ACADEMIC ACHIEVEMENT IN PUBLIC AND PRIVATE PRIMARY SCHOOLS IN KENYA

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THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN ECONOMICS OF THE UNIVERSITY OF NAIROBI

2019

DECLARATION

This thesis is my original work and has not been presented for award of a degree in any other university.

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DEDICATION

To my parents, Stanley Ng'ang'a Kibuthi and Grace Wanjiru Ng'ang'a, and to my baby girl Thea Chege.

ACKNOWLEDGEMENTS

I am indeed grateful to my thesis supervisors, Professor Anthony Wambugu and Professor Leopold P. Mureithi, who worked hand in hand with me to produce this thesis. Thank you very much for your advice, support, time, tireless effort and patiently guiding me through the research process.

This thesis also benefited from constructive comments from Professor Damiano Kulundu, Professor Germano Mwabu, and Dr Kamau Gathiaka, to whom I am extremely grateful. I am also grateful to the University of Nairobi, School of Economics. I benefited immensely from the University's personnel and facilities.

I also extend my gratitude to my family. I thank my parents, my ultimate role models, whose guidance has been immense in all my endeavours. My sisters, Njambi, Njeri and Kabura, you always encouraged me to do more and, as the first born in the family, I have no choice but do so in order to be a role model to all of you. My baby girl Thea, you have been a good girl, you provided unending inspiration. My friend, Roger (Baba Thea) thank you for your support and encouragement. As a family, your prayers, moral support and encouragement are most appreciated.

My PhD classmate Laura, thank you for your friendship and support throughout the PhD study period.

God bless you all.

I am, however, solely responsible for any errors in this thesis.

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LIST OF ABBREVIATIONS AND ACRONYMS

2SLS	Two-stage Least Squares
2SRI	Two-stage Residual Inclusion
DID	Difference in Difference
EAC	East African Community
EFA	Education for All
FPE	Free Primary Education
GER	Gross Enrollment Ratio
GOK	Government of Kenya
GPA	Grade Point Average
IV	Instrumental Variables
KCPE	Kenya Certificate of Primary Education
KNEC	Kenya National Examinations Council
MDGs	Millennium Development Goals
NER	Net Enrollment Ratio
NGO	Non-Governmental Organization
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Squares
SACMEQ	Southern and Eastern Africa Consortium for Monitoring Education Quality
SDGs	Sustainable Development Goals

SES	Socio-Economic Status
STEM	Science, Technology, Engineering and Mathematics
USA	United States of America

OPERATIONAL DEFINITION OF TERMS

Cognitive skills: The ability to perform the various learning and problem-solving tasks, including reading and mathematics problem solving skills.

Enrolment in primary education/Access to primary education: Total number of pupils enrolled in primary schools irrespective of age**.**

Official primary school age: The official lower limit of primary school age is six (6) years while the upper limit is seventeen (17) years.

Gross Enrollment Ratio (GER): Total enrollment in primary schools as a percentage of the total children of official primary school age population.

Net Enrollment Ratio (NER): Number of children of official school age enrolled in primary school as a percentage of the total children of official primary school age population.

Primary school completion rate: Total number of entrants in the last grade of primary education minus repeaters in that grade, expressed as percentage of the total population of the official graduation age.

Pupil: A person who attends primary school.

Educational resources: Inputs and characteristics useful in the production of cognitive skills. They include pupils' characteristics, school characteristics and family socio-economic indicators.

Abstract

Education is a component of human capital. In Kenya, primary education is provided by both the government and the private sector. Private school pupils consistently attain higher test scores than public school pupils, indicating differences in the contribution of the two sectors in the accumulation of human capital. More than 90% of all primary school pupils are enrolled in public schools. The private-public primary schools' academic achievement (test scores) gap indicates inequalities in education attainment. This study analyzed academic achievement in public and private primary schools in Kenya using the Southern and Eastern Africa Consortium for Monitoring Education Quality (SACMEQ) cross-sectional data set of measurements of academic achievement of class six pupils in Kenya. The first essay investigated whether or not attending either a private or a public primary school leads to higher test scores. The control function approach was used to control for potential endogeneity of the school type in the education production function. The empirical evidence suggests that private school attendance has positive significant correlation with both reading and mathematics test scores. Higher quality school infrastructure and small class sizes are associated with higher test scores. The second essay decomposed the gender test score gap in mathematics in public and private primary schools using the Blinder-Oaxaca approach. Boys outperform girls in mathematics in both school types. On average, a boy scores 3.44 and 2.81 percentage points higher than a girl in a private and public primary school, respectively. In both school types, boys take better advantage of the resources more than girls, hence the girls' score can be improved by better utilization of education resources. There are significant differences in educational resources between boys and girls in favour of girls who perform worse than boys. Thus, resource-based policies aimed at increasing girls' mathematics scores may not necessarily close the gender gap, and may reverse the gender gap and disadvantage the boys. The third essay investigated whether or not the relationship between academic achievement and its covariates differs across the conditional test score distribution. The quantile regression results show that the positive association of the private school and test scores increases with the academic strength of the pupils. Further, academically strong pupils are more likely than the academically weak pupils to be enrolled in private schools. Thus, government policies to improve public primary schools can improve academic achievement of academically weak pupils.

Key words: academic achievement, education resources, gender gaps, quantile regression, school type.

CHAPTER ONE: INTRODUCTION

1.1 Context

Education is a main component of human capital development. Schultz (1961) defines human capital as the required and useful abilities of the people in a country and asserts that education and health are the key human capital investments. Becker (1962) defines human capital as the physical and mental ability to increase a person's future income, which is enhanced through schooling, on-job training and medical care.

Human capital influences a country's socio-economic outcomes. Education of women tends to lower fertility rate (Barro, 2001), mortality rate (Tamura, 2006) and is the main source of growth of labour productivity and earnings (Mincer, 1970; Oketch, 2006; Syverson, 2011). The economic performance of a country can be enhanced by improving the quality of education (Hanushek, 2013; Hanushek and Woessmann, 2012). Consequently, policies to promote increased growth and development should include elements to promote skills development through investment in quality education.

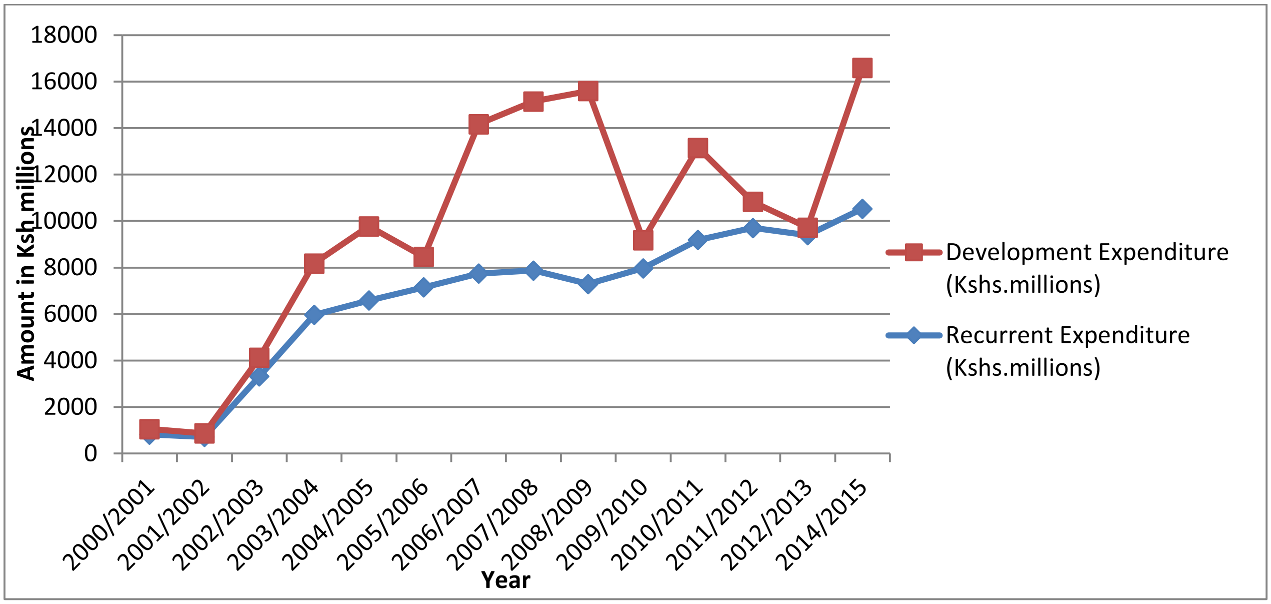
Kenya has shown commitment towards provision of education to her citizens. First, Article 53 of the Constitution of Kenya asserts that free and compulsory basic education is a basic right (Republic of Kenya, 2010). Second, Kenya is a signatory to international agreements such as Education for All (EFA) that emerged out of the Dakar framework for Action 2000, which committed countries to achieve Education for All by 2015 (UNESCO, 2000). Third, Kenya introduced Free Primary Education (FPE) in 2003, which was a major step towards achieving the second Millennium Development Goal (MDG) of achieving universal primary education (Republic of Kenya, 2013). Fourth, the objective of the social pillar of the Kenya Vision 2030 is to invest in the citizens of Kenya in order to improve the quality of life through education and training (Republic of Kenya, 2007). Finally, Kenya signed the Sustainable Development Goals (SDGs) that emphasize the provision of inclusive and quality education (Republic of Kenya, 2015).

Primary school education is the first phase of the 8-4-4 (8 years of primary; 4 years of secondary; and 4 years of university) education system in Kenya. The curriculum for primary and secondary education designed in 1981 ushered the 8-4-4 system and its implementation started in primary schools in 1985, followed by a review in 2003 (Republic of Kenya, 2016). Several changes at the national and international level made it necessary for Kenya to reform her education system and curricula. These include the development of the Kenya Vision 2030 in 2007; promulgation of the Kenya Constitution in 2010; the development of the EAC Harmonization of Curriculum Framework in 2014; and the adoption of SDGs in 2015, and specifically SDG Number 4 on Quality Education. The Kenya Institute of Curriculum Development (KICD) conducted a national needs assessment survey in 2016, and the findings have been used to conceptualize curriculum reforms with far reaching implications on Kenya's education system at all levels. The curriculum was piloted in 2017 followed by a national roll-out for grades 1, 2 and 3 in January 2019. Among the key reforms are changing the structure of education from 8-4-4 to 2-6-6-3 (2 years of pre-primary; 6 years of primary; 6 years of secondary; and 3 years of university education) (Republic of Kenya, 2016).

The official primary school age is between 6-17 years (Republic of Kenya, 2012[a]). However, under the FPE, pupils above 17 years of age can access primary education. Five subjects, namely Mathematics, English, Kiswahili, Social Studies and Science and Agriculture are taught and examined. Under the 8-4-4 curriculum, completion of primary school education level is marked by the national examination, the Kenya Certificate of Primary Education (KCPE). Academic achievement measured by KCPE test scores attained determine progression to secondary education.

Under FPE policy, the government increased funding to the education sector. Public primary schools receive a capitation of Ksh 1,420 per enrolled pupil per year for learning materials such as books and repair of school facilities (Republic of Kenya, 2017). In addition, the government has been financing school infrastructure (Republic of Kenya, *various issues*). Recurrent and development expenditure increased by 80% in 2002/2003 and 178% in the year 2003/2004 (Figure 1). Before FPE, school fees covered recurrent costs such as of books, teaching materials such as chalk, and school infrastructure maintenance.

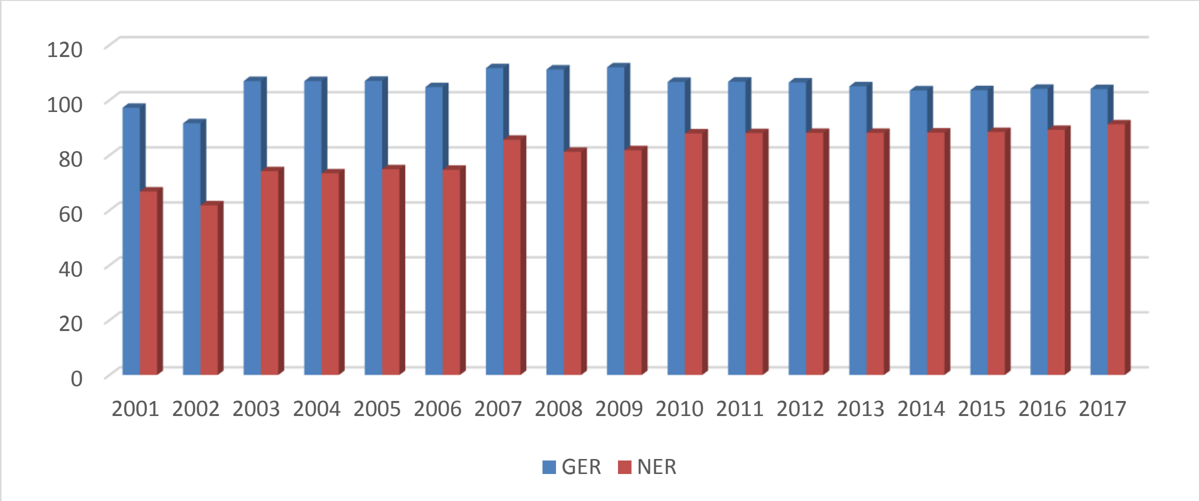
Figure 1: Government expenditure on primary education, (Ksh million), 2000-2015



Source: Republic of Kenya (Various issues)

Primary school enrolment increased after the introduction of FPE as Figure 2 shows. Gross enrolment ratio (GER) increased from 88.2% to 108% while Net Enrolment Ratio (NER) increased from 61% to 78% between the years 2002 and 2003. If GER is above 100%, it means that some learners are above or below the primary school age while a NER below 100% indicates that some pupils of primary school age are not enrolled (Ministry of Education, 2014). The increase in enrolment resulted from increased enrolment in both public and private primary schools (Bold, Kimenyi, Mwabu and Sandefur, 2011; Sawamura and Sifuna, 2008).

Figure 2: Primary schools GER and NER, 2001-2017



Source: Republic of Kenya (Various issues)

There are, however, apparent differences in the contribution of private and public primary schools in the accumulation of human capital. This is observed in the difference in academic achievement between public and private schools (KNEC, 2017; Uwezo, 2014). Pupils in private primary schools consistently achieve higher KCPE scores than pupils in public primary schools. Out of a total 500 marks, average KCPE score is higher in private schools than in public schools (Table 1). This may be as a result of private primary schools being more effective in developing human capital than primary public schools or due to endogenous sorting of pupils in the two school types.

Table 1: Average KCPE examination scores in public and private primary schools

Year	Public schools	Private schools
2013	241.4	287.58
2014	240.62	287.20
2015	239.12	292.49
2016	241.42	284.42

Source: Kenya National Examination Council (2017)

In addition to increasing overall access to basic education, FPE has been associated with improved access to education by girls. This indicates success of interventions to attain gender parity in access to basic education (Karogo, Kawira, Kipchirchir, Matei and Omunyang'oli, 2016). The gender composition in primary schools changed from 48% girls and 52% boys in 2010 to 49.7% boys and 50.3% girls in 2016.

However, while gender disparities in access to primary education have reduced, there are still gender differences in academic achievement. This is specifically in mathematics where boys outperform the girls (KNEC, 2018; Wasanga, Ogle and Wambua, 2011). Thus, the formulation of the National Education Sector Plan (NESP) 2013-2018 with an aim to eliminate gender disparities in education (Republic of Kenya, 2012[b]). Further, there are differences in achievement across the distribution of scores where some pupils are academically strong while others are academically weak (KNEC, 2018). An all-inclusive education should aim at closing these gaps. Any disparities in access to education and in education achievement should be addressed (Ministry of Education, Science and Technology, 2015).

1.2 Research Problem

Although introduction of FPE in 2003 in Kenya increased access to primary education, it has not translated to more learning (Jones, Rajani, Ruto and Schipper, 2014). Further, average examination scores in public primary schools are lower than in private primary schools (KNEC, 2017; Uwezo, 2014). This difference in examination scores between the two school types is worrying, since more than 90% of all primary school pupils in Kenya are enrolled in public schools. The relatively low examination performance is attributed to strained resources in public primary schools after the introduction of FPE (Manda and Mwakubo, 2013 and Sawamura and Sifuna, 2008). In addition to public-private schools performance gaps, gender gaps in examination scores have persisted (Republic of Kenya, various issues).

The existing studies on the effect of school type on academic achievement (Aslam, 2009[b]; Goyal, 2009; McEwan, 2001; Newhouse and Beegle, 2006) found contradicting results on relative effectiveness of public and private schools. This suggests that the results are country-specific. In Kenya, despite the expansion of the private schools' sector and increased enrolment in public schools, no study has examined relative performance using nation-wide data. Several studies have focused on the effect of educational resources on academic achievement (Bold, Kimenyi, Mwabu, Ng'ang'a and Sandefur, 2013; Case and Deaton, 1999; Duflo, Dupas, and Kremer, 2007a; Hanushek, 2003). However, the focus of the studies on Kenya (Bold et al., 2013; Duflo et al., 2007a) is on public primary schools only. Thus, in Kenya, it is not known whether there is an association between private primary school attendance and test scores or whether the existing differences in test scores between private and public school pupils can be fully attributed to differences in access to educational resources.

Further, the existing studies mainly examine the relationship between educational resources and test scores at the mean of test score distribution. This leaves the question of whether the relationship differs across the test score distribution. That is, whether low performing pupils benefit from educational resources as much as other pupils. Empirical evidence on this issue from other countries, for example Eide and Showalter (1998) and Costanzo and Desimino (2017) show that the effect of resources, and test score gaps between different groups of pupils can vary across the achievement distribution.

Further, the importance of science, technology, engineering and mathematics (STEM) subjects in the growth of an economy has led to affirmative action to reduce gender academic achievement gap in STEM. A few studies have examined gender gaps in academic achievement (Asadullah and Chaudhury, 2009; Golsteyn and Schils, 2014; Dickerson, McIntosh and Valente, 2015; Rodríguez-Planasa and Nollenbergerb, 2018). However, none of the existing studies has investigated the sources of the gender gap in mathematics scores to distinguish what proportion of the gap is explained by the difference in resource endowments between boys and girls, and the proportion resulting from the difference between how boys and girls utilize the available resources.

