 2: Structure effect}}} \quad (6)$$

where $\beta_{M0}, \beta_{F0}, \beta_0^*, \beta_{MK}, \beta_{FK}, \beta_k^* (k = 1 \dots K)$ are the estimated intercept and slope coefficients of each covariate included in the regressions of the male-managed, female-managed and pooled plot samples.

Equation (6) is known as the aggregate decomposition. The first component is the endowment effect (i.e. the portion of the gender gap that is explained by differences in the levels of observable covariates between both groups). It is the sum across all covariates, of the differences by group, valued at the corresponding average return. The second component is the structure effect (i.e. the portion of the gender gap driven by deviations of each group's return from the corresponding average return). The first term of the structure effect, $(\beta_{0M} - \beta_0^*) + \sum_{k=1}^K [E(X_{MK})(\beta_{MK} - \beta_k^*)]$, represents the male structural advantage, which is equal to the portion of the gender gap accounted for by deviations of male regression coefficients from pooled counterparts. The second term of the structure effect, $(\beta_0^* - \beta_{0F}) + \sum_{k=1}^K [E(X_{FK})(\beta_{FK} - \beta_k^*)]$, represents the female structural disadvantage, which is equal to the portion of the gender gap driven by deviations of pooled regression coefficients from female counterparts.

For each of the 4 crop types equation 1 is estimated for (i) male-managed plots, (ii) female-managed plots, and (iii) the pooled plot sample. The resulting vector of coefficients β_M, β_F , and β^* , together with the mean values for each covariate for each group X_M and X_F are then used to compute the components of equation (6). Moving beyond the aggregate decomposition, the detailed decomposition involves subdividing the endowment and the structure effects into the respective contributions of each observable covariate which corresponds to the variable-specific subcomponents of the summations included in equations (6).

The questions attempted to be addressed by the Oaxaca-Blinder decomposition method require a strong set of assumptions. In particular, these methods follow a partial equilibrium approach, where observed outcomes for one group can be used to construct various counterfactual scenarios for the other group. A limitation is that while decompositions are useful for quantifying the contribution of various factors to a difference in an outcome across groups or a change in an outcome for a particular group over time, they are based on correlations, and hence cannot be interpreted as estimates of underlying causal parameters (Fortin *et al.*, 2011). However, decomposition methods do document the relative quantitative importance of factors in explaining an observed gap, thus suggesting priorities for further analysis and, ultimately, policy interventions.

Fortin *et al.* (2011) present a detailed account of the assumptions required to identify the population parameters of interest. Two crucial assumptions for the validity of aggregate decomposition are (i) overlapping support and (ii) ignorability. Overlapping support implies that no single value of $X = x$ or $\varepsilon = e$ exists to identify membership into one of the groups. Ignorability refers to the random assignment of female plot management conditional on observable attributes. The additional essential assumptions required by detailed decomposition to identify the individual contribution of each covariate include additive linearity and zero conditional mean. The latter implies that ε is independent of X . In other words, it is assumed that there is no unobservable heterogeneity that jointly determines the outcome and observable attributes. It should be noted that even if the additional assumptions required by detailed decomposition may not hold true, aggregate decomposition would remain valid as long as overlapping support and ignorability assumptions are tenable (Fortin *et al.*, 2011). The sensitivity analyses to determine if overlapping support and ignorability assumptions hold are presented later on.

RESULTS

Descriptive statistics

Descriptive statistics and results from tests and mean differences by gender of the plot manager are presented in Table 2. Plots were dropped that were missing production information, or where unit values could not be computed reliably for the crops reported to be cultivated on the plot, or where a clear manager of the plot could not be identified, or plots that had missing values among the independent variables of interest. These exclusions left us with the final analysis sample of 784 maize plots, 46% of which were managed by female farmers; 232 groundnut plots, 48% of which were managed by female farmers; 212 tobacco plots, 35% of which were managed by female farmers; and 199 cotton plots, 36% of which were managed by female farmers. The average output per acre, which is the dependent variable and proxy for agricultural productivity, is seen to be lower across all the four crop types for the female managed plot samples. Gender productivity gaps for all four crops were statistically significant. Of the four crop types, the largest gender productivity gap was seen in tobacco production where average output per acre was 36% lower on female managed plots and the difference was statistically significant at the 1% level. The gender productivity gap was smallest in groundnut production where female managed plots produced 3% less output per acre on average compared to male managed plots. Female managed plots, on average, are overseen by individuals that are older and have slightly fewer years of schooling compared to their male-managed comparators across all the four crop types. The average GPS-based plot area for male farmers across all four crop types is 0.93 acres compared to 0.84 acres for female managed plots. Female-managed plots are, on average, 10% smaller than male-managed plots and the gender difference in plot sizes is statistically significant for all crop types. Tobacco farmers tend to have relatively large land sizes. In terms of land utilization, most farmers in Malawi allocate more land to maize and tobacco. Together, these two crops take up almost 85% of the total land under cultivation (NSO, 2017). It is in tobacco farming where the largest gender difference in plot size is seen where female managed plots are, on average, 18% smaller compared to male managed tobacco

plots. The smallest gender differences in plot sizes were seen in groundnut and maize farming where female-managed plots were 3% and 4% smaller respectively compared to male managed plots. The incidence of organic or inorganic fertilizer application is lower on female managed plots across all four crop types but the difference is only statistically significant for maize farming. This trend could signal gender differences in Farm Input Fertilizer Subsidy Program (FISP) voucher distribution and redemption outcomes. Kilic *et al.* (2015) observe that based on data from the third Malawi Integrated Household Survey, the average number of fertilizer vouchers that were received among female-headed households were lower than the analogous statistic for male-headed households and the difference was statistically significant at the 1% level. Similarly, the average number of fertilizer vouchers that were redeemed by female-headed households was lower compared to male-headed households and the difference was again statistically significant at the 1% level. Female managed plots are associated with overall higher labour use (both household and hired) compared to male managed plots, and they are, on average, 4% less likely to be associated with households that receive agriculture extension services on topics that relate to crop production and marketing. Table 3 presents the naïve plot-level regression results on the gender gap in output where the dependent variable is the log of gross output per acre. The findings presented in panels (1), (2) and (3) of the table originate from regressions that, in addition to the dummy variable on female plot management, control only for agro-ecological zone, regional, and district fixed-effects, respectively.

The gender gap estimate ranges recorded were as follows: 11 to 14 percent for maize farming; 7 to 8 percent for groundnut farming; 18 to 22 percent for tobacco farming; and 14 to 18 percent for cotton farming. The gender gap estimates are statistically significant for maize, tobacco and cotton farming and statistically insignificant for groundnut farming. These results indicate a statistically and economically large difference between male and female farmers, particularly for men's crops (tobacco and cotton). Additional estimates of the gender gap were obtained this time conditional on additional covariates commonly found in the literature (see Peterman *et al.*, 2011; Kilic *et al.*, 2015). Base OLS regression results underlying the mean decomposition for the pooled, male-managed and female-managed plot samples can be found in the Annex to this paper. Results from the pooled regression that includes both male- and female-managed plots showed that once key factors of production are controlled for, the gender gap is reduced to 3.8 percent for maize farming; 1.5 percent for groundnut farming; 5.8 percent for tobacco farming; and 5.1 percent for cotton farming. The gender gaps are now statistically significant for all four crops. Unfortunately, this type of analysis does not allow us to delve deeper into the processes that underlie the movement from the relatively higher unconditional to the relatively lower conditional gender gaps for all the four crop types. In the following sections, a decomposition approach is applied that will allow unpacking the relative contributions of different factors towards this gap and to suggest priority areas for policy interventions.

Decomposition econometric results

The first step in the mean decomposition is the estimation of equation (1).

Table 2. Descriptive statistics and results from tests and mean differences by gender of the plot manager

Variable	Pooled sample				Male-managed plot sample				Female-managed plot sample				Difference			
	Maize	G.Nut	Tobacco	Cotton	Maize	G.Nut	Tobacco	Cotton	Maize	G.Nut	Tobacco	Cotton	Maize	G.Nut	Tobacco	Cotton
Outcome variable																
Output per acre (kg/ac)	651.96	418.92	212.82	143.44	667.89	425.25	259.44	163.23	635.37	413.83	166.15	123.94	32.52**	11.42*	93.29***	39.29***
Plot manager characteristics																
Age (years)	41.59	40.64	46.29	43.36	40.15	39.36	45.36	42.71	43.39	42.52	47.58	44.42	-3.24**	-3.16**	-2.22**	-1.71**
Years of schooling	5.42	6.08	7.43	6.94	6.55	6.68	7.89	7.16	4.87	5.13	6.94	6.29	1.68*	1.55*	0.95*	0.87*
Agriculture extension receipt δ	0.26	0.29	0.32	0.29	0.27	0.31	0.35	0.33	0.23	0.27	0.31	0.30	0.04	0.04	0.04*	0.03*
Household characteristics																
Household size	4.83	4.74	4.91	4.97	6.09	5.69	5.77	5.51	5.12	4.81	5.03	4.90	0.97*	0.88*	0.74*	0.61*
Child dependency ratio	0.65	0.66	0.68	0.63	0.67	0.69	0.69	0.64	0.71	0.74	0.72	0.68	-0.04*	-0.05*	-0.03*	-0.04*
Plot area																
Acres	0.83	0.74	1.22	0.73	0.84	0.75	1.35	0.76	0.81	0.73	1.11	0.69	0.03***	0.02***	0.24***	0.07*
Plot input use																
Incidence of fertilizer use (organic or inorganic) δ	0.48	0.04	0.98	0.99	0.49	0.04	0.99	0.99	0.46	0.03	0.97	0.98	0.03*	0.01	0.02	0.02
Household male labour use (days/ac)	18.12	19.04	28.41	26.15	21.95	22.13	30.17	31.28	12.52	15.62	20.98	22.62	9.43**	6.51*	9.19**	8.66*
Household female labour use (days/ac)	21.14	22.48	30.13	29.77	18.98	20.37	19.95	20.54	27.17	28.23	36.67	33.80	-8.19**	-7.86*	-16.72**	-13.26*
Incidence of hired labour use (days/ac)	8.12	7.68	12.88	10.39	7.33	8.19	10.70	9.51	9.59	9.37	11.82	12.07	-2.26**	-1.18**	-1.12*	-2.56*
Agro-ecological characteristics																
Sandy soil δ	0.217	0.223	0.207	0.200	0.219	0.226	0.198	0.205	0.213	0.224	0.219	0.210	0.006**	0.002*	-0.021*	-0.005**
Clay soil δ	0.135	0.126	0.153	0.117	0.129	0.120	0.112	0.103	0.141	0.129	0.121	0.102	-0.012**	-0.009*	-0.009*	0.001**
Sandy and clay (the base category) δ	0.648	0.651	0.640	0.683	0.652	0.654	0.690	0.692	0.646	0.647	0.660	0.688	0.006**	0.007*	0.03*	0.004**
Tropic-warm/semiarid δ	0.46	0.47	0.44	0.45	0.47	0.49	0.45	0.43	0.46	0.48	0.46	0.46	0.01	0.01	-0.01	-0.03
Tropic-warm/subhumid δ	0.32	0.38	0.45	0.46	0.37	0.40	0.46	0.46	0.31	0.35	0.44	0.45	0.06***	0.05***	0.02**	0.01**
Tropic-cool/semiarid δ	0.13	0.09	0.06	0.05	0.13	0.09	0.04	0.05	0.10	0.07	0.05	0.04	0.03	0.02	-0.01	0.01
Tropic-cool/subhumid δ	0.09	0.06	0.05	0.04	0.09	0.07	0.05	0.06	0.07	0.05	0.05	0.05	0.02***	0.02***	0.00	0.01
Observations																
	784	232	212	199	423	120	138	127	361	112	74	72	62	8	64	55

***/**/* indicate statistical significance at the 1/5/10 percent level, respectively. δ denotes a dummy variable.

Table 3. Naïve regression results on gender productivity differences in farming

	Dependent variable: Log[plot gross output / acre]											
	(1)				(2)				(3)			
	Maize	G.Nut	Tobacco	Cotton	Maize	G.Nut	Tobacco	Cotton	Maize	G.Nut	Tobacco	Cotton
Fixed effects	Agro-Ecological Zones				Regions				Districts			
Female Plot Management δ	-0.142 (0.021)	-0.083 (0.022)	-0.222** (0.023)	-0.175** (0.024)	-0.111 (0.021)	-0.067 (0.021)	-0.184** (0.022)	-0.156** (0.023)	-0.113 (0.020)	-0.072 (0.021)	-0.218** (0.020)	-0.141** (0.023)
Observations	784	232	212	199	784	232	212	199	784	232	212	199
R-Squared	0.019	0.016	0.022	0.024	0.024	0.021	0.029	0.031	0.066	0.057	0.068	0.064

Note: ***/**/* indicate statistical significance at the 1/5/10 percent level, respectively. δ denotes dummy variable.