When the academic achievement gaps are left unresolved, it leads to low education achievement by some groups. This is a burden both to the households and the economy (Klasen, 2002) and lowers the relative wage at the labour market entry level (Maurin and Xenogiani, 2007). At the macro level, Hanushek and Kimko (2000) suggest that improvement in the quality of education boosts economic growth. Moreover, gender gaps in education achievement are a source of inequality and inefficiency in the society (Kingdon, 2002) and adversely affect economic growth by lowering the average level of human capital (Klasen, 2002).

1.3 Research Questions

This study addressed the following questions regarding education achievement in private and public primary schools in Kenya:

(i) Does school type explain test scores of primary school standard six children in Kenya?

(ii) What factors contribute to the gender test score gap in mathematics of primary school standard six pupils in Kenya?

(iii) Is the effect of school type and educational resources on test scores heterogeneous across the conditional distribution of mathematics and reading tests scores?

1.4 Research Objectives

This study analyzes academic achievement in private and public primary schools in Kenya. The specific objectives of the study are:

(i) To estimate the relationship between school type and test scores of primary school children in Kenya.

(ii) To estimate and decompose the gender mathematics test score gap in public and private primary schools in Kenya.

(iii) To estimate the relationship between school type and educational resources and academic achievement across the conditional test score distribution.

(iv) To draw implications for education policy in Kenya.

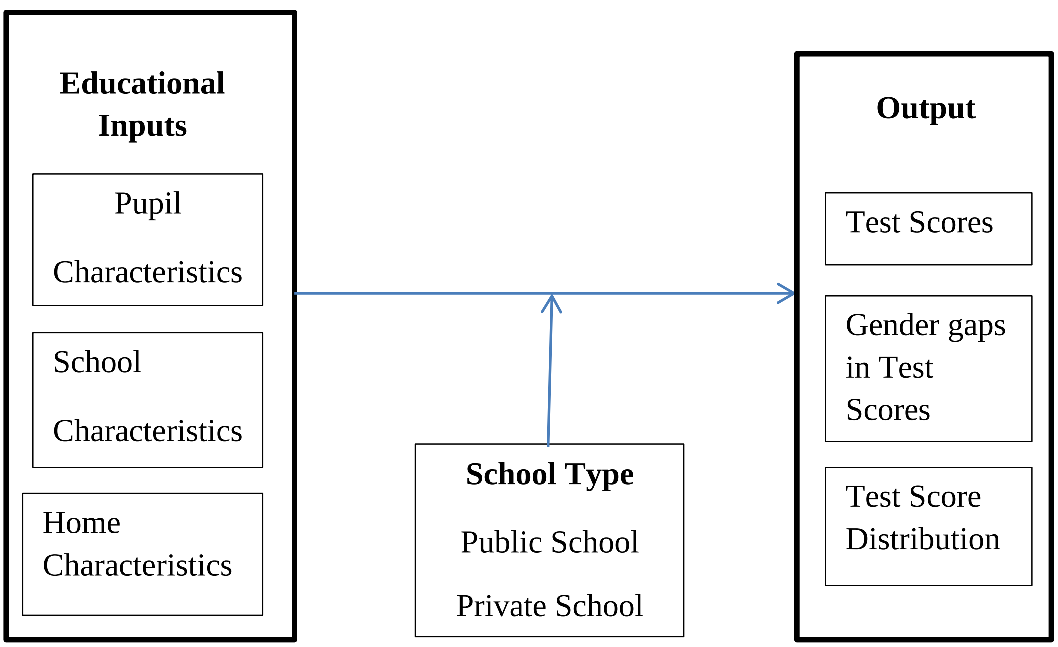
1.5 Conceptual Framework

The relationship between education resources and academic achievement in public and private primary schools is conceptualized as an achievement production function (Ruggiero, 1996). Student achievement depends on socio-economic and environmental factors, and therefore the need to set different production functions for different environments. Bowles (1970) defined an education production function as academic achievement as a function of the school environment, student characteristics and home characteristics. The author posits that since education achievement has an economic effect through labour productivity, the effect can be attributed to cognitive skills acquired in school. This would explain why high achievers in school are more productive in the labour market.

Similar to Bowles (1970), Hanushek (2007) posit that education output is a function of educational inputs under control of the policy makers such as school resources, and those not in control of the policy makers such as family resources. Hanushek (2007) recognized that common school inputs were not strongly related to academic achievement. This may point to inefficiency in the use of resources in schools. Thus, concluding that although schools matter, the relationship between education inputs and academic achievement remain unclear.

In this study, academic achievement is measured by test scores in Mathematics and English/ reading for class six pupils. While years of education is a measure of education attainment, it is not reflective of cognitive skills that would be significant for labour market outcomes (Hanushek, 2007). Thus, test scores are a more reliable measure of acquired cognitive skills. The analysis includes the estimation and decomposition of the gender gap in Mathematics test scores, and an analysis of the relationship between school type and educational resources and achievement of pupils along the test score distribution. The inputs in the education production function are pupils' characteristics, school characteristics and home characteristics (Figure 3). School type is assumed to be a mediating variable. A mediating variable accounts for the difference between the independent and the dependent variable. In total mediation, the relationship between the independent and the dependent variable is reduced to zero (Baron and Kenny, 1986). To this extent, academic achievement would be fully explained by school type. In the case of zero mediation, the relationship between school type and test scores would be reduced to zero if the inputs in the education production function fully explain academic achievement.

Figure 3: Conceptual framework: Relationship between educational inputs and test scores



Source: Author

1.6 Data and Methods

1.6.1 Theoretical framework

Households make choices that maximize their utility derived from goods and services consumed (Das et al., 2013; Glewwe and Kremer, 2006). Households also derive utility from the academic achievement (test scores) of their children (Hanushek, 2007).
Following Glewwe and Kremer (2006), a household utility maximization objective is:

$$\text{Max} \quad U(G, A) \tag{1}$$

Where G is goods and services consumed including leisure, and A is the academic achievement of learners (pupils in this case) in the household.

The household maximizes (1) subject to an achievement production function constraint (2).

$$A = a(Y, S, X, F, I) \tag{2}$$

Where A is defined as in (1), Y is the years of schooling, S is a vector of school characteristics, X is a vector of child characteristics, F is a vector of household/family background characteristics and I is a vector of other educational inputs under the control of a parent.

In an education system with one school type, households choose Y and I to maximize utility. Years of schooling, Y, and educational inputs, I, are functions of school characteristics, S, child characteristics, X, household characteristics, F, and the price of schooling, P (Glewwe and Kremer, 2006) as presented in (3) and (4).

$$Y = y(S, X, F, P) \tag{3}$$

$$I = g(S, X, F, P) \tag{4}$$

The price of schooling, P, includes school fees and cost of books and materials. Price, P, however, does not directly impact on academic achievement. Therefore, it is not included in the academic achievement function (2). The price effect is through variable I, which is assumed to be endogenous.

The reduced form achievement function is obtained by substituting (3) and (4) into (2) to obtain (5).

$$A = f(S, X, F, P) \quad (5)$$

The above analysis assumes that households do not choose between schools. If households have a choice of school type, the years of schooling, Y, and price, P would be endogenous. In this case, a household maximizes utility by choosing a school type and educational inputs, I. If $S, X, F,$ and P are varied, the change in years of schooling, Y, would be seen through (3) and the change in A, would be seen in the reduced form achievement function (5). The effects of changes in school characteristics, S, can be estimated through the same function (5). There are two effects in this regard: First, households reduce their share in educational inputs when a school acquires more of such inputs. The reduction in household educational inputs has a negative effect on academic achievement. Two, the reduction may shift household expenditure from educational inputs to consumer goods and services, which may increase academic achievement. Since the two effects have opposite effects on academic achievement, nothing is lost by estimating the achievement production function (2), which ignores the two effects (Glewwe and Kremer, 2006).

1.6.2 Econometric model

Given the conceptual presentation in the foregoing section, the academic achievement function to be estimated is therefore:

$$A_i = \alpha + \beta X + u_i \quad (6)$$

Where A_i is pupil's academic achievement and X is a vector of variables that includes child characteristics, school characteristics and family background characteristics. The definitions and measurement of variables are shown in Table 2.

Table 2: Definitions and measurement of variables

Variable	Measurement
Dependent variable	
Reading/mathematics score	The pupil's percentage score in the subject
Independent variables	
School characteristics	
School type	=1 if private, 0 if public
Condition of school infrastructure	=1 if good, 0 if poor
Head-teacher's sex	=1 if female, 0 if male
Parents homework signing	=1 if parent is required by the teacher/school to sign the pupil's homework, 0 if not
School Location	=1 if urban, 0 if rural
Classroom characteristics	
Class size	Number of pupils in the particular class that the pupil attends
Pupil absenteeism	Number of days absent from class in the previous one month
Book-pupil ratio	The ratio of textbooks to the number of pupils in class
Pupil and home characteristics	
Pupil age	Pupil's age in months
Socio-economic status (SES)	Pupil SES - low, medium and high. SES index in the data, 1 lowest and 15 highest High SES represents index 11-15, middle SES represents index 6-10 and low SES represents index 1-5
Mother/father education	=1 if attained secondary education, 0 if not attained secondary education
Number of tuition hours per week	Total number of tuition hours that the pupil attends per week
Teacher characteristics	
Teachers test score	The percentage score of the teacher in the subject evaluation (measurement of teacher's cognitive skills)
In-service teacher's training	Number of days of in-service training attended by the subject teacher in the previous three years
Teacher years of professional	Number of years of teacher professional training
Teacher experience	Number of years of teacher experience
Teacher contract	= 1 if permanent, 0 if temporary
Teacher's living condition	=1 if good, 0 if poor
Teacher's sex	=1 if female, 0 if male

Estimation issues

The main econometric issues in the estimation of an education production function (6) are endogeneity and unobserved heterogeneity (Aslam, 2009[b]). An explanatory variable is endogenous if it is correlated with the disturbance term (Greene 2012; Wooldridge, 2002). In estimation of an education production function, the school type is likely to be endogenous because the factors that influence school type choice may be correlated with the factors that influence academic achievement (Aslam, 2009[b]). The instrumental variable approach has been used by various authors to deal with endogeneity (e.g. Newhouse and Beegle, 2006; Sander 1999). In this study, the two-stage residual inclusion (2SRI) procedure proposed by Terza, Basu and Rathouz (2008) was used to deal with potential endogeneity of school type in equation (6).

Unobserved heterogeneity arises where the interaction between the disturbance term and the endogenous variable causes the effect of the endogenous variable on the dependent variable to vary across individuals (Wooldridge, 2002). In estimation of an education production function, the problem would arise if the unobserved factors cause the effect of school type on academic achievement to vary across pupils. This would yield biased estimates of the effect of school type on academic achievement. The study used the control function (CF) approach (Wooldridge, 2015) to address the problem of unobserved heterogeneity.

1.6.3 Data

This study used the most recent Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ III) data from the Kenya National Examinations Council (KNEC). This is a cross-sectional data set collected in 2007 and the latest SACMEQ data available for use by researchers at the time of this study. The sample was drawn from a population of Standard six pupils in public and private primary schools in 15 Southern and Eastern Africa countries (Hungi, 2011). This study analyzed the data on Kenya.

The sample was selected using a stratified two-stage cluster sampling procedure. In Kenya, the former eight provinces were used as the administrative blocks. Schools were randomly selected in each province based on the proportion of pupils in the province. In the second stage, a random sample of 25 pupils was taken from each of the selected schools. A sample of 193 schools were randomly selected from which 4,436 pupils were randomly sampled (Hungi, 2011). SACMEQ however, provides two exclusion restrictions when selecting the schools. That is, in Kenya, schools with less than 15 Standard six pupils and special needs schools for the disabled are excluded (Onsomu, Nzomo and Obiero, 2005). All other public and private primary schools are randomly selected.

According to Onsomu et al. (2005), SACMEQ chooses Standard six because it provides a reasonable point to assess literacy and numeracy achievement for three reasons: 1) Standard six is near end of the primary school education, and therefore, at that point school participation is high; 2) It is considered that at lower levels of education such as in Standard three and four, teachers in some schools especially in rural areas are transiting from the use of local language to national language as a language of instruction, thus making it difficult to measure school attainment; 3) Since information on home characteristics is collected from the pupils, pupils in Standard six are likely to give more accurate information than pupils in lower grades.

In the SACMEQ data, educational achievement is measured by test scores in reading, Mathematics and health knowledge. This thesis used the test scores in reading and Mathematics. The justification for use of reading and mathematics tests scores to test school attainment is that both subjects are used by KNEC and SACMEQ to test literacy and numeracy skills, and to nurture scientific skills (Wasanga, Ogle and Wambua, 2010). Mathematics achievement is also a good indicator of school effectiveness since Mathematics is mostly learnt in school, unlike reading which can also be taught at home through speaking (Lubienski, Crane and Lubienski, 2008; Sander, 1999). This is particularly in cases where children speak English at home, which is similar to the language of instruction and the test language at school. Performance in both literacy and numeracy are therefore good indicators of academic ability of a pupil.

1.7 Contribution of the Thesis

This thesis contributes to the literature on economics of education by providing empirical evidence on the production of education in Kenya. First, the study used the education production function to examine whether there is an association between school type (public or private) and academic achievement of primary school children. To the best of the author’s knowledge, this is the first econometric study to address the issue in Kenya. Existing studies focus on the relationship between educational resources and educational achievement, without taking into account this important distinction in Kenya's education system. It is evident from KCPE examination results and various literacy and numeracy assessments that private primary schools outperform public primary schools. These differences indicate inequalities between pupils of public and private primary schools. This study provides evidence that private primary attendance is correlated with higher educational performance even after controlling for endogeneity of school type.

Second, the study provides empirical evidence on the size of gender gaps in mean Mathematics score of public and private primary school pupils and decomposes the gender gap in Mathematics to identify the sources of the gender gap. Gender gaps at the early stages of education persist to higher levels of education and to the labour market (Bharadwaj, De Giorgi, Hansen, and Neilson, 2016; Marks, 2008). A gender gap in favour of male pupils disadvantages the female pupils later in higher levels of education and in the labour market. Development of an economy should be inclusive, thus reduction of gender gaps at early stages of skill development at the primary school level is crucial. The study results inform policy on the possible steps to take to reduce the gender Mathematics test score gap.

Third, the study provides empirical evidence of heterogeneity in the relationship between school type and educational resources and the academic achievement along the conditional distribution of test scores. This is uncovered using the quantile regression approach. It adds value to the existing literature, which has mainly focused on effectiveness of resource-based policies in raising average test scores. Inclusivity in the allocation of resources to reduce the inequality between high performing and low performing pupils requires the estimation of the effect of resources on the achievement of pupils along the distribution of test scores. That is, to examine 'for whom the resources matter' over and above 'do resources matter' to improve overall performance. This is helpful in school management and specifically in the prioritization of resources to improve overall performance.

In addition, the study contributes to existing literature theoretically and empirically. It employs frontier econometric methods to take care of potential econometric problems when using cross-sectional data in the estimation of the education production function. The two-stage residual inclusion (2SRI) method and the control function approach were used to deal with the problems of endogeneity of school type and unobserved heterogeneity, respectively. The study also demonstrates the value of applying quantile regression approach in comparison to classical linear regression approach to estimate education production functions.

Lastly, the study uses nation-wide data on monitoring student achievement at the primary school level. This is reliable data collected by KNEC and it has not been used to do such an in-depth analysis as the one in this study.

1.8 Organization of the Thesis

In the rest of the thesis, the chapters address the research questions. Chapter two answers the question on the relationship between school type and academic achievement. In chapter three, the gender academic achievement gap in Mathematics test scores is estimated and decomposed in both public and private primary schools. Chapter four examines the relationship between school type and educational resources and academic achievement across the test score distribution. Chapter five gives a summary of the thesis, a conclusion, policy implications drawn from the study and limitations of the study.

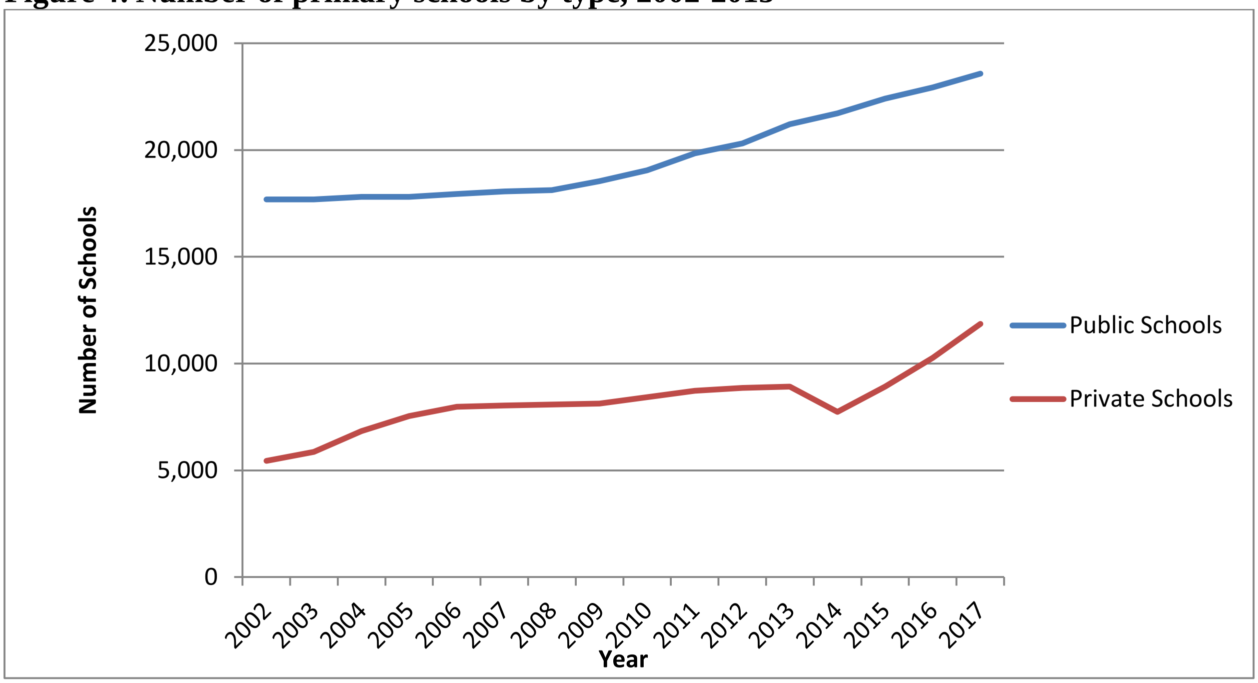
CHAPTER TWO: SCHOOL TYPE AND ACADEMIC ACHIEVEMENT IN KENYA

2.1 Introduction

2.1.1 Background

Primary education in Kenya is provided by both the government and the private sector. The government provides FPE in day public primary schools since the year 2003. The private sector provides primary education through private schools owned by individuals and non-governmental organizations such as religious organizations. The number of public primary schools is more than double the number of private primary schools (Figure 4). In 2015, there were 22,414 public primary schools in Kenya. The number rose to 22,939 and 23,584 in 2016 and 2017, respectively. Despite the FPE policy, the number of private primary schools increased to 10,263 and 11,858 in 2016 and 2017, respectively, from 8,919 in 2015 (Republic of Kenya, 2018).