Table 4 Decomposition of the gender differential in agricultural productivity

A. <u>Mean Gender Differential</u>					Maize	G/Nuts	Tobacco	Cotton								
Mean male-managed plot agricultural productivity					9.849** (0.020)	6.442 (0.031)	10.894*** (0.019)	9.109** (0.022)								
Mean female-managed plot agricultural productivity					9.706** (0.027)	6.359 (0.037)	10.671*** (0.026)	8.933** (0.028)								
Mean gender differential in agricultural productivity					0.143** (0.025)	0.083 (0.036)	0.223*** (0.024)	0.176** (0.030)								
B. <u>Aggregate decomposition</u>																
Total	Endowment effect				Male structural advantage				Female structural disadvantage							
	Maize	G/Nuts	Tobacco	Cotton	Maize	G/Nuts	Tobacco	Cotton	Maize	G/Nuts	Tobacco	Cotton				
	0.102** (0.028)	0.051 (0.031)	0.179*** (0.023)	0.137** (0.029)	0.000 (0.002)	0.000 (0.003)	0.000 (0.002)	0.000 (0.003)	0.041** (0.030)	0.032 (0.032)	0.044*** (0.026)	0.039** (0.033)				
Share of the gender differential					71%	61%	80%	78%	0%	0%	0%	0%	29%	39%	20%	22%
C. <u>Detailed decomposition</u>																
	Endowment effect				Male structural advantage				Female structural disadvantage							
	Maize	G/Nuts	Tobacco	Cotton	Maize	G/Nuts	Tobacco	Cotton	Maize	G/Nuts	Tobacco	Cotton				
Plot manager characteristics																
Age(years)	0.007 (0.004)	0.004 (0.003)	0.011 (0.006)	0.009 (0.007)	-0.026 (0.021)	-0.011 (0.019)	-0.029 (0.022)	-0.031 (0.025)	-0.046 (0.042)	-0.023 (0.028)	-0.054 (0.036)	-0.050 (0.044)				
Years of schooling	0.018** (0.009)	0.011* (0.008)	0.028** (0.013)	0.024* (0.016)	-0.013 (0.009)	-0.011 (0.007)	-0.017 (0.010)	-0.015 (0.011)	-0.029* (0.016)	-0.015* (0.014)	-0.036* (0.019)	-0.031* (0.022)				
Agriculture extension receipt δ	0.006 (0.003)	0.003 (0.001)	0.010** (0.006)	0.008** (0.005)	-0.009 (0.004)	-0.006 (0.004)	-0.012* (0.009)	-0.010* (0.007)	-0.014 (0.008)	-0.010 (0.009)	-0.022** (0.010)	-0.019** (0.012)				
Household characteristics																
Household size	0.013** (0.006)	0.010* (0.008)	0.018** (0.007)	0.016* (0.009)	-0.017 (0.013)	-0.013 (0.010)	-0.021 (0.015)	-0.019 (0.016)	-0.058* (0.023)	-0.051* (0.030)	-0.077** (0.035)	-0.068* (0.039)				
Child dependency ratio	0.00 (0.001)	0.000 (0.002)	0.000 (0.001)	0.000 (0.002)	0.024** (0.012)	0.021* (0.014)	0.031** (0.013)	0.028* (0.016)	0.042** (0.015)	0.039* (0.018)	0.049** (0.016)	0.045* (0.017)				
Plot area																
Log[GPS based plot area/ac]	-0.025*** (0.007)	-0.020* (0.011)	0.037*** (0.009)	0.030** (0.013)	-0.019 (0.015)	-0.015 (0.013)	0.027 (0.018)	0.021 (0.019)	-0.013 (0.044)	-0.010 (0.048)	0.021 (0.052)	0.018 (0.055)				
Log[GPS based plot area/ac squared]	-0.013** (0.005)	-0.010* (0.007)	0.019*** (0.004)	0.016** (0.005)	-0.002 (0.011)	-0.002 (0.014)	0.001 (0.009)	0.002 (0.010)	0.004 (0.024)	0.003 (0.027)	-0.005 (0.025)	-0.004 (0.028)				
Plot input use																
Incidence of fertilizer use (organic or inorganic) δ	0.011* (0.007)	0.004 (0.019)	0.015*** (0.004)	0.014** (0.006)	0.008* (0.005)	0.002 (0.009)	0.013** (0.007)	0.011** (0.008)	0.023* (0.016)	0.011 (0.013)	0.037* (0.018)	0.032* (0.019)				
Log[Household male labour use (days/ac)]	0.084*** (0.019)	0.079*** (0.022)	0.097*** (0.017)	0.088*** (0.020)	0.171*** (0.059)	0.165*** (0.068)	0.193*** (0.047)	0.182*** (0.051)	0.044*** (0.014)	0.041*** (0.017)	0.058*** (0.012)	0.055*** (0.015)				
Log[Household female labour use (days/ac)]	-0.013*** (0.006)	-0.010** (0.009)	-0.025*** (0.007)	-0.017* (0.013)	-0.060** (0.019)	-0.034* (0.023)	-0.081*** (0.017)	-0.070* (0.028)	-0.102* (0.064)	-0.055* (0.031)	-0.127* (0.071)	-0.094* (0.058)				
Log[Hired labour use (days/ac)]	0.001 (0.003)	0.004 (0.007)	0.003 (0.005)	0.002 (0.004)	0.001 (0.003)	0.002 (0.004)	0.002 (0.003)	0.001 (0.003)	-0.004 (0.006)	-0.005 (0.008)	-0.007 (0.009)	-0.005 (0.007)				
Number of observations	Maize				Groundnut				Tobacco				Cotton			
	784				232				212				199			

This is done separately for the pooled, male-managed and female-managed plot samples for each of the four crop types. Estimation results are reported in the Annex. The log of GPS-based plot area has a negative coefficient that is statistically significant in each of the three plot samples (i.e. pooled, male-managed and female-managed) for maize and groundnuts. This finding is consistent with recent studies that have provided support for the inverse yield hypothesis – the proposition that small farms are more productive than large farms particularly for staple crops in low resource settings (see Larson *et al.*). The pure cash crops (tobacco and cotton) have a positive coefficient that is statistically significant in each of the three plot samples. Years of schooling has a positive coefficient and is statistically significant only within female-managed plot samples, suggesting that if female plot managers acquired similar years of schooling as male counterparts, the mean gender gap in productivity could be reduced. Agriculture extension services receipt has a positive coefficient which is only statistically significant for tobacco and cotton farming for both male and female managed plots alike, suggesting that greater priority is placed on provision of extension services to plot managers that grow cash crops. A key variable that is positively associated with gross output per acre, irrespective of the plot sample and crop type, is fertilizer use per acre. The return to fertilizer use is higher within male-managed plot samples in comparison to the female-managed plot samples and this difference is statistically significant for all crop types except groundnut.

The log of household adult male labour hours per acre has a sizeable and positive coefficient that is statistically significant within the male-managed plot samples for all four crop types, while the comparable estimate within the female-managed plot samples is not statistically significant across all the four crop types. In contrast, the log of household adult female labour hours per acre has a positive and statistically significant coefficient across both male and female plot samples for all crop types, with a larger magnitude and statistical significance among female-managed plots. Although household size has a positive coefficient that is statistically significant irrespective of the plot sample, the magnitude of the coefficient within the female-managed plot samples is more than double that within the male-managed plot samples. The coefficient for child dependency ratio has a negative sign for female-managed plot samples across all crop types and the coefficient is consistently statistically significant. For each crop type, the coefficient is also more than double compared to the coefficient for male-managed plot samples. Conversely, the coefficient for child dependency ratio for male-managed plots is positive but statistically insignificant across all crop types. The gender differences in returns to household size and child dependency ratio imply that the burden of childcare is more likely to reduce female agricultural productivity. The decomposition of the mean gender gaps for the different crops, which were estimated at 14.3% for maize; 8.3% for groundnut; 22.3% for tobacco; and 17.6% for cotton, are presented in Panel A in Table 4. Panel B presents the aggregate decomposition components, namely the endowment effect, the male structural advantage, and female structural disadvantage. Panel C includes the results from the detailed decomposition. The aggregate decomposition indicates that the endowment effect (10.2% for maize; 5.1% for groundnut; 17.9% for tobacco; and 13.7% for cotton), i.e. the portion of the gender gap driven by differences in levels of observable attributes, accounts for 71%, 61%, 80% and 78% of the mean gender differential in

agricultural productivity for maize, groundnut, tobacco and cotton farming respectively. The female structural disadvantage is estimated at 4.1% for maize; 3.2% for groundnut; 4.4% for tobacco; and 3.9% for cotton farming, explaining the remaining 29%, 39%, 20% and 22% of the gender gap for maize, groundnut, tobacco and cotton respectively. The aggregate decomposition reinforces the notion that large and significant gender disparities in access to inputs and asset ownership are central factors behind the gender gap particularly in the case of maize, tobacco and cotton farming where statistical significance is reported for the mean gender differential in agricultural productivity, the endowment effect and the female structural disadvantage. The key assumptions additionally required by the detailed decomposition are additive linearity and zero conditional mean. In trying to lend support to the ignorability and zero conditional mean assumptions, the methodology applied by Acemoglu *et al.* (2001) and Altonji *et al.* (2005) is used and incorporate into the base specification thematically-grouped control variables such that the results are compared to those from the base specification. The purpose is to gauge the stability of the key regression coefficients that underlie the decomposition results. If the coefficients on the covariates included in the base specification, including the female plot management dummy in the pooled regression, are stable subsequent to incorporation of the additional covariates, they are less likely to change if potentially missing omitted variables are taken into account. The following sets of variables are used to perform this analysis: (i) district fixed effects, (ii) plot geospatial characteristics, informed by GIS data, (iii) other plot characteristics solicited by IHS4, and (iv) additional household characteristic. Results from the regressions including the additional controls for the pooled, male-managed, and female-managed plot samples show that an overwhelming majority of the coefficients, with respect to the base specification, are stable across the specifications and the plot samples, and do not change sign or significance. This suggests that the assumptions of ignorability and zero conditional mean might not be unfounded.