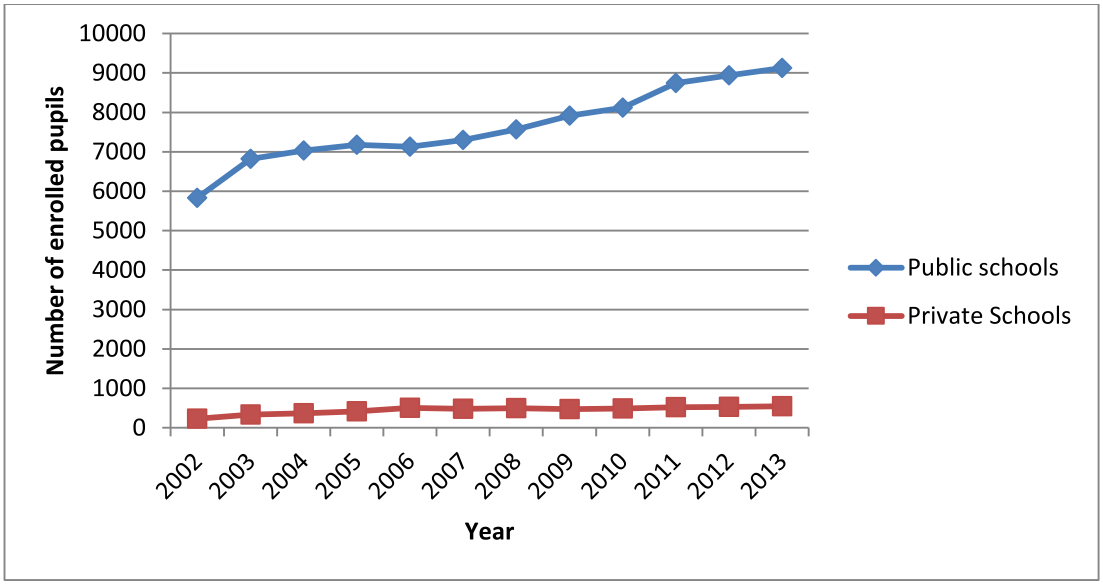
Figure 4: Number of primary schools by type, 2002-2015



Source: Republic of Kenya (various issues)

Although more than 90% of primary school pupils are enrolled in public primary schools, private school enrollment has increased since the FPE policy was introduced. Bold et al. (2013) observed that while primary school enrollment increased by about 35% after introduction of FPE, private school enrolment also increased. Bold et al. (2013), Bold, Kimenyi, Mwabu and Sandefur (2014), Manda and Mwakubo (2013) and Sawamura and Sifuna (2008) attribute the unexpected increase in private school enrolment to perceived reduction in the quality of public schools due to congestion.

Figure 5: Number of pupils enrolled by primary school type ('000'), 2002-2013



Source: Republic of Kenya (various issues)

Public primary schools in Kenya face several constraints. Many schools are congested, and therefore putting pressure on existing resources (Sawamura and Sifuna, 2008; Bold et al., 2014). Duflo, Dupas and Kremer (2015) reported pupil-teacher ratios of 84:1 in some public primary schools two years after FPE was implemented. More than 45% of public schools compared with 15% of private schools had a pupil teacher ratio above the government standard of 45:1 (Wasanga et al., 2011). Public primary schools are also prone to strikes by teachers' union demanding improved working conditions and remuneration (Mugho, 2017). Private school teachers are not unionized, and therefore pupils in private schools benefit from uninterrupted learning when public schools temporarily close down during teachers' strikes. A survey by Uwezo (2014) found high absenteeism of both teachers and pupils in public schools. One in ten enrolled pupils was absent from school at any one time while one in every ten schools had a daily attendance of teachers at less than 70% (Uwezo, 2014).

Third, absenteeism of both teachers and pupils is high in public schools. One in ten enrolled pupils is absent from school at any one time while one in every ten schools has a daily attendance of teachers at less than 70% (Uwezo, 2014). Teacher attendance encourages pupil attendance (Duflo, Hanna and Ryan, 2012). Therefore, teacher absenteeism can have adverse effects on pupils' academic achievement.

Despite the continued investment in education and particularly primary education by the Kenyan government, academic achievement in public primary schools is poor and lower than in private primary schools. This is evident from the KCPE scores. The average KCPE scores are consistently higher for private than for public schools (KNEC, 2017). In addition, surveys of both public and private primary schools in Kenya for pupils between six and sixteen years revealed that less than half of the Standard 4 pupils did not pass the mathematics test for Standard 2 and 3 levels (Uwezo, 2014). One out of ten of the Standard 7 pupils did not pass English and Mathematics tests for Standard 2 level. These problems are more aggravated in public schools than in private schools (Uwezo, 2014).

2.1.2 Research problem

The Government of Kenya aims at accessible and inclusive high quality basic education (KNEC, 2018). However, while access to primary education has increased since introduction of FPE (Republic of Kenya, 2017; World Bank, 2014), national data from KNEC raises a question of inclusivity in skills development. The KCPE mean grade for private schools in the years 2015 and 2016 was 292.49 and 284.42, respectively, out of 500 and 239.12 and 241.42, respectively, for public primary schools (KNEC, 2017). The concern is that disparities in academic achievement between public and private primary school pupils introduce inequalities in human capital development.

Previous studies on the effect of educational resources on academic achievement have focused mainly on public schools (Bold et al., 2013; Case and Deaton, 1999; Duflo et al., 2007a; Hanushek, 2003). But a few studies, for example Aslam (2009[b]) and Goyal (2009), consider the public-private school academic achievement gap debate and conclude that private schools are more effective than public schools in raising test scores. On the other hand, Lubienski et al. (2008), Newhouse and

Beegle (2006) and Psacharopoulos (1987) conclude that public schools are more effective than private schools in raising test scores. This suggests that results may be country-specific.

Despite the role played by private primary schools in Kenya, existing literature on academic achievement in Kenya are confined to public primary school performance. Consequently, two questions remain unanswered. First, what factors drive parents to select either private school or public school for their children. Secondly, what is the relative performance of private and public primary schools? That is, is private primary schooling associated with higher academic achievement?

2.1.3 Research objectives

The main objective is to estimate the academic achievement production function of primary school pupils in Kenya. The specific objectives are:

(i) To examine the relationship between school type and pupils' test scores in Kenya.
(ii) To draw policy implications for primary education in Kenya.

2.2 Literature Review

2.2.1 Theoretical literature

Educational investment affects present and the future well-being of an individual and an economy. Schooling enhances workers' skills and, therefore, increases individual income (Becker, 1962; Schultz, 1961) and overall economic growth (Hanushek, 2013). Schultz (1961) further suggested that provision of public investment in education is an effective and efficient way to reduce income inequalities in a community. Improved education quality is, therefore, a key step towards closing or reducing the economic development gap between developing and developed economies (Schultz, 1961).

School quality measured by the ability to produce high test scores differs across and within school type. Parents associate high quality with better equipped schools in terms of text books, teachers' commitment and enforcement of children discipline (Piper and Mugenda, 2013). School performance is driven by either the resources available in the schools or the relative effectiveness of the school in use of resources (Hill, 2018).

2.2.2 Empirical literature

Why do parents choose to send their children to a particular school type?

Several recent studies have examined correlates of school choice. Using a Multinomial Logit model, with panel data from two provinces in rural Kenya, Nishimura and Yamano (2013) determined that the probability of attending private schools increases with the pupil-teacher ratio in public schools. Similarly, the probability of transfer from low quality (with high pupil-teacher ratio) public primary schools to private primary schools (with low pupil-teacher ratio) increases with increase in the pupil-teacher ratio in public schools. In addition, transfer from public to private schools is higher for pupils from wealthy backgrounds than for pupils from poor backgrounds.

Dixon and Humble (2017) also used a Multinomial Logit model to investigate how school choice is determined by parental preferences and family characteristics in Sierra Leone. The four school types considered in the study were government, private, faith-based and non-governmental organizations (NGO) schools. The results were similar to Nishimura and Yamano (2013). Families with high income were more likely to select NGO schools than government schools.

In contrast to the foregoing studies, Oketch, Mutisya, Ngware and Ezeh (2010) estimated a binary logit model using data from slums in an urban area in Kenya. The objective was to identify the determinants of school choice (public versus private primary schools). The results showed that those who attend private schools in urban areas have been pushed to private schools by the unavailability of adequate space/places in public schools. In addition, in these areas, public and private schools are perceived as perfect substitutes.

Qualitative studies such as Hill (2018) also confirm that when parents have choices, they choose high quality schools where children achieve high test scores. Zuilkowski, Piper, Ong'ele and Kiminza (2018) also used a qualitative approach to analyze the choice of low-cost private schools in Kenya despite the government provision of FPE. The study revealed that parents view private primary schools as having better quality than public primary schools. School quality is captured as availability of resources such as books and committed teachers to enhance academic performance by pupils. On the other hand, parents who choose public primary schools do so because the school may be near home and affordable, hence endogenous selection of pupils into these schools.

The second question addressed by existing literature is: ***Are particular school types more effective than others in production of cognitive skills?*** This has been addressed using diverse methods. While some studies use OLS, others control for endogeneity of school type using the IV approach. Others treat school type choice as a selectivity issue and apply Heckman (1979) two-step method.

Alcott and Rose (2016) used OLS to determine the effectiveness of school type on academic achievement using household data from Kenya, Uganda and Tanzania. The study found that the wealthy were more likely to enroll their children in private schools. Further, on average, a pupil in a private school scored between 6 to 8 percentage points higher in literacy and numeracy scores than a pupil in a government school. Private schooling was positively and significantly related to test scores among pupils of all socio-economic status in Kenya and Uganda. However, for Tanzania, the positive association was only significant for pupils from wealthy homes. Similarly, Aslam (2009[b]) used OLS and found that in Pakistan, on average, a private school pupil scored 12 percentage points higher in both literacy and numeracy than a government school pupil.

The OLS estimate of the relationship between academic achievement and school type may be biased due to endogeneity and unobserved heterogeneity. This is because of non-random selection of pupils into either private or public school. Altonji, Elder and Taber (2005) developed a method to control for non-random selection of students in the different school types. That is, estimating the bias as the normalized difference in the average values of the school children observable and unobservable characteristics in private and public schools. The measure of the bias is used to adjust the OLS estimate of the association between private schooling and academic achievement. Using the Altonji et al. (2005) method, Goyal (2009) examined the relative performance of public and private schools' grade four pupils in Mathematics and English scores in India. The results indicated that private schooling was associated with higher scores relative to public schools. Moreover, selection bias accounted for about 13% of the difference in academic achievement between private and public school pupils.

Other approaches have been used to control for endogeneity resulting from non-random selection of students in either of the school types. Sander (1999) compared OLS and 2SLS estimates of the effect of private schools on public schools' achievement in Illinois, USA. The study hypothesized that competition from private schools increased achievement in public school, but the same could have a negative effect on public schools' academic achievement if private schools absorb the best students from public schools. To control for the non-selection into private schools, the study used Catholic religion as an instrumental variable of school type. Achievement was measured by Mathematics test scores for Grades 6 and 10 and high school graduation rates. Both the OLS and 2SLS estimates showed insignificant effect of competition from private schools on public schools' achievement.

Newhouse and Beegle (2006) also used OLS and IV approach to estimate the impact of school type on student achievement in junior secondary schools in Indonesia. The study used the local availability of public school (percentage of public schools within the district where the student attended school) as an instrumental variable to control for endogeneity resulting from non-random selection of students into either public or private schools. The study used Multinomial Logit approach to determine the factors that explained selection of pupils to either of the school type. The estimates revealed that wealthy parents tended to choose public schools. The schools were considered to be of higher quality than private schools. Both the OLS and the IV estimates indicated a positive public school effect on student achievement, therefore concluding that endogeneity did not invalidate OLS results. The estimates showed that public school improved test score in the range of 0.17 to 0.31 standard deviations.

McEwan (2001) address the school selection problem using the Lee (1983) selection bias correction approach. The approach uses a Multinomial Logit selectivity model. The study used the density of school type in the student's locality as an instrumental variable. Test scores in Mathematics and Spanish for Grade 8 students in six (6) school types in Chile were analyzed. The data had been collected seven years after a voucher programme had been implemented. The school choice model in the first stage revealed that high income parents were more likely than low income parents to enroll their children to private schools, and girls were more likely than boys to attend private schools. After accounting for selectivity bias, Catholic private schools and non-voucher private schools were found to be relatively more effective in raising test scores than public schools.

There was no significant difference in test scores between public and non-religious voucher schools.

Panel data has also been used to deal with unobserved heterogeneity in estimations of relative effectiveness of private schools. Nghiem, Nguyen, Khanam and Connelly (2015) estimated the effect of primary school choices in Australia on test scores and non-cognitive skills. Controlling for unobserved heterogeneity, the study did not find evidence of significant difference in test scores between public and private primary schools. Thus, the observed difference in test scores by school type can be attributed to selection into various school types.

Jimenez, Lockheed and Paqueo (1991) reviewed studies in five developing economies and found that even after controlling for family background characteristics, private schools' students had higher Mathematics and language test scores than public school students. Psacharopoulos (1987) analyzed the differential outcomes between private and public secondary school students in Tanzania. The results revealed that private schools did better than public schools in academic subjects while public schools out-performed private schools in the specialized or vocational subjects. This may be because vocational training is more expensive, thus better funded by the government in public schools. However, estimates from the study may have been biased because the study did not control for potential selection bias.

2.2.3 Overview of literature review

The theoretical literature provides possible explanations of the differentials in academic achievement between private and public primary schools. Pupils who attend schools with more/better resources such as text books, teachers' commitment and enforcement of children discipline tend to achieve higher test scores than pupils in schools with less resources (Piper and Mugenda, 2013). This influences parents' choice of the school type (Hill, 2018).

In the estimation of the relationship between school type and academic achievement, the OLS estimates may be biased due to endogeneity resulting from non-random allocation of pupils in either of the school types. Nevertheless, some studies, for example Aslam (2009[b]) and Alcott and Rose (2016), still used OLS. Others such as Newhouse and Beegle (2006) used the IV approach to control for potential endogeneity of school type.

In the correction for endogeneity, modelling school type is the first step. Studies that examine the factors that determine school type choice have used a variety of economic models, including Multinomial logit (Dixon and Humble, 2017; Nishimura and Yamano, 2013) and binary logit (Oketch et al., 2010). These studies, however, fail to control for school characteristics (e.g. infrastructure quality) and teacher characteristics. The current study controls for these characteristics in the estimation of school type model.

Further, empirical studies on whether one school type (private or public) is relatively more effective than the other in raising test scores report mixed results. For example, Newhouse and Beegle (2006) found that public schools are relatively more effective than private schools. Alcott and Rose (2018), Aslam (2009[b]), Goyal (2009) and McEwan (2001) found that private schools are relatively more effective than public schools. In Kenya, the question of whether there is a relationship between school type (private/public) and test scores even after controlling for endogeneity and educational resources remains unanswered.

This study contributes to the debate on the effect of school type by estimating the relationship between school type and academic achievement in primary schools in Kenya. The study analyses data from SACMEQ survey for Kenya. Unlike previous studies on Kenya, the current study recognizes that all the variables in the test scores production function influence selection into either of the school type and are, therefore, included in the school type model. In addition, the study controls for potential endogeneity and unobserved heterogeneity using two-stage residual inclusion approach and the control function approach.

2.3 Methodology

2.3.1 Theoretical framework

A household maximizes the utility function $U(G, A)$; where G and A are commodities and academic achievement, respectively (Glick and Sahn, 2006 and Glewwe and Kremer, 2006). It is constrained by an achievement production function that can also be expressed as a reduced form achievement demand function:

$$A = f(Y, S, X, F, I) \qquad (7)$$

Where A, the academic achievement, is a function of years of schooling, Y, school characteristics, S, child characteristics, X, family background characteristics, F and education inputs under the parents' control, I.

According to Glick and Sahn (2006), unmeasured tastes and preferences affect the utility of the household. In this case, the choice of school type, T, has an effect on the utility of a household, such that the reduced form academic achievement function is:

$$\mathrm{A} = \mathrm{f}(\mathrm{Y}, \mathrm{S}, \mathrm{T}, \mathrm{X}, \mathrm{F}, \mathrm{I}) \tag{8}$$

2.3.2 Econometric model

The question addressed in this essay is: ***Is there a relationship between school type and test scores of primary school pupils?***

The academic achievement equation estimated to answer the above question is:

$$A_i = \beta_0 + \beta_1 K_i + \beta_2 T_i + u_i \tag{9}$$

Where

A_i= Test score of pupil i.

K_i = A vector of pupil characteristics, school characteristics and family background characteristics.

T_i= School type; 1 if private and 0 if public.

u_i = Error term.

The unobserved characteristics that influence the probability of a pupil to enroll in either public or private school may also influence the pupil's academic achievement. School type is, therefore, potentially endogenous; that is, $Cov(T, u_i) \neq 0$. This may arise due to the non-random selection of pupils in either school type, hence school type dummy in the achievement production function could be confounded with the effect of unobserved variables making it endogenous. This is among other sources of endogeneity such as omitted variables, measurement error and simultaneity (Wooldridge, 2002).

In the estimation of the achievement production function (9), the first stage is to estimate the school type model below (equation 10):

$$T_i = \alpha_0 + \alpha_1 K_i + \alpha_2 Z_i + \varepsilon_i \qquad (10)$$

Where Z are the instrumental variables; distance from school to the nearest secondary school and the distance from the school to the nearest market, ε_i is the error term in the school type model, and all other variables are as defined in equation (9).

Following Vandenberghe and Robin (2004), instrumental variables approach is used to control for endogeneity. Specifically, the current study used the two-stage residual inclusion (2SRI) method developed by Terza et al. (2008) to control for endogeneity. Further, unobserved heterogeneity would arise if unobserved factors such as pupils' ability cause the effect of school type on academic achievement to vary across pupils, thus giving biased estimates of the effect of school type on achievement. The control function (CF) approach was used to control for unobserved heterogeneity. The 2SRI approach is a special case of the CF approach.

The CF approach requires valid instrumental variables. A valid instrument should be correlated with the endogenous variable (in this case school type) but uncorrelated with the error term in the outcome equation (Wooldridge, 2002), in this case equation (9). The choice of valid instrumental variables depends on intuition and economic reasoning (Vandenberghe and Robin, 2004). Newhouse and Beegle (2006) used the percentage of public schools in a district as an instrument for school type. Vandenberghe and Robin (2004) used the proximity to a big city as an instrumental variable. There was a strong significance of the effect of being located in a big city on the probability of attending a private school. The available instrumental variables for the current study are the distance from primary school to a secondary school, and the distance from primary school to the nearest market. The two instrumental variables are highly correlated with private primary school attendance. According to Pal (2010), presence of public facilities increases the return to investment in a private school. The presence of a secondary school in an area is, therefore, likely to increase the return to investment in a private school as pupils will get access to a nearby secondary school after completion of primary school education, and therefore justifies the negative coefficient of the distance from primary school to nearest secondary school. That is, the further the secondary school, the lower the likelihood to be enrolled in a private school (since there is lower motivation to invest in a private school if secondary schools are located far). This is the opposite of the correlation between private school and the nearest market, which may not be seen as a motivation for investment in a private school.

The CF approach was implemented in three stages. First the school type equation (10) is estimated using a binary response model, specifically probit model. Secondly, the generalized residuals (R) from the probit are included in achievement equation (9) as an explanatory variable to test and control for endogeneity of school type. This is the 2SRI estimation procedure that yields equation (11).

$$A_i = \beta_0 + \beta_1 K_i + \beta_2 T_i + \beta_3 R_i + u_i \tag{11}$$

Thirdly, to test and control for unobserved heterogeneity, a new variable is generated by interacting the generalized residuals and the school type dummy variable. This variable is included in the achievement equation (11) to yield equation (12) below. These three stages constitute the CF approach.

$$A_i = \beta_0 + \beta_1 K_i + \beta_2 T_i + \beta_3 R_i + \beta_4 (R_i * T_i) + u_i \tag{12}$$

2.3.3 Descriptive statistics

Table 3 presents the sample descriptive statistics separately for public and private primary schools' pupils and for the pooled sample. There are apparent differences in academic achievement and educational resources between public and private primary schools' pupils. The mean scores for the full sample are 56.82% and 51.62% in reading and Mathematics, respectively. The mean scores in reading and Mathematics in private schools are 63.84% and 57.96%, respectively, compared with 56.03% and 50.91%, respectively, in public schools.

Pupils in private schools have higher SES than pupils who attend public schools. About 70% of the private school pupils come from high and middle SES backgrounds while 30% come from low/poor SES background. On the other hand, about 56% of public primary school pupils come from high and middle SES background while 44% come from low SES. About 48% of mothers and 56% of fathers of private schools' pupils have attained secondary education or higher. The parents of public schools' pupils have less education; 27% of the mothers and 37% of the fathers have a secondary education and above.

The statistics show that class and school characteristics also differ across school types. The private schools' average class size (36 pupils) is smaller than the average class size (44.7 pupils) in public schools. Private primary school pupils have a higher textbook-pupil ratio (1.08) than public schools (0.73). The average tuition hours that a public school pupil has in a week is higher (6.44) than for a private primary school pupil (6.20). The average number of days absent from school for the month prior to the survey was 1.22 for a public primary school pupil and 1.16 for a private school pupil. About 57% of the infrastructure in private schools was reported to be in good condition while only 15% of the public schools' infrastructure was reported to be in good condition.

There are differences in teacher characteristics between public and private primary schools. On average, public primary school teachers have more years of training (2.1) than private primary school teachers (1.5). Similarly, public primary school teachers have more teaching experience than private school teachers; that is, 13 years and 14 years for reading and Mathematics teachers, respectively, compared to private primary school teachers who have 8 years and 10 years of teaching experience for reading and Mathematics teachers, respectively. In addition to professional training, teachers receive in-service training. Reading and Mathematics teachers in public schools had attended 31 and 29 days, respectively, of in-service training in the three years prior to the survey. This is more than four times the days of in-service training attended by private primary school teachers. Private school reading and mathematics teachers had attended 6 and 3 days of such training, respectively. Approximately 84% and 53% of the reading teachers have permanent contracts in public and private schools, respectively, while the rest have temporary contracts. 89% and 37% of the Mathematics teachers have permanent contracts in public and private schools, respectively, while the rest have temporary contracts. In the sampled private schools, about 49% and 62% of the reading and mathematics teachers report to be living in good conditions. On the other hand, 60% and 59% of the reading and mathematics teachers in public schools report to be living in good conditions.

The private schools' teachers scored higher marks in the respective tests of cognitive ability in their respective subjects. In reading, private school teachers mean score was 84.55% while that of public school teachers was 82.52%. In mathematics, private school teachers mean score was 75.53% while that of public school teachers was 74.50%.

Private schools are concentrated in urban locations compared to public primary schools; 65% of public schools are located in rural Kenya while 35% are located in urban areas. On the other hand, 36% of private schools are located in rural areas while 64% are in urban areas. Public primary schools are also far from other amenities compared to private primary schools. The average distance from a public primary school to the nearest secondary school is 9.11 kilometers while the distance to the nearest market is 2.95 kilometers. On the other hand, the average distance from a private primary school to the nearest secondary school is 1.26 kilometers while the distance to the nearest market is 1.38 kilometers.

Table 3: Descriptive statistics by primary school type

Variable	Mean (Standard deviation)		
	Combined	**Private Schools**	**Public schools**
Number of pupils in the sample	4,436	449	3,987
Pupil English/reading score	56.82 (10.39)	63.84 (12.27)	56.03 (9.85)
Pupil Mathematics score	51.62 (8.52)	57.96 (10.48)	50.91 (7.97)
Pupils age in months	165.35 (21.05)	162.95 (27.62)	165.62 (20.15)
SES- low SES	0.43 (0.49)	0.30 (0.46)	0.44 (0.50)
SES- middle SES	0.45 (0.50)	0.33 (0.47)	0.47 (0.50)
SES- high SES	0.12 (0.33)	0.37 (0.48)	0.09 (0.29)
Mother's education	0.29 (0.46)	0.48 (0.50)	0.27 (0.45)
Father's education	0.39 (0.49)	0.56 (0.50)	0.37 (0.48)
Parents signing homework (reading achievement function)	0.38 (0.48)	0.45 (0.50)	0.37 (0.48)
Parents signing homework (mathematics achievement function)	0.41 (0.49)	0.65 (0.48)	0.38 (0.49)
Pupil absenteeism	1.22 (2.48)	1.16 (2.29)	1.22 (2.50)
Class size	43.83 (16.07)	36.04 (14.22)	44.71 (16.05)
Book-pupil ratio	0.76 (2.25)	1.08 (2.59)	0.73 (2.20)
Number of tuition hours per week	6.42 (6.55)	6.20 (6.55)	6.44 (6.55)
Reading teacher's test score	82.33 (5.59)	84.55 (6.12)	82.52 (5.50)
Mathematics teacher's test score	74.58 (7.73)	75.53 (7.72)	74.50 (7.73)
In-service teacher's training (reading teacher)	28.56 (69.98)	6.86 (14.33)	31.01 (73.26)
In-service teacher's training (Mathematics teacher)	27.09 (64.77)	3.44 (6.61)	29.75 (67.77)
Teacher's years of professional training (reading)	2.04 (0.89)	1.57 (0.83)	2.09 (0.88)

Teacher's years of professional training (Mathematics)	2.03 (0.86)	1.35 (0.87)	2.11 (0.82)
Reading teacher's experience	12.51 (8.99)	7.99 (8.92)	13.01 (8.87)
Mathematics teacher's experience	13.61 (8.86)	9.81 (8.12)	14.04 (8.84)
Reading teacher contract	0.80 (0.40)	0.53 (0.50)	0.84 (0.37)
Mathematics teacher contract	0.84 (0.37)	0.37 (0.48)	0.89 (0.32)
Reading teachers living conditions	0.59 (0.49)	0.49 (0.50)	0.60 (0.49)
Mathematics teachers living conditions	0.59 (0.49)	0.62 (0.49)	0.59 (0.49)
Condition of school infrastructure	0.18 (0.39)	0.57 (0.50)	0.15 (0.35)
Head teacher's sex	0.16 (0.37)	0.29 (0.45)	0.15 (0.36)
School location	0.38 (0.49)	0.64 (0.48)	0.35 (0.48)
Distance from school to nearest secondary school in kilometers	8.32 (32.08)	1.26 (0.84)	9.11 (33.75)
Distance from school to nearest market in kilometers	2.79 (14.64)	1.38 (0.97)	2.95 (15.43)

Source: Author's computation from the SACMEQ (2007) data

2.4 Estimation Results and Discussion

This section presents the reduced-form probit school type selection model marginal effects in Table 4 and OLS and CF estimates of the relationship between school type and other educational resources on test scores in Table 5. The first stage reduced-form school type selection model coefficients are presented in Appendix 1.

2.4.1 Reduced-form estimates

The results are on the probability of a pupil being enrolled in a private school. Two reduced-form equations were estimated separately for reading scores and Mathematics scores. Some of the covariates in the two reduced form equations are not the same. These are, the teachers' characteristics such as the teacher's experience, in-service teacher's training, the number of years of professional training, teacher's test score, teacher's contract and teacher's living conditions. This is because, in most cases, pupils in a particular class are taught the two subjects (reading and Mathematics) by different teachers.

Pupils from more affluent homes are likely to attend private primary schools. Pupils from middle and high SES backgrounds are more likely to be in private primary schools compared to those from low SES backgrounds. Specifically, a pupil from high SES background is 8 percentage points more likely than a pupil from a low SES background to be enrolled in a private school. This finding is similar to that in Dixon and Humble (2017) and Nishimura and Yamano (2013). The two studies found that affluent parents enroll their children in private schools where the facilities are deemed better than in public schools. The differences in pupils' SES can, therefore, be said to influence primary school choice.

The availability of class and school resources also increase the pupil's probability of attending a private school. The probability of a pupil choosing a private school decreases by 0.2 percentage points with the increase in class size by 1 pupil and increases by 0.5 percentage points with reduction of the number of pupils sharing a text book by one pupil. A school with good infrastructure is likely to increase the probability of a pupil being enrolled in a private school by 8 percentage points and 4 percentage points, considering reading and Mathematics scores, respectively.

Teacher characteristics also influences the probability of being enrolled in a private primary school. If a Mathematics teacher scores a point higher in the teachers test, it decreases the probability of being enrolled in a private school by 0.4 percentage points while the same change in the reading teacher's score increases the probability of private school enrolment by 0.2 percentage points. The presence of a female reading teacher reduces the probability of a pupil being enrolled in a private school by approximately 3 percentage points. The presence of a female head-teacher increases the probability of a pupil being enrolled in a private school by 3 percentage points and 5 percentage points, considering the reading and mathematics score functions, respectively. An extra year of teacher professional training reduces the probability of a pupil's choosing a private school by 0.4 percentage points. An extra day of in-service teacher's training reduces the probability of private school enrolment by 4 percentage points and 0.1 percentage points with respect to reading and Mathematics score functions, respectively. If a teacher has a permanent contract, it reduces the probability of private school enrolment by 7 percentage points. An extra year of the Mathematics teacher experience increases the probability of a pupil being enrolled in a private school by 0.1 percentage points.

The location of a school also affects school choice. If a school is in an urban area, it increases the probability the pupil being enrolled in a private school by 1.5 percentage points. The two instrumental variables used to instrument for school type selection are distance from primary school to a secondary school and distance from primary school to a market. They are both correlated with the probability of selecting a private school. If a school is a kilometer further away from a secondary school, it decreases the probability of a pupil being enrolled in a private school by 2 percentage points, and if a kilometer further from the nearest market, it increases the probability of enrolment in a private school by about 1.5 percentage points and 1.4 percentage points, considering the reading and Mathematics score, respectively.

Table 4: Reduced-form probit school type selection model - marginal effects

	Probability school type=1 (private school) (Reading function)	**Probability school type=1 (private school) (Mathematics function)**
Pupils age	-0.0001 (0.0002)	0.0000 (0.0002)
Pupil SES (base- low SES)		
Middle SES	0.0246** (0.0097)	0.0346*** (0.0093)
High SES	0.0762*** (0.0146)	0.0838*** (0.0136)
Parent's education (base-below secondary education)		
Mothers education	0.0019 (0.0093)	-0.0090 (0.0085)
Fathers education	0.0072 (0.0092)	-0.0002 (0.0083)
Parents homework signing: =1 if yes, 0 if no	-0.0240*** (0.0080)	0.0424*** (0.0076)
Pupil absenteeism	0.0016 (0.0014)	0.0020 (0.0014)
Class size	-0.0023*** (0.0003)	-0.0024*** (0.0002)
Book-pupil ratio	0.0046*** (0.0016)	0.0055*** (0.0015)
Number of tuition hours per week	-0.00089 (0.0006)	-0.0013** (0.0006)
Teacher's test score	0.0022*** (0.0006)	-0.0037*** (0.0005)
In-service teacher's training	-0.0004*** (0.0001)	-0.0015*** (0.0004)
Teacher years of professional training	-0.0372*** (0.0051)	-0.0419*** (0.0051)
Teacher experience	0.0008 (0.0005)	0.0011** (0.0005)
Teacher contract; 1 =permanent, 0=temporary	-0.0739*** (0.0111)	-0.0702*** (0.0110)
Living conditions, =1 if good, =0 if poor	-0.0358*** (0.0081)	0.05622*** (0.0080)
Teacher's sex =1 if female, 0 if male	-0.0279*** (0.0084)	0.0031 (0.0079)
Head-teacher's sex =1 if female, 0 if male	0.0324*** (0 .0087)	0.0487*** (0.0085)
School infrastructure condition=1 if good,= 0 if poor	0.0754*** (0.0078)	0.0362*** (0.0078)
School location; =1 if urban and 0 if rural	0.0488*** (0.0090)	0.01529* (0.0090)
Distance from the primary school to the nearest secondary school	-0.0221*** (0.0037)	-0.0178*** (0.0037)
Distance from the primary school to the nearest market	0.0161*** (0.0034)	0.0143*** (0.0037)
n	4,191	4,191

Standard errors in brackets.***, ** , *: significant at 1%, 5% and 10%, respectively

2.4.2 School type and academic achievement of class six primary school pupils

Both the validity and the strength of the IVs were checked. According to Staiger and Stock (1997), the F-statistic should be greater than 10 for the instrument to be strong. The computed F-statistics are 33.6965 (p-value=0.0000) in the reading score sample and 22.9845 (p-value=0.0000) in the Mathematics score sample, and thus the instruments are strong. For the over-identification test, both the Sargan and the Basmann tests are large, about 0.2 for both subjects, and therefore the IVs are valid.

Table 5 presents the estimates of education achievement function. The results of the reading scores production function regression show that the residuals in the 2SRI approach regression is statistically insignificant *(P-value=0.910)*, meaning that the OLS estimates are not biased due to endogeneity of school type. When the generalized residual is interacted with the school type in the control function, the interaction term is also not statistically significant *(P-value=0.321)*, meaning that there is no bias as a result of unobserved heterogeneity. The OLS estimates of the reading scores production function are therefore, unbiased.

The results of the Mathematics scores production function regression using the 2SRI show that the generalized residual is statistically significant *(P-value=0.032)*, hence evidence of endogeneity. The interaction term of the school type and generalized residual is also statistically significant *(P-value=0.012)*, hence evidence of unobserved heterogeneity. For interpretation of the results, therefore, we rely on the control function approach for the mathematic scores production function. The evidence for bias in the OLS estimates due to endogeneity and unobserved heterogeneity in the mathematics function and not the reading function can be explained by the fact that Mathematics and reading production are estimated in different production functions. The characteristics in the two production functions have different measures. For example, a pupil scores different marks in the two subjects because some teachers' characteristics are different since the two subjects are taught by different teachers. It is thus possible that the effect of the unobservable factors that influence school type selection on the test scores differ across the different subjects.

The estimates from the test scores production function indicate that private school is positively correlated with both reading and Mathematics score. On average, a pupil in a private school scores

3.9 and 3.2 percentage points higher in reading and mathematics, respectively, than a pupil in a public school. These findings are in line with the findings in Aslam (2009[b]) and Goyal (2009) who concluded that private schools were more effective than public schools in raising test scores. The results contradict Newhouse and Beegle (2006) who concluded that public schools are more effective than private schools. The contradicting results suggest that school type association with academic achievement differs across states or countries.

The results show that a pupil from a high socio-economic status home background scores 6.6 and 4.2 percentage points higher in reading and Mathematics, respectively, than a pupil from a low socio-economic status background. The number of tuition hours only have a statistical significant correlation with the reading scores but does not significantly change the Mathematics score. On average, an extra hour of tuition increases the reading score by 0.06 percentage points.

Some educational resources are positively correlated with test scores. Higher book-pupil ratio is associated with higher performance in Mathematics and reading. A reduction in the number of pupils sharing a book by one pupil, hence an increase in the book-pupil ratio, is associated with an increase of reading and Mathematics test scores by 0.16 and 0.12 percentage points, respectively. These results contradict Glewwe et al. (2009) who found that text books improved only the scores of academically strong students, hence no effect on the average performance. It is, however, necessary to evaluate whether the text-book effect differs across students along the test score distribution (Glewwe et al., 2009).