DISCUSSION

Earlier when analysing the study data and descriptives, it was noted that male-managed plots tend to be overseen by individuals that have higher years of schooling and who access agricultural extension more frequently. Male-managed plots also exhibit higher incidence of fertilizer use and higher household adult male labour input per acre. In view of the positive correlation between these covariates and agricultural productivity, I find these variables to be contributing positively towards the endowment effect, thereby widening the gender gap. Conversely, the smaller plot areas farmed by female managers appear to be a contributing factor in shrinking the gender gap given that in these data there is an inverse relationship between cultivated plot area and agricultural productivity for maize and groundnut farming. Furthermore, the higher rate of household adult female labour provision within the female-managed plot samples contributes negatively towards the endowment effect, hence working to close the gender gap. It is not only the difference in the fertilizer endowment that contributes to the gender gap, but also relatively higher return to fertilizer among the male-managed plots in comparison to their female-managed counterparts, particularly for maize, tobacco and cotton farming. The same applies to the log of household adult male labour hours per

acre for all four crops. The underlying causes of these findings could potentially be the subject of future research but may indicate household adult male labour supervision difficulties on female-managed plots. The fact that household adult male labour input is associated with a wider gender gap is, however, partially offset by the higher returns that household adult female labour provides on female-managed plots for all four crops. Regarding the child dependency ratio, although the contribution of this factor towards the endowment effect is zero, its contribution towards the female structural disadvantage is large and positive. This is driven by the sizeable and highly significant negative association between this variable and agricultural productivity solely within the female-managed plot samples for all four crops. This result highlights the differential productivity impacts of heterogeneous household roles assumed by male and female managers. Since female managers, who are just as likely to be household heads or spouses, are more likely to combine farm management with household duties particularly in the Malawian rural social setting, including child care, their pattern of time use is directly related to their low productivity outcomes. The structural effect measures the part of the productivity differential attributable to the differences in the returns of the covariates. A positive and significant value will imply that male managers have a structural advantage over female managers in regards to the specific covariate. Household adult female labour input is a key variable that is associated with negative and significant contributions towards both the endowment effect and the male structural advantage component. From Table 4 we see that the magnitude of the relationship between the variable and the endowment effect is higher for male-dominated crops (tobacco and cotton). It is economically significant for all crops and this indicates the importance of household female adult labour in the context of labour market failures and insufficient household male adult labour. The sustained negative contributions towards the male structural advantage components for all the crop types are driven by lower returns to household adult female labour on male-managed plots vis-à-vis pooled and female-managed plots.

Conclusion

The study offers a fresh look at gender differences in agricultural productivity in Malawi using decomposition techniques that identify the relative quantitative importance of factors explaining the gender gap at the mean of the agricultural productivity distribution. The study was carried out using nationally representative data, collected within a multi-topic framework and with emphasis on gender disaggregation of crop farming preferences. Significant gender gaps exist where men are more productive in the cultivation of both male and female dominated crops. The gender gap is estimated at 14.3%, 8.3%, 22.3%, and 17.6% at the mean for maize, groundnut, tobacco and cotton farming respectively. The findings support the view that large and significant gender disparities in use of inputs (particularly fertilizer and labour) is a central factor behind the gender gap. At the mean, the differences in observable covariates (i.e. the endowment effect) are associated with 71%, 61%, 80%, and 78% of the gender gap for maize, groundnut, tobacco and cotton farming respectively. The structure effect, which is driven by gender differences in returns to factors of production, explain 29%, 39%, 20%, and 22% of the gender gap for maize, groundnut, tobacco and cotton farming respectively. Higher levels of

household adult male labour on male-managed plots, in particular, widen the gender gap; a result which was consistent for all four crops. These disparities appear to be compounded by gender differences in the availability of time devoted to productive activities, as negative returns to household child dependency ratio on female managed plots are found to exacerbate the female structural disadvantage component of the gender gap. In addition, lower and declining returns to household adult male labour on female managed plots vis-à-vis male managed counterparts across the four crop types might be suggestive of potential household adult male labour supervision difficulties on female managed plots. These mutually reinforcing constraints appear to generate a female productivity trap. This study shows a number of factors that seem to be driving the gender differences in agricultural productivity in Malawi. Diversification among female farmers into high-value agriculture with appropriate adoption support and risk mitigation mechanisms, and counteracting the effects of household male labour shortages on female-managed plots with enhanced access to fertilizer could lead to significant contractions in the agricultural productivity gender gap across several crops. However, this analysis alone is not enough to inform effective policy interventions that will ensure the realization of these outcomes. In other words, while it was possible to quantify the relative contributions of various factors towards the gender gap, it could not be determined why inequalities in time use, access and returns to agricultural inputs, and the like persist. Although this limitation is inherent in the use of decomposition methods, this empirical approach identifies the key inequalities that could be the focus of other worthwhile future research, which could seek to map out their determinants in order to inform policy interventions aimed at addressing the gender gap at its roots in Malawi and other parts of sub-Saharan Africa.

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Effects of Education on Fertility and Labour Supply: Evidence from MalawiLamulo Nsanja[†]**Abstract**

Women play a crucial role in the development of the Malawian economy. Their ability to blend household demands with labour market activities has been a remarkable phenomenon, one that has attracted the attention of an emerging literature on gender dynamics. This paper, in an attempt to add to this growing literature, sought to model female labour force participation and fertility in Malawi with a focus on the role of education using demographically enriched household survey data from the 2015/16 Malawi Demographic and Health Survey. The study results showed that empowered women who are educated and engaged in the labour market will have less time for many children as the opportunity cost of staying at home and taking care of children becomes very high. In this regard, extending free education beyond primary school level to include secondary education could be an important measure that could help further reduce the fertility rate in Malawi. Policies to reduce fertility can also play direct and indirect roles in enhancing maternal and child mortality reductions. When women give birth to fewer children, it reduces their exposure to the risks of childbirth, particularly in rural areas where health and maternal care services are poor or non-existent.

Key words: Education; Employment; Fertility; Labour; Malawi

JEL Classification Codes: I12, J01, J13, J21

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1. Introduction

Malawi has recorded significant socio-economic progress over the past two decades. Real GDP per capita rose from USD 297 in 1998 to USD 391 in 2018; prevalence of stunting of children under the age of five years improved from 62% to 38% between 1998 and 2016. Infant mortality declined from 110 per 1,000 live births in 1998 to 35 per 1,000 live births in 2016, which was lower than the Sub-Saharan average of 56 and not far off from the world average of 31 (World Bank, 2017). Progress has been notable in advancing towards universal primary education enrolment with a primary net enrolment rate of 90 in 2016 and gender parity in primary education of 1.01 in 2016 (Malawi Government, 2017). Efforts in the fight against HIV and AIDS saw prevalence falling to 8.8% in 2016 from 15.2% in 1999 (World Bank, 2017).

However, challenges remain in other key socio-economic areas such as ensuring gender parity in secondary education, reducing fertility, and improving maternal health. Consequently, Malawi still experiences some of the poorest health indicators and outcomes in the world. For example, the country's maternal mortality ratio (per 100,000 live births) while improving from 859 in 2004 to 451 in 2016 was still high compared to 286 in neighboring Zambia (World Bank, 2017).

Total fertility rate (TFR) while improving from an average of 6.7 children per woman in 1992 to 4.4 in 2016 in Malawi was still almost double the world average of 2.4 (NSO, 2017; World Bank, 2017). Both women and men have consistently reported that their ideal family size is smaller than the national total fertility rate; often couples have more children than they want (NSO, 2017).

As a result of high fertility rates, Malawi registered a high population growth rate of 2.71% and high dependency ratio of 90 dependents for every 100 working-age population in 2016 (World Bank, 2017). The adverse implications of these trends are large. From both a theoretical and empirical perspective, it is notable that Malawi's high population growth is constraining its per capita income growth and service delivery prospects. In 2015, there were approximately 6.7 million child dependents in Malawi. Malawi Government and University of Malawi (2017) estimated that if the fertility rate remained constant, there would be 15.9 million child dependents by 2050. If the fertility rate declined to 2.3, this number was projected to fall to 9.6 million, which would permit greater investment in health and education per child.

Furthermore, under a reduced fertility scenario, GDP per capita was projected to be 25% higher at approximately USD 1,100 by 2050, compared to USD 880 per capita if fertility remained constant (Malawi Government & University of Malawi, 2017). Such a fertility decline would also have the potential to contribute significantly to the acceleration of reductions in poverty and inequality.

The 2015/16 Malawi Demographic and Health Survey (MDHS) prepared by the Malawi National Statistics Office elaborated on some of the factors that contribute to the high fertility rates among women in Malawi. Some of these factors include sexual characteristics of women such as the age at which a woman first enters marriage, age of first sexual relations and frequency of sexual relations. The MDHS analysis provides descriptive evidence on the underlying factors, dwelling mainly on age group and regional differences but does not provide a rigorous quantitative analysis, for example on the impact of the level of female education on fertility or the level of education on labour force participation.

There has been considerable interest in the relationship between female education and participation in the labour force, and fertility rates. This has been particularly so following the development of economic models of fertility behavior. In these models, price and income variables are postulated to affect fertility decisions. Accordingly, childbearing and early nurturing of infants, which are of biological necessity a woman's role (Ellis, 1988), are seen as activities that intensively use a woman's time. With increased education, urbanization and modernization, the opportunity cost of women staying at home and taking care of children also rises. These activities also consume a lot of the woman's time, which can otherwise be used to earn income. Therefore, a woman's expected lifetime wage rate is an important variable that may affect the number of children she gives birth to. But since a woman's expected lifetime wage rate is not a directly observable variable, her educational attainment provides an important proxy for her expected lifetime wage rate.

A number of studies, using data from both developed and developing countries, show that female education is associated with a decrease in fertility (Sackey, 2005; Lam & Duryea, 1999; Ainsworth *et al.*, 1996; Vavrus & Larsen, 2003; Guilkey *et al.*, 1998; Ben-Porath, 1973; Gardner, 1973). While studies from various countries show fertility declines to follow periods of active family planning programmes, Brazil provides an example of a country where, despite the limited family planning programmes and volatile economic growth, fertility has steadily declined since the 1960s, underscoring the importance of women's education in this trend, even in the absence of other factors (Lam & Duryea, 1999). In addition to the importance of women's education, higher levels of education of people in the community have a strong negative impact on fertility. Using demographic and health surveys data for 22 Sub-Saharan African countries, Kravdal (2002) finds a strong negative impact of the level of education at community level on fertility rates. These findings confirm the neoclassical theory, which suggests that as investment in human capital increases and as more women participate in the labour market, the fertility behaviour of households is bound to change in favour of fewer children. However, the quantitative impact had not been explicitly estimated for Malawi. This study aimed to test this theory using data from the 2015/16 MDHS. Given Malawi's high fertility rates, it is important to gain more understanding into the factors that affect household fertility decisions.

The study seeks to provide answers to the following questions: Does the level of education acquired by a woman affect her decision in terms of the number of children born, and if so, how many years of a woman's schooling have a significant negative impact on fertility in Malawi? What are the factors that are more likely to influence a woman's decision to participate in the labour force? This study provides evidence on the impact of female education and labour force participation on fertility in Malawi and makes recommendations on how to achieve the optimal fertility targets. The study also adds to the stock of knowledge on female education, fertility and labour force participation.

The remainder of this study is organized as follows: Section 2 discusses the importance of education in fertility reduction. Section 3 reviews the relationship between female employment and fertility. The nature of the data used in the empirical analysis is covered in Section 4. Section 5 presents trends in Malawi's fertility rate. The theoretical framework underpinning this study is presented in Section 6 while Section 7 presents the methodology and models for estimation thereof. Penultimately, empirical results and their interpretation are covered in Section 8 and finally, Section 9 concludes.

2. Importance of education in fertility reduction

Empirical evidence from both developed and developing countries unambiguously reveals that female education is associated with a decrease in fertility (Sackey, 2005; Lam & Duryea, 1999; Ainsworth *et al.*, 1996; Vavrus & Larsen, 2003; Singh, 1994; Ben-Porath, 1973; Gardner, 1973). Increased participation of women in schooling and the labour market raises the economic value of their time, which increases the opportunity cost of raising children (Guilkey *et al.*, 1998; Singh, 1994; Ben-Porath, 1973; Gardner, 1973).

Studies on female education and fertility conclude that female education leads to a decrease in fertility; that is, with higher levels of education, the number of children born per woman reduces (Guilkey *et al.*, 1998; Ben-Porath, 1973; Gardner, 1973). Schultz (1993) confirms that women's education is associated with smaller desired family sizes across the world. This negative relationship between women's education, fertility and desired family size is explained by several factors that have been explored by both economists and sociologists. First, with higher levels of education, a woman's expectations of future earnings are higher, increasing the opportunity cost of giving birth to, and raising children. Second, the longer a woman stays in school, the lower the chances of giving birth to many children. Related to this is the fact that with more education and exposure, women acquire more information about their bodies and are more able to process that information to their advantage (Vavrus & Larsen, 2003; Singh, 1994).

The positive impact of women's education on their autonomy leads to later marriages, increased use of contraceptives, and lower fertility as discussed by Mason (1986). More importantly, higher levels of women's education are associated with lower child mortality rates, in the order of 5-10% for each additional year of the mother's schooling (Schultz, 1993; Mensch *et al.*, 1985; Cochrane *et al.*, 1980). This is because higher levels of women's education lead to improved childcare, nutrition, and basic health and better child outcomes – health and school attainment (Strauss & Thomas, 1995).

In general, there are two major determinants of fertility in Malawi. First, are the underlying or indirect factors known as socio-cultural and economic (intermediate) determinants, including education, the desire for large families, extended family influence, economic value of children, occupation, property ownership, and residence. Second, is the immediate or direct (proximate) determinants, including marriage patterns, sexual customs, and frequency of sexual activity, access to and use of contraceptives, length of post-partum amenorrhea, sterility, and abortion. In this study, focus is on education, a factor that policy makers can influence. It is also a factor that has other important implications, including participation in labour force, poverty reduction and improved standards of living.

Table 1: Trends in total fertility rates in Malawi between 2010 and 2016

Background characteristics	Total fertility rate (TFR)	
	2010	2016
Education		
No education	6.9	5.5
Primary	5.9	4.8
Secondary	3.8	3.3
More than secondary	2.1	2.3
Residence		
Urban	4	3
Rural	6.1	4.7
Wealth quintile		
Lowest	6.8	5.7
Second	6.8	5.2
Middle	6.3	4.6
Fourth	5.3	4.1
Highest	3.7	2.9

Source: Malawi DHS 2010 and 2015/16

In Malawi, women start giving birth at an average age of about 15 years and in some cases, girls have given birth at ages as low as 12 years (NSO, 2017). The peak age group for childbearing is 20-29 years (NSO, 2017), such that if between these ages the women are still at school it would tremendously reduce their chances of having many children. Table 1 illustrates how the TFR in Malawi has improved over time and that the level of education has been found to significantly reduce the ideal number of children both women and men would choose to have.

The Malawi DHS 2010 and 2016 show that women with more than secondary education have fewer children (approximately 2) compared to those with no education at all (an average of 6). It is also noteworthy that TFR is significantly lower in urban areas (between 3 and 4) than in rural areas (between 5 and 6). One reason for the urban-rural differential is the concentration of women with secondary and higher levels of schooling in urban areas, and also the greater access to contraceptives and other medical facilities in urban areas. Women who have completed primary schooling or those with some secondary schooling have a lower TFR than women without schooling. Overall, Table1 shows that there is a strong negative relationship between female education and fertility. The intention of this study is to explicitly estimate the quantitative impact for Malawi and provide empirical evidence on this assertion, and thereafter draw policy recommendations.