Larger class sizes are negatively correlated with both reading and Mathematics scores. On average, an increase in class size by one pupil reduces scores by 0.05 percentage points in both reading and Mathematics. This means that pupils benefit from smaller classes that could mean more teacher-pupil interaction. This contradicts Hanushek (2003) and Bold et al. (2013) who concluded that reduced class sizes do not necessarily improve student performance. The result is, however, consistent with Altinok and Kingdon (2012) and Konstantopoulos and Sun (2014). According to Altinok and Kingdon (2012), class size effects are larger in developing countries where class sizes are generally large compared to developed economies. Konstantopoulos and Sun (2014) found that class size effect may differ with the pupil ability, implying that class size may matter in affecting the pupils' performance. In addition, pupils in schools with good condition infrastructure score 1.36

and 1.12 percentage points higher in reading and Mathematics, respectively, than pupils in schools with poor condition infrastructure.

The estimates show that teachers' characteristics are also correlated with academic achievement. The pupil's test scores increase with the teacher's training in reading but not in Mathematics. An extra year of professional training for the reading teacher is associated with an increase in pupil's reading test score by 0.85 percentage points. The results on Mathematics score is statistically insignificant. The result from the estimation of the Mathematics scores regression is similar to Aslam and Kingdon (2011) who concluded that teachers' certification and training had no effect on pupil performance in both government and private schools in India.

Teacher job security has different associations with scores across subjects. A pupil taught by a teacher with a permanent employment contract scores on average 1.69 percentage points higher in reading than a pupil taught by a teacher on temporary contract. On the other hand, there is no statistically significant difference in mathematics score between a pupil taught by a teacher on permanent contract and one taught by a teacher on temporary contract.

While there is no significant effect on the reading score resulting from the teacher's cognitive ability measured by the teacher's score in a test, the teacher's cognitive ability is positively correlated with the pupil's mathematics score. On average, a 1% increase in a teacher's mathematics score is associated with a 0.05 percentage points increase in a pupil's mathematics score. The result on the reading score is consistent with Gronqvist and Vlanchos (2016) who concluded that high teacher cognitive and social abilities have no effect on average student performance.

Living conditions of teachers enhance Mathematics scores but not reading scores. Pupils taught by a Mathematics teacher living in good conditions score 0.72 percentage points higher than pupils whose teachers report to be living in poor conditions. Other factors whose estimates are statistically significant are the sex of the teacher and the school location. On average, a pupil who is taught Mathematics by a female teacher scores 0.89 percentage points higher than one taught by a male teacher. There is no significant teacher gender association with the reading test score. Lastly, pupils whose schools are in urban areas score higher marks than pupils whose schools are in rural areas. On average, a pupil's score is 3.22 and 2.41 percentage points higher in reading and Mathematics, respectively, for a pupil who attends a school in an urban area than for a pupil who attends school in a rural area.

Table 5: School type and academic achievement of primary school pupils: OLS, 2 SRI and control function approach results

	Reading score			Mathematics score		
	OLS	2 SRI	Control Function	OLS	2 SRI	Control Function
Generalized residual	-	0.0887 (0.7853)	0.9137 (1.1328)	-	1.4214** (0.6609)	2.9989*** (0.9114)
Generalized residual*school type	-	-	-1.186691 1.174303	-	-	-2.6070** (1.0378)
School type: =1 if private, 0 if public	3.9196 *** (0.5701)	3.7791*** (1.3684)	3.9702*** (1.3814)	4.5658*** (0.5271)	2.5294** (1.0836)	3.2117*** (1.1164)
Pupils age	-0.0978*** .0072585	-0.0979*** (0.0073)	-0.0977*** (0.0073)	-0.0416*** (0.0065)	-0.0421*** (0.0065)	-0.0411*** (0.0065)
Pupil SES (base- low SES)						
Middle SES	1.8563*** (0.3703)	1.8609*** (0.3726)	1.9009*** (0.3747)	0.6115* (0.3277)	0.6613** (0.3284)	0.7236** (0.3291)
High SES	6.6072*** (0.6626)	6.6320 (0.6980)	6.6871*** (0.7002)	3.8852*** (0.5809)	4.2056*** (0.5994)	4.2612*** (0.5994)
Parent's education (base-below secondary education)						
Mothers education	0.4459 (0.3943)	0.4459 (0.3944)	0.4452 (0.3944)	-0.1045 (0.3482)	-0.1103 (0.3480)	-0.1172 (0.3478)
Fathers education	-0.1081 (0.3733)	-0.1077 (0.3734)	-0.1099 (0.3734)	0.3533 (0.3285)	0.3538 (0.3284)	0.3781 (0.3283)
Parents homework signing: =1 if yes, 0 if no	-0.7930*** (0.2975)	-0.7948*** (0.2980)	-0.8286*** (0.2998)	-0.2227 (0.2668)	-0.0745 (0.2754)	-0.0364 (0.2757)
Pupil absenteeism	-0.2334*** (0.0553)	-0.2331*** (0.0554)	-0.2330*** (0.0554)	-0.2230*** (0.0483)	-0.2161*** (0.0484)	-0.2151*** (0.0484)
Class size	-0.0492*** (0.0092)	-0.0497*** (0.0101)	-0.0514*** (0.0102)	-0.0404*** (0.0084)	-0.0465*** (0.0089)	-0.0481*** (0.0089)
Book-pupil ratio	0.1662** (0.0665)	0.1670** (0.0669)	0.1648** (0.0669)	0.1248** (0.0573)	0.1330** (0.0574)	0.1204** (0.0575)
Number of tuition hours per week	0.0550** (0.0222)	0.0549** (0.0223)	0.0522** (0.0224)	0.0294 (0.0191)	0.0268 (0.0192)	0.0217 (0.0193)

Teacher's test score	0.0023 (0.0254)	0.0028 (0.0258)	0.0073 (0.0262)	0.0562*** (0.0167)	0.0541*** (0.0167)	0.0466*** (0.0169)
In-service teacher's training	-0.0012 (0.0021)	-0.0012 (0.0021)	-0.0016 (0.0021)	-0.0030 (0.0019)	-0.0032* (0.0019)	-0.0037** (0.0019)
Teacher years of professional training	0.8497*** (0.1858)	0.8458*** (0.1891)	0.8066*** (0.1931)	0.0780 (0.1685)	0.0434 (0.1692)	-0.0500 (0.1731)
Teacher experience	-0.0377* (0.0200)	-0.0377* (0.0200)	-0.0358* (0.0200)	-0.0619** (0.0163)	-0.0599*** (0.0163)	-0.0596*** (0.0163)
Teacher contract; 1 if permanent, 0 if temporary.	1.6880*** (0.4703)	1.6724*** (0.4902)	1.6189* (0.4931)	0.5022 (0.4560)	0.1306 (0.4875)	0.1135 (0.4872)
Living conditions, =1 if good, =0 if poor	-0.1661 (0.3079)	-0.1712 (0.3112)	-0.2032 (0.3128)	0.5366** (0.2596)	0.5926** (0.2608)	0.7220*** (0.2657)
Teacher's sex =1 if female, 0 if male	-0.4652 (0.3021)	-0.4741 (0.3123)	-0.5314* (0.3174)	0.9008*** (0.2828)	0.8542*** (0.2835)	0.8889*** (0.2837)
Head-teacher's sex =1 if female, 0 if male	2.0887*** (0.3974)	2.0917 (0.3984)	2.1423*** (0.4015)	0.9173 (0.3524)	0.9887*** (0.3538)	1.1211 (0.3575)
School infrastructure condition=1 if good,= 0 if poor	1.3583*** (0.3863)	1.3846*** (0.4512)	1.4547*** (0.4565)	1.1788*** (0.3390)	1.4982*** (0.3700)	1.1211*** (0.3575)
School location; =1 if urban and 0 if rural	3.2185*** (0.3473)	3.2291*** (0.3599)	3.2852*** (0.3641)	2.3628*** (0.2846)	2.4295*** (0.2862)	2.4085*** (0.2861)
Constant	68.8388*** (2.5438)	68.8527*** (2.5471)	68.7335*** (2.5498)	53.3847*** (1.7990)	54.1821*** (1.8360)	54.8911 (1.8564)
n	4,191	4,191	4,191	4,068	4,068	4,068
R^2	0.2448	0.2448	0.2450	0.1725	0.1735	0.1748

*Standard errors in brackets.***, ** , *: significant at 1%, 5% and 10%, respectively*

2.5 Summary, Conclusion and Policy Implication

2.5.1 Summary and conclusion

According to theory, the household utility is a function of goods and services consumed , and children's academic achievement (Glewwe and Kremer, 2006). The academic achievement, measured by test scores, is produced in school. The household school type selection may be important in determining the child's academic performance. Empirical evidence in Kenya is mostly on the estimation of an academic achievement production function in one school type, and specifically public schools. Literature on the effect of school type on academic achievement in different countries has shown different results. Some studies show a positive private school effect (Goyal, 2009) while other studies show a positive public school effect (Newhouse and Beegle, 2006).

In Kenya, there are huge disparities in the performance of public and private primary school pupils both in KCPE scores and in various assessments. There is, however, scarce empirical evidence on the relationship between school type and academic achievement. This essay, therefore, fills this research gap. The main objective was to examine the relationship between private school attendance and academic achievement of primary school pupils.

Public and private primary schools differ in many characteristics. The average pupils' score in private schools is higher than that of public schools. The private school pupil's average age is lower than that of their counterparts in public schools. Private school pupils also come from wealthier homes compared to public school pupils. Parents of private school going children are also more educated. Private school going pupils enjoy smaller class sizes. The school infrastructure in private schools is in better condition than that in public schools. Public school teachers have more years of professional training and more years of experience than private school teachers. However, private school teachers get higher scores when assessed using the teachers' test compared to public school teachers.

School type is potentially endogenous in the academic achievement equation. There is also potential unobserved heterogeneity. The 2SRI method and control function was used to control for endogeneity and unobserved heterogeneity. There is evidence of unobserved heterogeneity in Mathematics achievement function. OLS estimate of Mathematics production function would therefore be biased. However, there is no evidence of endogeneity or unobserved heterogeneity in the reading achievement production function. OLS results from estimation of the reading scores production function are therefore unbiased.

The results show that private school is positively correlated with both the Mathematics and reading scores. Further, there is evidence that some resources are positively associated with test scores. These include pupil's socio-economic status, small class sizes, good condition school infrastructure, years of teachers' professional training, and teachers with permanent contract. Differences between public and private primary schools scores and educational resources point to inequalities in the conditions of learning that lead to disparities in pupils' academic achievement between public and private primary schools.

2.5.1 Policy implications

The private school advantage revealed by the estimation results provides a possible explanation of expansion in private primary school sector, both in number of schools and enrolment. The private school advantage can be traced to differences in relative resource endowment in private and public schools. Private primary schools have more educational resources, including small class sizes, high book-pupil ratio and good condition infrastructure. This suggests that the gap in private-public school performance may be reduced by closing the resource gap between the two school types. The reduction of these inequalities between public and private schools is crucial as more than 90% of all primary school pupils attend public schools.

In the wake of curriculum reforms, the results in this study show that continuous reforms should include efforts to improve public schools' performance and reduce the inequality between private primary schools and public primary schools' pupils. Still, future research can investigate empirically management practices and incentive structures in public and private schools to identify the sources of private primary school advantage in producing cognitive skills.

CHAPTER THREE: GENDER GAPS IN MATHEMATICS ACHIEVEMENT IN PRIMARY SCHOOLS IN KENYA

3.1 Introduction

3.1.1 Background

Many developing economies have made notable strides towards the achievement of universal basic education (Hanushek, 2013). However, gender gaps in academic achievement still exist. According to UNESCO (2003) and Republic of Kenya (2011), gender equality in education means that neither boys nor girls are disadvantaged in terms of opportunities available to them.

Gender gaps in academic achievement adversely affect economic growth by lowering the level of human capital (Klasen, 2002). Further, gender gaps at the lower levels of education account for a high proportion of the gender gaps that occur later in age (Freeman, 2004; Klasen, 2002). Durrant, Forsythe and Korzeniewicz (2000) posit that gender gaps in employment, wages and vulnerability to poverty arise from gender differentials in human capital. The gender differentials in skills sometimes arise from discrimination. For example, in some societies, parents favour education of boys over that of girls as they believe it is more economically beneficial to educate boys than girls (Kingdon, 2002).

Gender parity in enrolment and completion at primary school level has been achieved in most developing countries including Kenya (Grant and Behrman, 2010). In Kenya, policies such as Free Primary Education (FPE) have increased enrolment but gender gaps in academic achievement still persist (Grant and Behrman, 2010; Lucas and Mbiti, 2012). Girls have lower academic achievement than boys (Lucas and Mbiti, 2012; Republic of Kenya, 2012[b]). This gender academic achievement gap is higher in Science, Technology, Engineering and Mathematics (STEM) disciplines than in other disciplines (Republic of Kenya, 2012[b]).

The promotion of education and training in the STEM disciplines is one of the government policies to promote innovation and economic growth in Kenya (Republic of Kenya, 2012[a]). The steps suggested to promote STEM include setting affirmative gender actions that are specific to STEM programmes (Republic of Kenya, 2012[b]). Due to the recognition of the importance of STEM subjects in the economy and the existing gender gaps in academic achievement in these disciplines, the current curriculum rolled out in 2019 for Grades one, two and three is aimed at encouraging girls to perform well in STEM subjects from early stages of education (Republic of Kenya, 2016). This will encourage them to enroll in STEM disciplines at tertiary levels. The enrolment and performance by girls in these disciplines has been low (Republic of Kenya, 2016).

There is evidence that ability to learn mathematics, one of the STEM subjects, is the same for both men and women (Hyde, 2005; Smetackova, 2015). Differences in performance in Mathematics between male and female children and within each group increases with age. This variability in performance is partly due to girls' attitude towards Mathematics and boys' strong identification with Mathematics that makes the boys to perform better than the girls (Smetackova, 2015).

In Kenya, boys have consistently performed better than girls in Mathematics. In KCPE, for instance, Mathematics mean score in 2016 was 29% and 27% for boys and girls, respectively, (KNEC, 2018). These scores depict low (below 50%) performance and disparities in performance between boys and girls. These disparities are also observed in other assessments (Wasanga et al., 2011). However, the Government of Kenya (GoK) has continued to implement policies in favour of both male and female pupils. The aim is to eliminate gender and regional disparities in basic education by 2017 (Republic of Kenya, 2012[c]). The efforts towards elimination of the disparities include provision of FPE, provisions for school re-entry for girls who drop out due to pregnancy, affirmative action bursary allocation, and Kenya being a signatory to International Conventions such as the SDGs (Republic of Kenya, 2015).

3.1.2 Research problem

The Government of Kenya gender policy (Republic of Kenya, 2015) provides that both males and females are accorded equal access to resources and opportunities in the provision of education. Before FPE was introduced in 2003, there were large disparities in enrolment and academic achievement, with boys out-performing girls (Lucas and Mbiti, 2012).

Since the introduction of FPE, some gender gap indicators of education attainment such as access and achievement in some subjects have improved while others have not. There was near gender parity in proportion of enrolment of boys (51%) and girls (49%) in primary schools over the period

2012-2016 (Republic of Kenya, 2017). Similarly, the gender achievement gap in English has declined (Wasanga et al., 2011). However, gender gaps still persist in Mathematics at the primary school level, with boys outperforming girls (KNEC, 2018; Wasanga et al., 2011). It is not clear why the gender test score gap in Mathematics still persists, and few econometric studies have focused on the issue in Africa.

Previous studies on gender test score gap in Mathematics, such as Asadullah and Chaudhury (2009), Golsteyn and Schils (2014) and Rodríguez-Planasa and Nollenbergerb (2018) focus on non-African countries. Studies that use data from Kenya to estimate/analyze gender gaps in academic achievement (Dickerson et al., 2015; Lucas and Mbiti, 2012) do not decompose and explain the gender gap in Mathematics score in public and private primary schools. Thus, it is not clear how much of the gap is due to educational resource endowment differences between boys and girls, and how much of the gap is due to differences in utilization of the resources. Therefore, while it is known that gender test score gap in Mathematics exist, the nature of the gap remains unknown, making it difficult to reduce it. This study provides evidence to fill this gap in the literature. This study addressed the question: ***What factors contribute to the gender test score gap in mathematics in public and private primary schools in Kenya?***

Reducing the gender test score gap in Mathematics accords both boys and girls equal opportunity to acquire knowledge and skills in STEM subjects. Consequently, they can contribute to innovation and economic growth (Republic of Kenya, 2012[b] ; Republic of Kenya, 2016) and economic development (Klasen, 2002). Second, reducing gender gaps at early stages of education reduces chances of gender gaps at later stages of life, such as in the labour market (Marks, 2008).

3.1.3 Research objectives

The main objective is to analyze the gender gap in Mathematics achievement of class six primary school pupils in Kenya.

The specific objectives are:

(i) To estimate education achievement (test score) functions separately for class six male and female pupils in public and private primary schools in Kenya.

(ii) To decompose the male-female test score gap in mathematics in public and private primary schools in Kenya.

(iii) To draw policy implications for addressing the gender test score gap in mathematics.

3.2 Literature Review

3.2.1 Theoretical literature

There are several possible explanations for the gender gaps in education and in the labour market. There is a possibility of differences in social norms between men and women. That is, since men are prone to taking more risk than women, then they (men) are likely to be more aggressive than women in the market (Marianne, 2011). This behavior may translate to less aggression by women in schools. Women also tend to avoid more difficult tasks (Mariann, 2011). These preferences can be partly explained by differences in biological make-up between men and women. As a result, teachers may have greater expectations of boys than girls, thus demand higher academic achievement from boys than from girls, implying differences in the socialization process.