3. Female employment and fertility

The participation of women in the economic market is presumed to compete with their family obligations, since mothers are usually primarily responsible for household duties in many cultures. Accordingly, a negative relationship is generally expected between female labour force participation and fertility at the micro level, although there is controversy about the casual direction of the relationship between the two phenomena (Felmlee, 1993; Cramer, 1980; Stolzenberg &

Waite, 1977). Beguy (2009) observes that while a consistent negative relationship between women's paid work and fertility has been found at the micro level in developed countries, no clear pattern has emerged in developing countries. In particular, in Sub-Saharan Africa it has been suggested that no relationship should exist between labour force status and fertility because of limited wage employment, extended family networking, and cheap domestic labour, as well as traditional social norms regarding gender roles and the division of household duties between men and women. However, it is likely that these mediating factors vary across different settings in sub-Saharan Africa, thereby resulting in the discrepancy in the female employment-fertility relationship in this region (Beguy, 2009).

The maternal role incompatibility hypothesis in socio-demographic literature attempts to explain the work-fertility relationship. Unlike the economic approach, the socio-demographic approach does not focus on female wages, which represent the opportunity cost of childbearing, as a determinant of fertility (Beguy, 2009). Rather, this approach argues that an inverse relationship exists between female employment and fertility owing to the assumed conflict between women's work and their reproductive roles (Standing, 1983). Conflict between the roles of mother and worker is understood to originate from concurrent demands of the home and workplace, the nature of employment and social norms regarding the roles of men and women (Beguy, 2009). There are certain circumstances under which this conflict can be attenuated. For instance, some jobs have characteristics that allow for simultaneous fulfilment of worker and mother roles, hence reducing incompatibility between the two. For example, women occupied in agriculture and working at home are largely able to combine their working and mothering roles. These women are more likely to have higher fertility. For women working predominantly outside the home, particularly in the modern sector, it is more difficult to combine parenting and worker roles (Beguy, 2009). These types of jobs are therefore conducive to small family size.

The availability and low cost of domestic help or parental surrogates (grandparents, cousins, older children) is another factor that could attenuate the conflict between work and childbearing, allowing women to fulfill both roles and thereby resulting in higher fertility (Blau & Robins, 1989; Rindfuss & Brewster, 1996). The traditional social norms regarding gender roles and the division of household duties between men and women could also affect the relationship between female employment and fertility (Beguy, 2009). In many societies, such norms assign to women the role of rearing children, while men have the responsibility to take care of the household by working and providing revenue. When prevailing, these social norms can alter women's aspirations and attitudes towards work outside the home. Negative attitudes towards work outside the home could reduce a woman's employment chances or predispose her towards a job that is more compatible with her maternal responsibilities. Traditional women favour the mother-and-wife role, resulting in large family sizes, while modern women favour professional life and are therefore more likely to have lower fertility levels. These conditions, which prevail generally in developing countries have led to the assumption that no or weak relationship should exist between labour force status and fertility. This could be true in rural settings in developing countries only, where such conditions are more likely to prevail. By contrast, urban areas offer opportunities to women to be involved in paid, non-agricultural work outside the home and to have aspirations more favourable to paid work.

4. Data

This analysis used data from the Malawi Demographic and Health Survey (MDHS) conducted from October 2015 to February 2016 by the Malawi National Statistics Office (NSO). At the time of conducting this study, the 2015/16 MDHS was the most recent nationally representative household survey covering a sample of 26,361 households; 24,562 female and 7,478 male respondents. The survey collected detailed information on topics including demographic characteristics of the population, education, health, occupation of household members, household income and marital status among others. Similar to Bbaale (2014), a wealth index was constructed by combining information on household assets, such as ownership of consumer items, type of dwelling, source of water, and availability of electricity into a single asset index. The sample is divided into five equal quintiles from 1 representing the lowest or poorest segment to 5 representing the highest or richest segment. The poorest quintile is used as the base category in the estimations where the wealth index is used.

5. Trends in Malawi's fertility rates

In the 36-year period between 1980 and 2016, Malawi's TFR declined from 7.6 children per woman to 4.4 and was marginally below the Sub-Saharan Africa average of 4.8 children per woman but still significantly higher than the world average of 2.4 (World Bank, 2017). In the period between 2006 and 2016, Malawi's population grew rapidly at an average of 2.8% per annum reaching 17.2 million people in 2016 (World Bank, 2017). The country's population is youthful and predominantly rural based; 45% of the population is below the age of 15 and 81% of the population lives in rural areas (NSO 2017). The youthfulness of Malawi's population carries a demographic momentum toward further population growth. Teenage childbearing generally declined between 1992 (35%) and 2010 (26%) before increasing slightly in 2016 (29%). In rural areas, 31% of women aged 15-19 have begun childbearing, compared with 21% in urban areas (NSO, 2017). This descriptive evidence that Malawian women start giving birth at early ages is important for policy and actions to reduce fertility. It implies that female education and campaigns that are intended to keep girls in school could play an important role in reducing fertility. Malawi instituted a Universal (Free) Primary Education (UPE) programme, which aimed to provide an avenue to keep girls in school.

Until the 1980s, family planning in Malawi was banned under the one-party system regime. The idea of limiting births was slow to catch on, in a traditionally conservative society that saw promotion of family planning as foreign influence and opted to defend cultural values of large families (Chimbwete *et al.* 2005; Solo *et al.*, 2005). Family planning was forbidden and "child-spacing" was preferred as an integral part of the maternal and child health program in the 1980s, which acknowledged the health problems a woman faced when pregnancies were too early, too many, too late, and too frequent (Solo *et al.*, 2005; Chintsanya, 2013).

The advent of a multiparty system in Malawi in 1994 ushered in a new environment in which family planning programs could be implemented. While levels of use of modern contraceptive methods (oral pills, condoms, intrauterine devices, sterilization, implants, and injectables) have traditionally been low in sub-Saharan Africa, modern contraceptive use increased dramatically in Malawi in the 24-year period between 1992 and 2016 rising from 7% to 58%. (NSO, 2017).

While access to family planning is critical for keeping population growth at sustainable levels and also important to the reduction of poverty, several barriers hinder contraceptive access in Malawi. Most people live in rural areas, and these are the least served by health centres. Gender inequity remains pervasive, especially in the rural areas, where traditional values are strong and gender inequality practices such as support for early marriage of girls, polygamy, and widow inheritance make women less autonomous (Matinga and McConville 2002; Chintsanya, 2013). Such an environment impedes women's greater say in decision-making in general, and particularly concerning their own reproductive health.

6. Theoretical framework

This study adopts the one-period static life cycle model previously applied by McCabe and Rozenzweig (1976), Ben-Porath (1973), Willis (1973) and Sackey (2005) when examining the various dimensions of fertility and labour force participation. The model defines a woman's utility as a function of the number of children (c), which has been adjusted for quality, consumption of market goods (x), leisure (v) and taste (t) (i.e. $U = U[c, x, v, t]$). The woman is assumed to maximize a well-behaved twice-differentiable utility function subject to a time allocation constraint and an income budget constraint.

Theory indicates that lifetime demand for births is predicated on various socioeconomic factors. Notable among the factors affecting fertility are the woman's productive opportunities (which could be perceived as being primarily determined by her educational attainment), her households non-human capital assets, the survival rate of her children and her social environment (i.e. locality, and religion) (Sackey, 2005). Increases in the schooling of women enhances their probability of participating in the labour market only if the schooling causes a larger increase in their market wage than in their reservation wage (Lam & Duryea, 1999). The decision to participate reflects a comparison between gains from the market earnings and the opportunity costs in terms of forgone household production in childcare and in other activities for a given level of household income from all other sources.

7. Methodology and models for estimation

The analysis and models used in this study are based on the neoclassical labour supply model of labour-leisure choice (Abbott & Ashenfelter, 1976) and household production theory (Becker, 1965). The neoclassical model, which is an extension of the fertility maximization problem of consumer theory, analyses how individuals make choices in deciding how they will spend a fixed amount of time. In the model, an individual has two uses of their time; either working in the labour market at a real wage rate of W per hour or enjoying leisure (Baah-Boateng et al., 2013). According to this model, individuals wish to maximize their utility by purchasing consumption goods in the marketplace and by consuming time in leisure activities, conditional on individual's market wage, personal preferences and non-labour income. This study uses this model to explain family-size decisions. Households could be perceived to maximize their welfare by making choices between having children and other consumption goods. In this case, children are treated as a special type of good from which utility is derived and the cost of which is the time required to raise them.