Gender gaps in education outcomes may also be as a result of parents' preferences to educate boys more than girls (Lucas and Mbiti, 2012; Kingdon, 2002). Where there is a cost to investing in children's education, then parents will invest more where the expected returns are higher. According to Lucas and Mbiti (2012), before introduction of FPE, cost sharing (school fees) may have contributed to gender differences in academic achievement. This is because boys generally spent more time in school compared to girls. FPE aimed at reducing the cost of schooling, and therefore reduce gender gaps in education attainment. However, there are still other associated costs such as cost of uniform, opportunity cost of foregone labour, among others. When these costs are higher for girls than boys and the expected returns to education are higher for boys than girls, then the parents show more interest in the boys' education than in the girls' education. The result is that the gender gaps in education are increased.

Other than the unobservable factors such as preferences and socialization, observable and quantifiable factors may be responsible for the gender gaps in education. According to Machin and McNally (2005), school and non-school factors such as parents' education and household income levels account for the differences in the performance gaps between boys and girls in schools. Studies on gender gaps in different school types and using the education production function with quantifiable school and non-school characteristics therefore attest to the theory that supply-side effects may contribute to the academic achievement gender gaps.

This study has analyzed gender gaps based on the premise that the differences in quantifiable educational resources between male and female pupils may explain gender gaps in academic achievement.

3.2.2 Empirical literature

Aslam (2009[a]) investigated whether the labour market in Pakistan rewarded men more than women, thus motivating parents to invest more in boys' education than girls' education. The study used Oaxaca (1973) to decompose the differences in earnings between men and women and found that 94% of the difference in wage is unexplained by the regression. This was interpreted as discrimination in the labor market favoring men, which contributed to the motivation to parents to invest more in boys' education and less in the education for girls.

Golsteyn and Schils (2014) also used Blinder Oaxaca decomposition to explain the gender gap in Mathematics and language test scores in Dutch elementary schools for Grade six pupils. The boys performed better than girls in Mathematics. The results showed an overall endowment effect of 58%; that is, the gap would reduce by 58% if girls had similar educational resources as boys. On the other hand, the parameter effect was 40%, meaning that girls' score would increase by 40% if they took advantage of the resources available in a similar way to boys. For language, girls performed better than the boys. The results showed that, on average, the boys' score would be 0.18 standard deviations higher if they took advantage of the resources in a similar way to girls.

Asadullah and Chaudhury (2009) investigated the possibility of a reversal of the academic achievement gender gap in favour of girls caused by a stipend system to encourage secondary school enrolment of girls in Bangladesh. The estimation involved an OLS regression of outcomes such as enrolment rates, grade completion and child labour on the male dummy. The results indicated a positive gender bias for girls due to the stipend given to them to improve their secondary school enrollment. On the other hand, the intervention caused reduced enrolment and increased child labour for male students over time.

Rodríguez-Planasa and Nollenbergerb (2018) analyzed test scores data for immigrants from different countries to determine how social norms from countries of origin affect gender gaps in Mathematics, reading and Science. OLS estimates indicated that an increase in the gender gap index by 1 standard deviation increased the gender gap in reading, Science and Mathematics by 0.31, 0.34 and 0.29 standard deviations, respectively. Immigrant girls from gender-equal countries tended to like mathematics more than girls from gender-unequal countries and out-performed boys in all the three subjects. In addition, performance by girls in Mathematics was influenced by beliefs about economic opportunities, and the parents' influence on the preference for mathematics.

The sources of Mathematics gender gap in OECD countries was investigated by Bedard and Cho (2010). On the basis of OLS estimates, the study concluded that countries that place girls in classes where performance is above average have small gender gaps in Mathematics. Aslam (2009[b]) used the same approach to estimate whether there was gender discrimination in enrolment in better quality private schools in Pakistan. The study controlled for many factors that influence school choice including socio-economic status in the pupil's home. The OLS estimates showed that the gender gap in test scores was partly attributed to enrolment of boys in private schools that were of higher quality compared to public schools where girls were more likely to be enrolled compared to boys.

Lucas and Mbiti (2012) used the DID approach to examine the extent to which Kenya's FPE policy reduced the gender gaps on completion rate and academic achievement at primary school level across Kenya's administrative districts. Patterns of outcomes before and after FPE were compared. First, the results revealed that boys were more responsive to the abolishment of levies, thus widening the gender completion gap. Although the number of girls that completed school increased, the percentage of girls completing school decreased. Secondly, no significant change in gender test score gap was observed. FPE did not, therefore, reduce the gender gap in academic achievement. However, the use of school test scores at the district level lacked individual student characteristics and this limited the analysis (Lucas and Mbithi, 2012).

Machin and McNally (2005) also applied the DID approach to analyze changes in the gender achievement gap in England at the end of primary school and at the secondary school level. The results revealed that girls performed better than boys in many of the subjects. Gender gaps in

English test scores were more pronounced in secondary than in primary schools. Further, offering extra numeracy and literacy teaching hours favoured the weaker group, and thus were effective in reducing the gender test score gaps.

Like Machin and McNally (2005), Lucas and Mbiti (2012), Falch and Naper (2013) used the DID approach to test the effect of student-teacher interaction on boys' and girls' performance in Mathematics and English for Norway lower secondary school students. The results showed that boys performed better in exit examinations, but girls performed better than boys in teacher graded examinations that tested students on the same skills. Further, girls scored higher in English and Norwegian languages when assessed by male teachers and higher in Mathematics when assessed by inexperienced teachers. The results thus indicate the importance of teacher-student interaction or some form of discrimination.

Also using the DID approach, Muralidharan and Sheth (2016) studied the impact of the presence of a female teacher on the learning outcomes of female students in India. The study reported that female teachers were more effective in reducing the gender gap in test scores. Female students taught by female teachers performed 0.36 standard deviation higher than when they were taught by male teachers. Male students' performance, however, remained almost the same regardless of whether they were taught by a male or a female teacher. The positive impact of same-sex teacher was also reported by Dee (2007). Dee (2007) used the fixed effects approach (within student estimation) to examine the effect of assigning a teacher of the same gender in public and private schools on education outcomes in the USA. The results revealed that assignment of same gender teacher increases academic performance for boys and girls. It also improves teacher perception of student performance as the students also engage more with subject teachers. Further, assignment of a male English teacher lessens the gender gap by improving the boys' performance and reducing the girls' performance, thus reducing the gender gap in reading that was in favour of girls. These results are collaborated by Spilt et al. (2012). In a study of Dutch primary schools, using maximum likelihood estimation, Spilt et al., (2012) found that female teachers demonstrated a close relationship with girls while there was no positive match between male teachers and boys. The results by Muralidharan and Sheth (2016) and Dee (2007) were contradicted by de Zeeuw et al. (2014) who used a linear model and concluded that there was no difference in performance in

Mathematics by Netherlands students resulting from a pupil being taught by a teacher of the same sex as the pupil.

Dickerson et al. (2015) analyzed cross-sectional data from nineteen (19) Sub-Saharan African countries to explain what contributes to gender gaps in Mathematics at the primary school level. The OLS results showed that the gap in Mathematics performance between boys and girls was not explained by the observed individual characteristics. For example, after interacting the female pupil dummy and the parents' education, gender gap remained among children with educated parents, although it was worse among children with uneducated parents. Societal factors such as fertility rate and religious practices that were indicative of women empowerment had a greater influence on the gender gap. The gap was wider in societies where women were less empowered. In addition, a regression of the difference in the score between girls and boys showed that access to school resources and the SES did not reduce the gender Mathematics score gap, thus concluding that further research should be conducted to establish specific interventions to tackle gender gaps in academic achievement.

The results in Dickerson et al. (2015) were similar to Marks (2008) who showed that societal factors such as gender equity improve girls' Mathematics performance The author conducted a cross-sectional study of many countries, including the USA and European countries, to account for gender differences in Mathematics and English performance for secondary school students. Marks (2008) hypothesized that gender differences at older ages such as in school completion, transition to the university, participation in the labour market and labour earnings are associated with student achievement at lower education levels. In the study, girls performed better than boys in reading while boys performed better than girls in Mathematics. Girls also performed better in countries with a large public sector. Moreover, there was a lower gender gap in Mathematics achievement for countries with more gender equity in the labour market, implying that positive future aspirations in the labour market lowered the gap.

3.2.3 Overview of literature review

The theoretical literature suggests that gender gaps in academic achievement can be attributed to different factors. These include social norms (Marianne, 2011); parents' preferences to invest more in the education of children of a particular sex as compared to the other (Lucas and Mbiti, 2012);

school and non-school factors such as parents' education and household income levels (Machin and McNally, 2005).

Previous studies of gender gaps in student academic achievement have used different approaches. Some have used Oaxaca (1973) approach to decompose gender gaps in test scores (Aslam, 2009[a]; Golsteyn and Schils, 2014). Other studies add a gender dummy to an OLS regression (Asadullah and Chaudhury, 2009; Bedard and Cho, 2010; Dickerson et al., 2015; Rodríguez-Planasa and Nollenbergerb, 2018) yet other studies have used DID approach (Falch and Naper, 2013; Lucas and Mbiti, 2012; Machin and McNally, 2005).

Different authors have suggested different measures for closing the academic achievement gender gap. These include matching students to same-sex teachers (Dee, 2007; Muralidharan and Sheth, 2016) and discrimination in the allocation of more or better resources to one group of students (Asadullah and Chaudhury, 2009; Aslam, 2009[a]; Golsteyn and Schils, 2014).

The previous studies in Kenya that have focused on gender gaps in achievement are (Dickerson et al., 2015; Lucas and Mbiti, 2012). Lucas and Mbiti (2012) concluded that FPE in Kenya did not close the gender gaps in achievement as measured by test scores. Dickerson et al. (2015) showed that access to educational resources does not reduce the gender gap. These studies failed to uncover whether it is the mere availability of the educational resources or it is the differences in utilization of the resources by boys and girls that explain the gender gaps in academic achievement.

This study filled this gap by using the Oaxaca (1973) approach to decompose the gender test score gaps in Mathematics in Kenya at the primary school level. It contributes to the literature by providing empirical evidence to show the proportion of the gender gap explained by differences in educational resource endowments between boys and girls, and the proportion explained by differential utilization of the resources (parameter effect). In addition, the decomposition of gender test score gap is done separately for private and public primary schools' Standard six pupils.

3.3 Methodology

3.3.1 Econometric model

Following Blinder (1973), Jann (2008) and Oaxaca (1973), two separate education achievement equations for boys and girls are estimated in each school type. The mean difference in the test scores is then decomposed into the difference resulting from differences in educational resource endowments between boys and girls, that resulting from differences in returns of the resources on mathematics test scores (coefficients effect), and the gap due to unobservable factors.

$$A_i^b = \beta_o^b + \beta_1^b X^b + \varepsilon^b \tag{13}$$

$$A_i^g = \beta_o^g + \beta_1^g X^g + \varepsilon^g \tag{14}$$

A_i = Mathematics test score of pupil i

X = a vector of pupil characteristics, school characteristics and family background characteristics

b = superscript indicating a male pupil (boy)

g = superscript indicating a female pupil (girl)

$\varepsilon =$ The error term

The *βs* are vectors of coefficients to be estimated

$\bar{A}^b - \bar{A}^g$ is the overall difference in the average test score in Mathematics for boys and girls. This difference is decomposed into two parts. 1) $E = \beta_1^b(\bar{X}^b - \bar{X}^g)$, the explained difference; explained by the differences in resource endowments between boys and girls and 2) $X_g'\left(\beta_1^b - \beta_1^g\right)$ unexplained part hence:

$$\bar{A}^b - \bar{A}^g = \beta_1^b(\bar{X}^b - \bar{X}^g) + X_g'(\beta_1^b - \beta_1^g) \tag{15}$$

The unexplained part is divided into two parts: 1) The difference due to differing returns to the educational resources, $(\beta_1^b - \beta_1^g)\bar{X}^g$ (this is the parameter effect); and 2) the unexplained difference due to unobservable factors, $\beta_o^b - \beta_o^g$.

3.3.2 Descriptive statistics

Sample characteristics are reported separately for male and female pupils in private (Table 6) and public (Table 7) primary schools. A simple t-test for the significance of the average difference between boys' and girls' characteristics is also reported. In both school types, the average test score in Mathematics for male pupils is significantly higher than that of female pupils. In private schools, the average Mathematics score for boys is 59.26% while the average for girls is lower at 56.27%, and therefore a difference of 2.99 percentage points. In public schools, the average Mathematics score is 52.02% for boys and 49.74% for girls, therefore a difference of 2.78 percentage points.

The share of girls from higher socio-economic status (SES) homes is larger than that of boys. In private schools, 9% more girls than boys come from middle SES homes; 9.5% more boys than girls come from low SES homes. In public primary schools, 2.2% more girls than girls come from high SES homes and 2.2% more boys than girls come from low SES. According to Dickerson et al. (2015), girls are likely to come from homes with a higher SES and are therefore less likely to suffer late enrolment in school. In public primary schools, the boys are on average 8 months older than the girls. The age difference between boys and girls is, however, insignificant in private primary schools.

In private primary schools, a higher proportion of the girls' parents (54%) than that of the of boys' parents (43%) have secondary education. This difference is insignificant in public primary schools. However, in public schools, on average, 3.3% more girls than boys get their homework checked by their parents while the difference is insignificant in private schools.

There are no significant differences in most of the teachers' characteristics between boys and girls. However, on average, girls in private primary schools are taught by teachers, with 1.7 more years of experience than boys. Further, on average, 8.3% more girls than boys are taught by female Mathematics teachers in private primary schools.

In private primary schools, on average, 9.8% more boys than girls attend school in urban locations. In public primary school, 2.6% more boys than girls attend schools whose infrastructure is reported to be in good condition. Despite few statistically significant differences in characteristics/resource endowment between boys and girls, most of them being in favour of girls, there are differences in mathematics scores, with boys' performance being higher than girls' performance. The difference in performance may, therefore, not necessarily be explained by the difference in resource endowment between boys and girls.

Table 6: Comparison of characteristics between male and female pupils in private primary schools: t-test, mean (standard deviation)

	Boys	**Girls**	**Difference (boys-girls)**	**t-stat**
Mean mathematics score	59.264 (10.947)	56.274 (9.609)	2.990*** (0.989)	3.024
Pupil's age in months	167.866 (31.255)	156.612 (20.462)	11.253 (2.577)	4.367
SES-Low SES	0.340 (0.475)	0.245 (0.4310	0.095** (0.043)	2.189
SES-Middle SES	0.292 (0.456)	0.383 (0.487)	-0.090** (0.045)	-2.0169
SES-High SES	0.368 (0.483)	0.372 (0.485)	-0.005 (0.046)	-0.1056
Mother's education	0.427 (0.496)	0.541 (0.500)	-0.114** (0.047)	-2.4075
Father's education	0.530 (0.500)	0.607 (0.490)	-0.077 (0.047)	-1.643
Parents signing homework	0.458 (0.499)	0.449 (0.499)	0.010 (0.047)	0.201
Pupil absenteeism	1.043 (2.000)	1.316 (2.606)	-0.273 (0.217)	-1.255
Class size	36.119 (14.123)	35.949 (14.391)	0.170 (1.355)	0.1252
Book-pupil ratio	0.996 (2.508)	1.189 (2.698)	-0.194 (0.247)	-0.786
Number of tuition hours per week	6.075 (6.713)	6.367 (6.349)	-0.292 (0.624)	-0.468
Teacher's test score	75.720 (7.589)	75.308 (7.880)	0.413 (0.851)	0.485
In-service teacher's training	3.478 (7.303)	3.383 (5.615)	0.096 (0.630)	0.152
Teacher's years of professional training	1.346 (0.881)	1.352 (0.864)	-0.006 (0.083)	-0.075

Teacher's experience	9.071 (8.184)	10.765 (7.921)	-1.694** (0.768)	-2.206
Teacher's contract	0.368 (0.483)	0.378 (0.486)	-0.010 (0.046)	-0.2161
Teacher's sex, =1 if female, 0 if male	0.162 (0.369)	0.245 (0.431)	-0.083** (0.038)	-2.191
Headteacher's sex	0.265 (0.442)	0.316 (0.466)	-0.052 (0.043)	-1.195
Condition of school infrastructure	0.577 (0.495)	0.556 (0.498)	0.021 (0.047)	0.444
Teacher's living condition	0.621 (0.486)	0.628 (0.485)	0.007 (0.046)	-0.152
School location	0.680 (0.467)	0.582 (0.495)	0.098** (0.046)	2.153

*Source: Author's computation from the SACMEQ, 2007 data. .***, ** , *: significant at 1%, 5% and 10%, respectively*

Table 7: Comparison of characteristics between male and female pupils in public primary schools: t-test, mean (standard deviation)

	Boys	**Girls**	**Difference (boys–girls)**	**t-stat**
Mean mathematics score	52.020 (8.450)	49.741 (7.247)	2.279*** (0.250)	9.118
Pupil's age in months	169.557 (21.229)	161.482 (18.060)	8.076*** (0.626)	12.906
SES-Low SES	0.452 (0.498)	0.429 (0.495)	0.022 (0.016)	1.423
SES-Middle SES	0.466 (0.499)	0.466 (0.500)	-0.000 (0.016)	-0.031
SES-High SES	0.082 (0.275)	0.105 (0.306)	-0.022** (0.009)	-2.377
Mother's education	0.260 (0.439)	0.287 (0.452)	-0.027 (0.014)	-1.9248
Father's education	0.363 (0.481)	0.384 (0.487)	-0.021 (0.015)	-1.358
Parents signing homework	0.362 (0.011)	0.395 (0.011)	-0.033** (0.015)	-2.123

Pupil absenteeism	1.329 (2.744)	1.109 (2.213)	0.220*** (0.079)	2.784
Class size	44.893 (15.888)	44.508 (16.220)	0.386 (0.509)	0.758
Book-pupil ratio	0.693 (2.176)	0.761 (2.229)	-0.068 (0.070)	-0.972
Number of tuition hours per week	6.332 (6.489)	6.556 (6.617)	-0.224 (0.208)	-1.077
Teacher's test score	74.450 (7.838)	74.554 (7.617)	-0.104 (0.253)	-0.411
In-service teacher's training	30.664 (68.873)	28.790 (66.599)	1.874 (2.147)	0.873
Teacher's years of professional training	2.126 (0.807)	2.090 (0.836)	2.108 (0.013)	1.376
Teacher's experience	14.006 (8.790)	14.077 (8.889)	-0.070 (0.280)	-0.251
Teacher's contract	0.895 (0.307)	0.880 (0.326)	0.015 (0.010)	1.534
Teacher's sex, =1 if female, 0 if male	0.269 (0.444)	0.295 (0.456)	-0.026 (0.014)	-1.797
Headteacher's sex	0.145 (0.352)	0.152 (0.360)	-0.008 (0.011)	-0.681
Condition of school infrastructure	0.158 (0.365)	0.133 (0.340)	0.026** (0.011)	2.288
Teacher's living condition	0.568 (0.495)	0.608 (0.488)	-0.040** (0.016)	-2.561
School location	0.356 (0.479)	0.343 (0.475)	0.012 (0.015)	0.797

Source: Author's computation from the SACMEQ, 2007 data. .***, ** , *: significant at 1%, 5% and 10%, respectively

3.4 Estimation Results and Discussion

This section presents estimation results of Mathematics test scores function for boys and girls, starting with private then followed by public schools (Table 8). It also presents the results on the decomposition of the gender test score gap (Table 9).