To achieve the objectives of this study, approaches by Sackey (2005) and Bbaale (2009) were followed, whereby the reduced form specifications for female labour force participation and fertility were estimated. It is assumed that the covariates are exogenous and also that the error

term, which captures all unobserved variables, is uncorrelated with any of the right-hand-side variables. Since the reduced form equations have no inherent simultaneity, they do not violate the classical assumption of non-correlation between explanatory variables and the stochastic term.

First, a model of labour force participation is estimated using a probit model with the aim to establish what factors explain women's decisions to participate in the labour market. Of particular interest is the role played by educational attainment. The coefficients obtained in our probit estimation would only serve to provide a sense of the direction of the effects of the covariates on participation in the labour market and cannot be used for magnitude of impact analysis. The marginal impact of these right-hand-side variables on the probability of participation is calculated to examine the magnitude of impact. The estimated model has the following form:

$$Y_i^* = X_i\beta + \mu_i, \quad \forall i = 1, \dots, n \quad (1)$$

$$Y_i = \begin{cases} 1: \text{if } Y_i^* \\ 0: \text{otherwise} \end{cases} \quad (2)$$

Where Y_i is a binary response variable of the i^{th} woman determined by the underlying latent variable Y_i^* . This takes on a value of 1 if the i^{th} woman participated in the labour force in the year of the survey and is equal to zero otherwise. X_i is a row vector of explanatory variables, while β is a vector of unknown parameters to be estimated and μ_i is the error term. In estimating the empirical probit model, labour force participation (LFP) will take the form:

$$LFP = f(MED, BIR, WEA, LOC, REL, FED) \quad (3)$$

Where $LFP, MED, BIR, WEA, LOC, REL, FED$ are the probability of female labour force participation, mothers level of schooling completed, birth cohort dummies, wealth status (measured by wealth quintiles), locality, religion and fathers education level respectively.

Following Bbaale (2009), Duryea and Lam (1999) and Ainsworth (1996), fertility is defined as a cumulative outcome and a fertility choice model is estimated. Variables for number of children born by age 20, 25 and 30 respectively, were created using birth histories of live births before the woman reached 20, 25 and 30 from the DHS. Regressors in this model include mother's education, father's education and education dummies for the birth year cohort. Ordinary Least Squares is used to estimate the reduced form equation with the fertility model specification taking the form:

$$CMF = f(MED, BIR, LOC, REL, FED) \quad (4)$$

where $CMF, MED, BIR, REG, REL, FED$ are cumulative fertility, woman's level of schooling completed, birth cohort dummies, locality, religion and father's education level, respectively.

8. Results and interpretation

This section presents results of estimations of a probit model where output was obtained related to the marginal impact of a woman's education level, marital status, age, residence, wealth status, religion and husband's education on her participation in the labour force. The section also presents OLS estimation results for total and cumulative fertility regression models. These are detailed in the sections below.

8.1. Results from probit model on female labour force participation

The marginal impact of respective right-hand-side variables on the probability of participation by women is shown in Table 2. The results confirm that women's education plays an important role in their labour force participation, which from the literature has important implications for fertility. Women with a primary school level of education and those with a secondary level are about 5% and 7%, respectively, more likely to be working (significant at 5% level) compared to those with no education at all (Table 2). Among the married, women with a post-secondary school education are about 10% more likely to be working compared to the uneducated. This is in line with theoretical expectations and attests to the fact that schooling in general and higher levels in particular increase the opportunity cost of women's time in household production. Through education, human capital of women becomes enhanced, thus increasing their employability.

Table 2: Female labour force participation

Variable	All women	Married women
<i>Dependent variable is currently working women</i>		
Woman's education		
Primary	0.053** [2.51]	0.036* [1.80]
Secondary	0.068** [2.63]	0.008 [0.42]
Post-secondary	0.029 [1.41]	0.098*** [3.01]
Partner's education		
Primary		0.077** [2.90]
Secondary		0.081*** [2.98]
Post-secondary		0.075* [1.94]
Age cohort		
20-24 years	0.104*** [10.81]	0.058** [2.42]
25-29 years	0.149*** [15.74]	0.105*** [4.31]
30-34 years	0.154*** [13.29]	0.109*** [4.55]
35-39 years	0.152*** [13.83]	0.121*** [5.27]
40-44 years	0.148*** [13.04]	0.113*** [4.72]
45-49 years	0.144*** [11.22]	0.122*** [5.27]

Variable	All women	Married women
Locality		
Rural resident	0.059*** [4.82]	0.129*** [5.44]
Religious affiliation		
Protestant	-0.009 [1.17]	0.004 [0.15]
Muslim	-0.011 [1.23]	-0.015 [0.27]
Other faith	0.012 [1.08]	-0.009 [0.22]
Wealth quintile		
Poorer	-0.054*** [3.62]	-0.041 [1.20]
Middle	-0.109*** [5.54]	-0.083** [2.33]
Rich	-0.137*** [7.41]	-0.117*** [3.41]
Richest	-0.172*** [8.44]	-0.155*** [4.36]
Observations	3,760	1,219
Pseudo R-squared	0.19	0.18

Absolute value of z statistics in parentheses: * Significant at 10%; ** Significant at 5%; * Significant at 1%.**

The results show the partner's education (at all levels) tends to have a significant positive effect on the probability of female labour force participation. Women whose partners have primary, secondary and post-secondary school education are about 8% more likely to be working compared to those whose partners have no education. The impact of age cohort on women's participation in the labour force is generally the same, ranging between 14-15% (except for the age cohort 20-24 years, which is 10% - some of whom are expected to still be in school) compared to the age cohort 15-19 years.

Women residing in rural areas are 6% more likely to be currently working compared to those in urban areas. For married women, the probability is even higher (13%) than that of unmarried women.

Women in poor households are more likely to be working compared to those in relatively richer households. Women in the second to the fifth wealth quintiles are 5-17% less likely to be working compared to those in the poorest quintile. Apart from those in the poorer quintile, the scenario is almost the same when comparing married with unmarried women.

8.2. Determinants of total and cumulative fertility

To understand the fertility behaviour of younger (married and unmarried) women in Malawi, Table 3 present the OLS regression results from the reduced form fertility model for determinants of fertility using the number of children ever born as the dependent variable. Table 4 presents evidence on the determinants of cumulative fertility by age 20, 25 and 30. It is observed from Table 3 that an inverse relationship is implied between education and fertility from the negative and significant coefficients on women's schooling levels. In particular, women's post-primary education reduces fertility in a significant manner. This suggests that efforts to improve access to education beyond the primary school level needs to be strengthened. The model suggests that relative to no schooling, completion of post-primary level leads every 10 women to have on average between 4 to 11 fewer children (Table 3). For all women, by age 20, 25 and 30 (cumulative fertility), every 10 women with at least secondary education will, on average, have 2 to 13 fewer children than those with no education at all (Table 4).

For married women, the husband's post-primary schooling reinforces the tendency towards reduced fertility. Yet, partners' secondary and post-secondary school education has limited impact on fertility given the statistical insignificance of the coefficients. The results indicate the male partners' primary education raises fertility compared to those without any education. This may be explained by those with at least primary education being able to earn higher incomes compared to those with no education and this may influence higher fertility.