3.4.1 Determinants of mathematics score for boys and girls in primary schools in Kenya

In private primary schools, on average, a male pupil from a high SES home background scores 6 percentage points higher than a boy from a low SES background. However, there is no statistically significant difference in performance scores between girls who come from low SES and high SES backgrounds. In public primary schools, a male pupil from a high SES home background scores about 4 percentage points higher than a boy from a low SES background. The result is similar for girls in the same school type.

The positive correlation between a parents' involvement in checking their child's homework and test scores is higher for boys by about 3 percentage points compared to that of girls, in private schools. In public schools, a boy whose homework is checked by the parent scores 0.9 percentage points less than a boy whose homework is not checked; the effect is insignificant for girls. In private schools, the correlation of the parents' education on both the boys' and girls' Mathematics score is statistically insignificant. On the other hand, in public schools, a boy whose mother has a secondary education scores 1 percentage point less that a boy whose mother has no secondary education; a girl whose mother has a secondary education scores 1 percentage point more than a girl whose mother has no secondary education.

Absenteeism negatively affects the boys' score where one day absence reduces the average score of a male pupil in a private school and public school by about 0.8 percentage points and 0.2 percentage points, respectively. There is no statistically significant association between a female pupil's absenteeism and on their Mathematics score in private schools; however, in public schools, a one-day absence from school reduces a girl's score by about 0.2 percentage points. In public schools, an increase in class size by one pupil reduces the boys and girls score by 0.02 and 0.04 percentage points, respectively. There is however, no significant class size association in private schools for both boys and girls. The increase in test scores as a result of a unit increase (the reduction of the number of pupils sharing a book by one pupil) in the text-book-pupil ratio is 0.8 percentage points for a boy in a private school and 0.2 percentage points for a girl in a public school. The result is statistically insignificant for girls in private schools and boys in public schools.

The teacher's cognitive test score has a positive correlation with the girls' but not the boys' score. An increase in the teacher's test score by 1% is associated with a 0.4 percentage point and 0.05 percentage point increase in girls' Mathematics score in private and public schools, respectively. An extra day of teacher's in-service training reduces a boy's score by 1.1 percentage points in private schools. In public schools, an increase in one years of the teacher's experience reduces a boy's score by 0.07 percentage points. The result is statistically insignificant for girls in public schools and for all pupils in private schools. A teacher's permanent contract is associated with a 1.8 percentage points more marks for a male pupil than a male pupil taught by a teacher whose contract is temporary in a public school. The result is statistically insignificant for girls in public schools and all pupils in private schools. A girl taught by a female teacher scores 1.3 percentage points higher than a girl taught by a male teacher; this result is only significant for girls in public schools. In public schools, a boy and girl in a school with a female head-teacher score 2.4 and 1 percentage points higher, respectively, than their counterparts in schools with male head-teachers.

The positive return due to good condition of school infrastructure accrues only to boys in public schools. They score 1.96 percentage points higher than boys in schools where the school infrastructure condition is poor. Lastly, pupils (both male and female) who attend public schools in urban areas score about 2 percentage points higher than pupils in the same school type but whose schools are located in the rural areas.

3.4.2 Decomposition of the mathematics score gender gap in public and private primary schools in Kenya

The results discussed in this section are reported in Table 9. The predicted Mathematics score is higher for boys than for girls in both private and public primary schools. The predicted average scores in private primary schools are 60.7% and 56.9% for boys and girls, respectively, and therefore a difference of 3.8%. The scores in public schools are 52% and 49.7% for boys and girls, respectively, and therefore a difference of 2.3%. For the decomposition, the girls score is the reference point.

In private primary schools, the difference in average Mathematics score between boys and girls resulting from a difference in resource endowment is statistically insignificant. This means that there is no statistically significant difference in resource endowment between boys and girls in private primary schools that would result to or explain the gap in performance between boys and girls. Therefore, the girls would not perform any better or worse if they had the resources available to the boys. The difference due to the parameter effect is 3.34 percentage points. That is, the difference due to the differences in the returns to the educational resources, which is the coefficients attached to the educational resources. This implies that girls would score 3.34 percentage points higher if the relationship between the resources and the test scores were similar to those of boys. It therefore means that boys are able to take advantage of the resources better than girls.

In public primary schools, the difference in average mathematics score between boys and girls resulting from a difference in resource endowment is negative and small, but statistically significant. On average, girls would score 0.74 percentage points lower than boys if they had the same educational resources as boys. This means that girls in public schools have more/better resources than boys, therefore giving the girls educational resources to match those of boys would reduce their (girls) score. The difference due to the parameter effect/coefficients is 2.81 percentage points. This implies that girls would score 2.81 percentage points higher if the relationship between the resources and the test scores would be similar to those of boys. It therefore means that: 1) girls have greater access to educational resources than boys; and 2) boys are able to take advantage of the educational resources better than girls. In both public and private primary schools, the difference in test scores between boys and girls due to un-observables is statistically insignificant.

The results in both private and public primary schools contradict Golsteyn and Schils (2014) who found that in Netherlands, boys perform better due to exposure to more educational resources. On the other hand, the results corroborate the evidence by Asadullah and Chaudhury (2009) who concluded that concentration on resource-based policies geared towards addition of educational resources to the group whose academic achievement is low in order to reduce the gender gap may cause a reversal of the gap. In this case, if girls continue receiving more resources in a case where the educational resources to boys and girls are in fact equal or the girls have more resources, it may do little to close the gender gap in test scores if the gap is as a result of differences in resource utilization. The result may be a reversal of the academic achievement gender gap.

Table 8: OLS estimates of mathematics test scores production function by gender and school type

	Private primary schools		Public primary schools	
	Boys	**Girls**	**Boys**	**Girls**
Pupils age	-0.0712*	-0.1010*	-0.0608***	-0.0626***
	(0.0365)	(0.0539)	(0.0093)	(0.0093)
Pupil SES (base- low SES)				
Middle SES	5.1414**	2.7706	0.6360	0.0977 (0.4161)
	(2.3990)	(2.3188)	(0.4934)	
High SES	6.0406*	1.7541	3.7997***	3.5069***
	(3.2089)	(2.9089)	(0.9517)	(0.7526)
Parent's education (base-below secondary education)				
Mother's education	-0.9119	0.6153	-1.0020*	1.0451**
	(1.7637)	(1.8104)	(0.5393)	(0.4463)
Father's education	-2.3427	-2.2052	0.3970	0.5432 (0.4178)
	(1.8929)	(1.9772)	(0.5016)	
Parents homework signing: =1 if yes, 0 if no	11.4372***	8.8175***	-0.9886**	-0.2319
	(2.6301)	(2.7445)	(0.4082)	(0.3381)
Pupil absenteeism	-0.8424***	-0.1824	-0.1861***	-0.2019***
	(0.3071)	(0.2265)	(0.0675)	(0.0701)
Class size	0.1317	-0.1189	-0.0245*	-0.0419***
	(0.1174)	(0.1387)	(0.0131)	(0.0108)
Book-pupil ratio	0.8093**	0.2166	0.1397	0.1683**
	(0.3945)	(0.4027)	(0.0905)	(0.0749)
Number of tuition hours per week	-0.1445	-0.2035	0.0195	0.0531**
	(0.1344)	(0.1303)	(0.0298)	(0.0241)
Teacher's test score	0.1372	0.4215**	0.01718	0.0530**
	(0.1845)	(0.1768)	(0.02488)	(0.0216)
In-service teacher's training	-1.1096**	-0.4022	-0.0017	-0.0052**
	(0.4537)	(0.5111)	(0.0027)	(0.0024)
Teacher years of professional training	-0.7318	-10.2796**	-0.3481	0.4481**
	(2.8397)	(5.3335)	(0.2655)	(0.2132)
Teacher experience	-0.1997	0.0223	-0.0787***	-0.0228
	(0.1366)	(0.1518)	(0.0252)	(0.0211)
Teacher contract; 1 if permanent, 0 if temporary	2.5826	-3.2177	1.7594**	-0.3450
	(2.9307)	(3.2134)	(0.7437)	(0.6160)

Living conditions, =1 if good, =0 if poor	1.3931 (4.4899)	23.0822** (9.3536)	0.9081** (0.3931)	0.5498 (0.3341)
Teacher's sex =1 if female, 0 if male	0.2486 (1.9680)	2.0255 (1.7645)	0.6057 (0.4412)	1.3479*** (0.3604)
Head-teacher's sex =1 if female, 0 if male	2.2232 (3.6781)	4.5278 (3.6410)	2.3865*** (0.5682)	1.0440** (0.4607)
School infrastructure condition=1 if good,= 0 if poor	-4.0493 (2.9533)	-9.1765*** (2.9380)	1.9625*** (0.5288)	0.0194 (0.4632)
School location; =1 if urban and 0 if rural	1.4120 (2.5713)	1.8130 (2.3725)	1.8083*** (0.4421)	1.9387*** (0.3814)
Constant	51.7583*** (13.9170)	41.4936*** (14.5400)	60.3755*** (2.6424)	54.9465*** (2.3713)
n	179	152	1,931	1,806
R^2	0.5182	0.4060	0.1045	0.1700

*Standard errors in brackets.***, ** , *: significant at 1%, 5% and 10%, respectively*

Table 9: Decomposed mathematics test scores gender gap

	Boys Predicted score	Girls Predicted score	Total Difference	Endowments	Coefficients	Unexplained Difference
Private school pupils	60.6775*** (0.8398)	56.8976*** (0.7401)	3.7798*** (1.1195)	-0.2426 (0.8710)	3.3441*** (0.9757)	0.6784 (0.8123)
Public school pupils	51.9791*** (0.1951)	49.7190*** (0.1703)	2.2601*** (0.2590)	-0.7361*** (0.1253)	2.8091*** (0.2562)	0.1871 (0.1217)

*Standard errors in brackets.***, ** , *: significant at 1%, 5% and 10%, respectively*

3.5 Summary, Conclusion and Policy Implications

This section presents the summary of this essay on gender gaps in mathematics test scores of standard six pupils in Kenya, the conclusions made and the derived policy implications.

3.5.1 Summary and conclusion

In Kenya, gender gaps are observed in various education outcomes, including enrolment, test scores and transition to higher levels of education. There have been attempts to close these gaps, including through introduction of FPE. However, FPE did not close the gender gap in test scores (Lucas and Mbithi, 2012). In particular, gender gap in mathematics still persist (KNEC, 2018; Wasanga et al., 2011).

This paper applied Oaxaca (1973) decomposition approach to explain the gender gap in Mathematics scores using scores of Standard six pupils in Kenya. Since primary education in Kenya is provided by government and private sector, the study sought to understand the academic achievement gender gap in both private and public primary schools. In particular, the study investigated whether the gap is explained by the difference in educational resource endowment or by differences in the utilization of the resources between boys and girls.

The results show a sizable Mathematics score gender gap in favour of boys in both public and private primary schools. First, the t-test results in Tables 7 and 8 show that there are only a few significant differences in resources endowment between boys and girls in both private and public primary schools, with girls being more advantaged compared to boys. Second, the decomposition results (Table 9) show a difference in educational resource endowment in favour of girls in public primary schools, and an indication of equality in resource allocation between boys and girls in private primary schools. The two results thus show that differences in resource endowment do not necessarily account for the gender test score gap in academic achievement. The decomposition results further show that the differences in utilization of the resources between boys and girls explain their differences in test scores. In both school types, boys take better advantage of the available educational resources than girls. The girls score can thus be improved by better utilization of the available resources.

3.5.2 Policy implications

Gender gap in Mathematics score uncovered in this study in both public and private primary schools can provide motivation to the government and private school owners to formulate measures of reducing the academic achievement gender gap. While introduction of FPE in 2003 increased access to primary school education, the finding in this study implies that a gender gap in academic achievement still exists, and specifically in Mathematics where boys out-perform girls.

The current curriculum piloted nationally in 2019 aims to promote STEM subjects and ensure that girls improve performance in these subjects. It is therefore important to address the causes of the gender gaps in Mathematics. The debate around reduction of gender gaps in education outcomes is usually around the provision of resources equally to both boys and girls or to increase resources to the low performing group. However, the results in this study show that the gender gaps in academic achievement may not be necessarily explained by resource gaps between boys and girls. The utilization of the resources explains most of the gap. Boys are seen to take more/better advantage of the available resources than girls. The girls' score would, therefore, improve by improving utilization of the available educational resources. Addition of school resources without considering how they are utilized may actually cause a reversal of the gender gap in academic achievement. It is thus important for school managers to consider evaluating how girls learn to ensure that they benefit from available resources. This study does not, however, dwell on the factors that influence utilization of educational resources. It also does not decompose the gender gap to the extent of explaining the gap that can be explained by each of the factors in the academic achievement production function.

CHAPTER FOUR: A QUANTILE REGRESSION ESTIMATION OF THE ACADEMIC ACHIEVEMENT PRODUCTION FUNCTION

4.1 Introduction

4.1.1 Background

The government and the private sector as providers of education generally consider increase in education resources as one of the ways to improve academic achievement. Educational resources not in the control of education providers, such as the home background of the pupil, also have an impact on academic achievement. However, research evidence is inconclusive on the effects of resource-based policies on academic achievement. This may make it difficult for policy makers to allocate scarce resources in education.

Pupils in the same class differ in their academic ability. Classes tend to have a mixture of academically strong, average and academically weak students. Tracking of classes, that is, where students are divided into different classes according to their academic ability has been suggested as one of the ways of improving performance especially in cases where teaching methods are geared more towards academically strong students (Duflo et al., 2011). Duflo et al. (2011) found that tracking helps to improve performance of both the high performing pupils and low performing pupils, especially where teachers change to teaching methods that suit the low achievers. According to Duflo et al. (2011), tracking is a way to improve performance without necessarily adding resources. However, this may lead to loss of positive peer effects present when both academically strong and weak students attend the same classes.

Tracking of classes may not be costless. For instance, there may be need to put more resources in classes attended by the weaker students to improve their performance. In developing economies, tracking is not common and may even be costly especially due to the already existing constraints of teacher and infrastructure shortages. In that case, investment in the scarce resources to improve overall performance may be achieved by other methods such as investing in educational resources that improve the overall performance of pupils. Research shows that, on average, educational resources can have insignificant effects on test scores (Hanushek, 2003). However, such resources may improve overall performance by increasing test scores of some students along the test score distribution (Glewwe et al., 2009). Glewwe et al. (2009) therefore justifies the use of quantile regressions in estimating education production functions to uncover the relationship between educational resources and test scores across the test score distribution. The major strength of using quantile regression approach as opposed to the classical linear regression in the estimation of an education production function is that the quantile regression results enable policy makers to identify and develop programmes and educational resources that enhance equity in academic achievement (Costanzo and Desimino, 2017).

4.1.2 Research problem

Academic achievement as measured by average test scores in primary schools in Kenya is generally low (Uwezo, 2014). However, the average scores mask large inequalities in academic achievement. Such education inequalities at lower levels of the education system lead to further inequalities in access to higher levels of education, and opportunities in the labour market (Marks, 2008).

The Kenya Government has increased funds to the education sector, especially after the introduction of FPE. For example, total expenditure for the education sector grew by 31.6% from Ksh 315.6 billion in 2016/17 to Ksh 415.3 billion in 2017/18 (Republic of Kenya, 2018). However, research has often not shown a positive relationship between increase in educational inputs and academic achievement (Bold et al., 2013; Duflo et al., 2007a). One explanation could be that the effect of education resources on academic achievement may differ along the test score distribution. That is, the effect of educational resources on test scores may differ between pupils with high scores and pupils with low scores. For example, while some resources such as text books improve the performance of academically strong students, they do not have any effect on the performance of academically weak students (Eide and Showalter, 1998; Glewwe et al., 2009).

If academically strong and academically weak pupils have different returns from education resources, there would be need to target educational resources to bridge the gap in achievement. However, empirical evidence of relationship between education achievement and education resources along the test score distribution in Kenya is lacking. The question is; for whom do the resources matter? Specifically, this study answers the question: ***What is the relationship between***

school type and educational resources and academic achievement across the test score distribution of class six pupils in primary schools in Kenya?

4.1.3 Research objectives

The main objective is to assess whether the effect of school type and education resources varies across the test score distribution.

Specific objectives:

(i) To examine the relationship between school type and test scores across the test score distribution of class six primary school pupils.

(ii) To examine the relationship between educational resources and academic achievement across the test score distribution of class six primary school pupils.

(iii) To draw policy implications based on the study findings.

4.2 Literature Review

4.2.1 Theoretical literature

There are several possible explanations for differences in performance between high performing pupils and low performers. These include peer effects; that is, group behaviour may impact on individual behaviour. High performing pupils influence each other while low performing pupils influence each other when grouped together (Lavy, Silky and Weinhardt, 2012).

Secondly, although the importance of educational resources in explaining academic achievement is disputed (Hanushek, 1986; Hanushek, 2003), resources may still explain academic achievement. Thus, variations in performance between high performing and low performing students may be explained by variations in the resources availed to the different pupils. Literature that has documented positive educational resource effect on academic achievement imply that resource gaps explain the gap in achievement. Thus, there is probability that there are inequalities in allocation of educational resources between high and low performers. These resources include school resources and home background characteristics. High performers could then be exposed to more of these resources as compared to low performers, explaining the academic achievement gap between the different students.