Table 3: Determinants of fertility

Variable	All women	Married women	Married by age 20	Married by age 25
<i>Dependent variable is currently working women</i>				
Woman's education				
Primary	-0.136*** [2.64]	0.006 [0.007]	-0.341*** [5.03]	-0.470*** [5.59]
Secondary	-0.779*** [10.41]	-0.637*** [5.81]	-0.436*** [5.17]	-0.522*** [5.63]
Post-secondary	-1.044*** [16.54]	-1.030*** [10.43]	-1.127*** [8.98]	-0.775*** [6.92]
Partner's education				
Primary		0.286*** [4.03]		
Secondary		-0.041 [0.36]		
Post-secondary		-0.044 [0.38]		
Age cohort				
20-24 years	1.340*** [21.09]	1.205*** [9.90]		
25-29 years	2.815*** [46.18]	2.054*** [19.59]	1.749*** [22.77]	
30-34 years	3.679*** [61.04]	3.381*** [29.78]	2.460*** [29.51]	2.181*** [19.67]
35-39 years	4.228*** [65.19]	4.316*** [37.11]	3.482*** [37.85]	3.263*** [25.49]
40-44 years	4.860*** [70.01]	4.418*** [38.14]	4.036*** [47.92]	3.669*** [28.75]
45-49 years	5.402***	5.313***	4.114***	3.803***

Variable	All women	Married women	Married by age 20	Married by age 25
	[73.68]	[44.87]	[40.70]	[26.34]
Locality				
Rural resident	0.547*** [8.33]	0.404*** [5.30]	0.245*** [4.33]	0.120** [2.18]
Religious affiliation				
Protestant	0.040 [1.19]	0.034 [0.84]	0.019 [0.37]	0.038 [0.92]
Muslim	0.061 [1.32]	0.063 [1.28]	0.049 [0.50]	0.004 [0.03]
Other faith	0.027 [0.31]	0.002 [0.02]	0.019 [0.024]	0.046 [0.78]
Observations	3,760	2,358	1,512	1,015
Pseudo R-squared	0.65	0.57	0.70	0.63

Absolute value of t statistics in parentheses: * Significant at 10%; ** Significant at 5%; * Significant at 1%.**

Table 4: Determinants of cumulative fertility by ages 20, 25 and 30.

	All women			Married women		
	By age 20	By age 25	By age 30	By age 20	By age 25	By age 30
<i>Dependent variable is currently working women</i>						
Woman's education						
Primary	0.058** [2.30]	0.180*** [5.03]	0.219*** [3.73]	0.054 [1.32]	0.192** [2.67]	0.218** [2.31]
Secondary	-0.383*** [8.81]	-0.317** [2.92]	-0.205* [1.90]	-0.266** [2.87]	-0.317** [2.72]	-0.195 [1.09]
Post-secondary	-0.785*** [12.17]	-1.303*** [10.34]	-1.299*** [6.83]	-0.884*** [7.80]	-1.309** [6.75]	-1.255** [3.09]
Partner's education						
Primary				0.133*** [2.90]	0.199 [2.23]**	0.202* [1.90]
Secondary				0.124** [2.13]	0.289** [2.06]	0.235 [1.49]
Post-secondary				0.136 [1.42]	0.196 [1.38]	0.271 [1.55]
Age cohort						

	All women			Married women		
	By age 20	By age 25	By age 30	By age 20	By age 25	By age 30
25-29 years	0.028 [0.97]			-0.127** [3.14]		
30-34 years	0.071** [1.97]	0.008 [0.19]		-0.067 [1.02]	0.004 [0.07]	
35-39 years	-0.055 [1.48]	-1.529*** [3.72]	-0.187*** [2.70]	-0.206*** [3.66]	-0.157** [2.11]	-0.209* [1.89]
40-44 years	-0.149*** [4.01]	-0.364*** [5.99]	-0.377*** [4.11]	-0.309*** [5.02]	-0.425*** [4.60]	-0.399*** [3.40]
45-49 years	-0.133*** [3.05]	-0.401*** [6.08]	-0.492*** [5.12]	-0.345*** [5.22]	-0.471*** [4.79]	-0.555*** [4.88]
Locality						
Rural resident	0.086*** [2.89]	0.235*** [3.93]	0.362*** [3.99]	0.131*** [3.00]	0.244*** [2.72]	0.388*** [3.07]
Religious affiliation						
Protestant	0.030 [1.11]	0.056 [0.80]	0.077 [0.96]	0.068 [0.84]	0.085 [1.29]	0.089 [1.35]
Muslim	0.112 [1.22]	0.104 [1.01]	0.109 [1.13]	0.117 [1.25]	0.133 [1.27]	0.128 [1.16]
Other faith	-0.003 [0.12]	0.007 [0.11]	0.010 [0.12]	0.034 [0.70]	0.94 [1.02]	0.108 [1.00]

	All women			Married women		
	By age 20	By age 25	By age 30	By age 20	By age 25	By age 30
Constant	1.121*** [23.02]	2.503*** [31.24]	4.110*** [30.19]	1.076*** [13.44]	2.191*** [16.62]	4.002*** [16.71]
Observations	2,901	2,170	1,548	1,154	916	650
Pseudo R-squared	0.11	0.13	0.10	0.12	0.16	0.12

Absolute value of t statistics in parentheses: * Significant at 10%; ** Significant at 5%; * Significant at 1%.**

As expected, the average number of children ever born, is positively related to age, so that as one moves from younger age cohorts to older ones, the number of children born increases accordingly. It is noted that fertility among all women in the age cohort 20-24 years is, on average, about 1.3 children higher than those in the age cohort 15-19 years, while fertility in the age cohort 45-49 is approximately 5 children higher compared to the base age cohort category. The same trend is portrayed for married women (Table 3).

The estimation results show that on average, women living in rural areas are likelier to have more children than those in urban areas. Other factors held constant, every 10 women, married and unmarried, residing in rural areas has on average 5 children more than women residing in urban areas. Regarding cumulative fertility by age 20, 25 and 30, every 10 women, married and unmarried, on average has 1, 2 and 4 children respectively more than those in urban areas. This finding is similar to that of married women (Table 4). In rural areas there seems to be relatively less conflict between women's role as a caregiver and that of labour market participant because some forms of rural work allow supervision of children. For example, it is not uncommon to find rural women taking their children to the farm (Sackey, 2005).

9. Conclusion

This study used data from the 2015/16 Malawi Demographic and Health Survey to examine the relationships between female education, labour force participation and fertility rates for Malawi. This was conducted against the hypothesis that female education leads to higher labour force participation, which in turn leads to higher opportunity costs of time, leading to lower fertility rate.

The study reconfirms that female education attainments matter. Based on the probit model on female labour force participation, the study shows that education of women exerts a positive impact on their participation in the labour market. The opposite obtains in the fertility models, where education results in a reduction in the number of children ever born to a woman. These results have important policy implications. It can be argued that providing women with education would be a useful investment and a good mechanism for the realization of their empowerment. With enhancement in their human capital, they will be better equipped to participate in a more productive way in the labour market. The implication of this is that as more females get educated and acquire more skills, they will increase their employability in the formal labour market, with favourable impacts on their perceptions of ideal family size and fertility preference. It is important, however, to ensure that the educational gains are sustained.

The findings from this study also have important implications for improving the quality of life of Malawian women and their children through a number of policy actions. Policies to reduce fertility can play both direct and indirect roles in enhancing maternal and child mortality reductions. When women give birth to fewer children, it reduces their exposure to the risks of childbirth, particularly in rural areas where health and maternal care services are poor or non-existent. Having fewer children also implies that family income is shared among a few heads. With fewer children born, parents are likelier to provide adequate care, thus ensuring better chances of child survival and greater attention to early childhood development requirements.

The findings of the study suggest that efforts to reduce fertility need to target measures that aim to educate women beyond primary school level. A well-planned and adequately resourced Government programme to extend free education to the secondary school level could therefore potentially be an important measure that may help to reduce fertility. To succeed, this would

need to be embraced by all stakeholders and actively campaigned to encourage girls to remain in school beyond the primary school level. Measures should be strengthened to remove or at least to minimize factors that influence high dropout rates among girls in school. This could include improving the quality of schools and teaching and ensuring that all schools have separate sanitary facilities for girls and boys.

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