4.2.2 Empirical literature

Previous studies on the effect of resources on student achievement, including Carnoy, Ngware and Oketch (2015), Das et al. (2013), Duflo et al. (2007a) and Hanushek (1986) obtained contradictory results on the effect of educational resources on academic achievement. For example, Hanushek (1986) posits that input based policies do not necessarily improve academic achievement. However, the lack of relationship between educational resources and academic achievement may be explained by the heterogeneity in the effect of resources on education achievement. For example, the effect of education resources on academic achievement may differ with the pupils' academic ability. In the presence of such heterogeneity, an education production function that estimates the effect of educational resources on mean test scores will not differentiate that effect between pupils of different abilities. Quantile regressions help in revealing such heterogeneity.

Earlier studies in education using quantile regression approach include Eide and Showalter (1998). The study estimated quantile regressions to examine whether the quality of school determines test scores and whether the effects vary across the distribution of test scores. The study used data on Mathematics test score gain between junior and senior public high school in USA to obtain OLS estimates and quantiles (0.05, 0.25, 0.50, 0.75 and 0.95) estimates. OLS results revealed that pupil-teacher ratio, length of school year, expenditure per pupil and teacher's education level were not significant in determining the Mathematics test score. However, quantile regression estimates showed that length of school year significantly improved student achievement for the 0.50, 0.75 and 0.95 quantiles. That is, extra class time improved performance for top students but not for low performing students. The effect of expenditure per child on academic achievement was significant for the students at the bottom of the test score distribution, that is, the 0.05 quantile.

Using data from schools in Italy, Costanzo and Desimino (2017) estimated the education production function using quantile regression to investigate the role of gender and school geographical location on student performance. The study reported that for Grade 2 and 5 students, gender gaps in Mathematics scores in favour of male students widened from the lower to the higher quantiles. Further, geographical location of the school only affected pupils' Mathematics performance for pupils in the lowest/10th percentile.

In Kenya, Glewwe et al. (2009) carried out a randomized evaluation study to measure the impact of text books on test scores in rural primary schools. The study analyzed test scores in reading, Mathematics and Science. The DID estimates showed insignificant impact of textbooks on mean test scores. However, when the pupils were divided into five quantiles reflecting performance along the distribution of test scores, textbooks had significant impact on performance of the students in the first three quantiles and insignificant impact on the lower (fourth and fifth) quantiles. The authors concluded that provision of textbooks only benefitted the academically strong pupils.

Rangvid (2003) investigated peer effects on reading abilities for students with different reading abilities for fifteen year old students in Denmark. While OLS results showed that attending classes with better peers increases the literacy scores, quantile regression estimates showed that peer effect is stronger for weak students. This effect declined at higher quantiles. These results justified mixing students with different reading abilities to improve overall performance.

Wöessmann (2005) used quantile regressions to estimate the effect of international exit examinations scores on student performance in secondary school. Using panel data from different countries, the results revealed that the effect increased with student ability. The effect was lower for students at the lowest quantile (5^{th}) than for students at the highest quantile (95^{th}).

Several researchers have used quantile regressions to analyze heterogeneous effects of resources on student performance at the university level. This include studies by Arulampalam, Naylor and Smith (2012), Bandiera, Larcinese and Rasul (2010) and Birch and Miller (2006). Birch and Miller (2006) tested whether secondary school performance is a good predictor for first year university performance based on cross-sectional data of school leavers in Australia. OLS results showed that the entry scores were positively correlated with the first year university scores. On the other hand, quantile regression results showed that the impact of secondary school achievement on first year university scores varied across the grade distribution, and specifically for the 65^{th} and 80^{th} quantiles. For the 85^{th} quantile and above, that is, students who performed extremely well at the university level, secondary school performance did not influence their performance in the first year of university. Secondary school scores only explained first year university performance for students at the lower quantiles.

Arulampalam et al. (2012) analyzed panel data from a university in the United Kingdom to test the hypothesis that the effect of student absenteeism on student performance varies with student ability. The results showed that the negative effects of missing class on test scores were greater for high ability (top 10% of the test score distribution) students than for low ability (bottom 10% of the test score distribution) students. The conclusion was that the marginal product of class attendance is higher for high ability students than for low ability students.

Similar effects on high ability students at a university in the United Kingdom were observed by Bandiera et al. (2010). Using panel data, the study used quantile regressions to estimate the effect of class size on student performance. There was evidence that high grade students would benefit from class size reduction when class size is very big. This implies that there could be change in faculty behaviour associated with big class sizes, and this behaviour may impact more negatively on high ability students. However, for small class sizes, with less than 33 students, large class sizes were associated with reduction of test scores of students in all quantiles. For medium class sizes, there was zero class size effect for all students across the different quantiles.

Instead of using the quantile regression approach, Gronqvist and Vlanchos (2016) interacted the teacher cognitive abilities with the student GPA to test whether the effect of teacher ability on student performance varies with student GPA in middle/high school grades in Sweden. This is a different approach for estimating the heterogeneous effects of covariates on the dependent variable. The results showed that high teacher cognitive abilities benefitted students with high GPA while the same was a loss to students with low GPA.

4.2.3 Overview of literature review

Possible explanations of differences in academic achievement between pupils include peer effects and differences in access to educational resources by the different pupils. The quantile regression method introduced by Koenker and Basset (1978) has enabled the estimation of heterogeneous effects of covariates on different economic outcome distributions. This includes effect of education resources on academic achievement, which may differ with academic ability of different students.

The studies reviewed give evidence of the usefulness of quantile regressions in analyzing the education production function. First, there is evidence of heterogeneous effects of the covariates on test scores. These studies include Costanzo and Desimino (2017), Eide and Showalter (1998), Glewwe, Kremer and Moulin (2009) and Wöessmann (2005). Using the quantile regression approach and data on Kenya, Glewwe et al. (2009) showed that education resources could have differential impact on test scores for academically strong students and academically weak students. Second, there are heterogeneous effects of the used covariates on performance at university level (Arulampalam et al., 2012; Bandiera et al., 2010; Birch and Miller, 2006).

The reviewed studies are evidence that while some input-based education policies may be dismissed on the premise that they do not improve average academic achievement, some inputs may be effective in improving the performance of some students and not others, depending on the student's academic ability. Moreover, many of these studies have been carried out in developed economies apart from Glewwe et al. (2009), whose focus was on the heterogeneous effect of textbooks on test scores in Kenya. This study was limited to Western Kenya. There is no study that has used country wide data in Kenya to estimate the education production function to examine heterogeneity in returns to education resources.

4.3 Methodology

4.3.1 Econometric model

Impact of resources on achievement across the test score distribution

In this study, the quantile regression approach was used to examine the relationship between educational resources and school type and pupils' test scores along the conditional distribution of test scores. The effect of inputs on academic achievement may be over/under predicted at the average test scores, hence the use of quantile regressions (Glewwe et al., 2009).

The general quantile regression model according to Buchinsky (2000) is:

$$y_i = x_i\beta_0 + u_0 \tag{16}$$

$$Quant_\theta(y_i|x_i) = x_i\beta_0 \tag{17}$$

$Quant_\theta(y_i|x_i)$ is the conditional quantile of y_i and x is a vector of regressors.

Assume that $Quant_\theta(u_\theta|x_i) = 0$. That is, the residuals from the quantile are minimized.

Quantile regressions minimize the sum of absolute residuals from each quantile (Koenker and Basset, 1978; Koenker and Hallock, 2001).

$$\text{Min} \sum_{t=1}^{T} \theta |y_i - (\beta_0 + \cdots, +\beta_i x_i)| + \sum (1-\theta)|y_i - (\beta_0 + \cdots + \beta_i x_i)| \tag{18}$$

θ is the conditional quantile of y given x.

The achievement production function to be estimated is therefore:

$$A_i = \alpha + \beta_{\mathrm{q}} X_i + \nu_i \tag{19}$$

$$Q_q(A_i|X_i) = \beta_q X_i \tag{20}$$

The parameter β_q in $\beta_q X_i$is the effect of X on achievement, A, for the q^{th} quantile of the dependent variable, in this case test scores.

Koenker and Basset (1978) introduced quantile regressions. This work was advanced by Koenker and Hallock (2001), explaining quantile regressions as a methodology that allows for the minimization of weighted sum of absolute errors by estimating conditional quantiles. This enables the estimation of effects of the independent variables on the distribution of the dependent variable.

The quantile regression approach is used to show the differences in response of the dependent variable to changes in the regressors at different points of the distribution of the dependent variable (Buchinsky, 2000). One of the goals of the quantile regression approach is to reduce the influence of outliers in a regression that would be more perverse when using OLS. The standard OLS estimates the relationship between the independent variables on the conditional mean of the dependent variable, and therefore gives one set of coefficients. On the other hand, quantile regression models the relationship between the independent variables and the conditional quantile of the dependent variable, and therefore gives different sets of coefficients.

While OLS minimizes the sum of squared residuals, quantile regression minimizes the sum of absolute deviations in the i^{th} quantile (Koenker and Bassett, 1978). Once a conditional quantile/ median is chosen, some values lie below while others lie above the regression line/the median. This implies that there will be both positive and negative errors, thus, under quantile regressions the sum of absolute deviations is minimized. The minimization of the absolute errors gives a symmetric penalty for over and under prediction.

Chapter two gives evidence of unobserved heterogeneity in the Mathematics scores production function. This was controlled for using the control function approach, and therefore the quantile regression estimates for the Mathematics production function are based on the control function variables. However, since no bias in the OLS estimates was uncovered in the reading scores production function, the quantile regression estimates were obtained using OLS.

4.3.2 Descriptive statistics

The sample of pupils was divided into three categories for this study: academically strong pupils (75^{th} percentile), median (50^{th} percentile) and academically weak (25^{th} percentile) pupils. Tables 10 and 11 show the differences in characteristics between the three categories of pupils considering reading and Mathematics scores, respectively.

The first category constitutes of pupils in the top one-third of the distribution of test scores. The average score is 69% and 61% in reading and Mathematics, respectively. These are the academically strong pupils. The second category constitutes of pupils in the second one-third of the distribution of test scores. The mean score is 57% and 51% in reading and Mathematics, respectively. These are average performance pupils. The third category constitutes of pupils in the bottom one-third of the distribution of test scores. Their average score is 46% and 44% in reading and Mathematics, respectively. These are the academically weak pupils.

The statistics show that 20% of the pupils who attend private primary schools are academically strong pupils. This is four times the proportion of the academically weak pupils who attend private schools. The academically weak pupils are, on average, older than the academically strong pupils.

The socio-economic status of the pupils also differs. The academically weak pupils come from poor home backgrounds compared to other pupils. Considering the reading score results, 56% of the academically weak pupils come from homes with low socio-economic status while only 27% of the academically strong pupils come from such homes (low SES). Similarly, academically strong pupils have more educated parents than academically weak pupils. Considering both reading and Mathematics subject, above 40% of the mothers and above 50% of the fathers of the academically strong pupils have secondary education. For the academically weak pupils, only about 20% and 30% of the mothers and fathers, respectively, have secondary education.

The highest proportion of pupils whose teachers require the parents to sign pupil's assignments is from the academically strong pupils, followed by the weak pupils then the average pupils. Pupils in all quantiles received about six hours of extra tuition per week. Pupil absenteeism among the academically weak pupils was higher (1.5 days) than among the academically strong pupils (less than a day).

The academically strong pupils generally learn in better learning environment than the academically weak pupils. On average, a pupil in the top (0.75) quantile is in a smaller class, 43 pupils in a class compared to class size of 44 and 45 pupils for the average (0.50 quantile) and academically weak (0.25 quantile) pupils, respectively. The academically strong pupils have greater access to textbooks and schools whose infrastructure is in good condition than the weak pupils. The book-pupil ratio reduces as you move from the top to the bottom quantile. The book-pupil ratio is 1:1 for pupils in the 75th percentile and 0.5:1 for pupils in the 25th percentile.

There are also differences in teachers' characteristics across the three categories of pupils. Average in-service training days of teachers who teach the academically weak pupils was approximately 30 and 32 days for reading and mathematics teachers, respectively, over the previous three months before the survey. Among teachers who teach the academically strong pupils, average in-service training days is lower at approximately 23 and 21 days for reading and Mathematics teachers, respectively, over the same period.

However, academically strong pupils are taught by reading teachers with more professional training (2.2 years) than the teachers teaching the academically weak pupils (2 years). The Mathematics teachers have, on average, the same number of years of professional training (about 2 years) across all quantiles.

About 64% of the teachers who teach the academically strong pupils live in good conditions while 56% of the teachers who teach the academically weak pupils live in good conditions. The chances of having a reading teacher with a permanent contract increases with the academic strength of the pupil. The proportion of the academically strong pupils taught by female teachers (52% and 31%

for reading and mathematics, respectively) is higher than that of academically weak pupils (40% and 22% for reading and mathematics, respectively).

Lastly, the percentage of academically strong pupils whose schools are in urban areas is higher than that of the average and academically weak pupils. Considering reading, 55% of the academically strong pupils go to schools in urban areas compared to 36% of the average pupils and 25% of the academically weak pupils.

Table 10: Difference in pupils' characteristics along the test score distribution in reading; mean (standard deviation)

	Academically strong pupils (75th quantile)	Average pupils (50th quantile)	Academically weak pupils (25th quantile)
Proportion of pupils in private schools	0.1997 (0.4000)	0.0615 (0.2402)	0.0513 (0.2207)
Reading score	68.9985 (6.0710)	56.5587 (2.6462)	45.9660 (4.5776)
Pupils age in months	157.9178(19.2881)	165.9353 (19.8112)	171.5526 (21.6640)
SES- low SES	0.2704 (0.4443)	0.4317 (0.4955)	0.5638 (0.4961)
SES- middle SES	0.4521 (0.4979)	0.4944 (0.5001)	0.4099 (0.4920)
SES- high SES	0.2776 (0.4480)	0.0739 (0.2617)	0.0263 (0.1601)
Mothers education	0.4492 (0.4976)	0.2662 (0.4421)	0.1789 (0.3834)
Father's education	0.5357 (0.4989)	0.3636 (0.4812)	0.2914 (0.4546)
Parent's signing reading homework	0.4261 (0.4947)	0.3342 (0.4719)	0.3711 (0.4832)
Pupil absenteeism	0.9488 (2.2635)	1.1105 (2.2604)	1.5651 (2.8335)
Class size	42.5169 (16.1281)	43.7639 (15.6427)	45.0915 (16.3980)
Book-pupil ratio	1.0854 (2.8406)	0.6741 (1.9433)	0.5555 (1.8516)
Number of tuition hours per week	6.7794 (6.8855)	6.2858 (6.2493)	6.2178 (6.5269)
Reading teacher's test score	82.9700 (5.4585)	82.3083 (5.4771)	82.3190 (5.7861)
In-service reading teacher's training	23.5343 (65.6005)	31.7724 (76.0993)	29.9184 (67.1780)
Reading teacher's years of professional training	2.1867 (0.8159)	2.0438 (0.9030)	1.9066 (0.9132)
Reading teacher experience	12.5516 (8.6002)	12.6213 (9.0347)	12.3480 (9.3130)
Reading teacher's contract	0.8320 (0.3740)	0.8136 (0.3896)	0.7704 (0.4207)
Reading teacher's sex, =1 if female, 0 if male	0.5220 (0.4997)	0.4722 (0.4994)	0.4013 (0.4903)
Head-teacher's sex, =1 if female, 0 if male	0.2459 (0.4307)	0.1419 (0.3491)	0.1072 (0.3095)
Condition of school infrastructure	0.2783 (0.4483)	0.16429 (0.3707)	0.1368 (0.3438)
Reading teacher living condition	0.6655 (0.4720)	0.1589 (0.3657)	0.5632 (0.4962)
School location	0.5458 (0.4981)	0.3597 (0.4801)	0.2454 (0.4305)

Source: Author's computation from the SACMEQ, 2007 data

Table 11: Difference in pupils' characteristics along the test score distribution in mathematics; mean (standard deviation)

	Academically strong pupils	Average pupils	Academically weak pupils
Proportion of pupils in private schools	0.1956 (0.3968)	0.0671 (0.2504)	0.0490 (0.2160)
Reading score	61.1685 (6.7689)	51.2760 (1.6314)	43.7227 (3.8697)
Pupils age in months	160.8180 (20.8189)	165.4650 (20.5697)	169.1103 (20.8730)
SES- low SES	0.3198 (0.4666)	0.4357 (0.4960)	0.5110 (0.5000)
SES- middle SES	0.4390 (0.4964)	0.4814 (0.4998)	0.4375 (0.4962)
SES- high SES	0.2413 (0.4280)	0.0829 (0.2757)	0.0515 (0.2210)
Mothers education	0.3976 (0.4896)	0.2800 (0.4492)	0.2157 (0.4114)
Father's education	0.4946 (0.5001)	0.3879 (0.4874)	0.3094 (0.4624)
Parent's signing homework	0.4276 (0.4949)	0.3457 (0.4758)	0.3560 (0.4790)
Pupil absenteeism	0.9957 (2.3452)	1.1314 (2.2604)	1.4786 (2.7400)
Class size	42.5289 (15.9585)	43.3029 (6.1477)	45.3658 (16.0192)
Book-pupil ratio	1.0595 (2.8164)	0.7398 (2.0772)	0.5266 (1.7554)
Number of tuition hours per week	6.7352 (6.7382)	6.4571 (6.4180)	6.1207 (6.4931)
Mathematics teacher's test score	75.3004 (7.9589)	74.5038 (7.3701)	73.9300 (8.0221)
In-service mathematics teacher's training	21.2761 (56.5387)	27.2957 (63.2705)	31.5527 (70.7254)
Mathematics teacher's years of professional training	2.0245 (0.8653)	2.0811 (0.8618)	2.0613 (0.8498)
Mathematics teacher experience	13.4647 (8.7109)	13.5364 (8.9434)	13.7935 (8.9072)
Mathematics teacher's contract	0.7894 (0.4079)	0.8621 (0.3449)	0.8511 (0.3561)
Mathematics teacher's sex, =1 if female, 0 if male	0.3148 (0.4646)	0.2950 (0.4562)	0.2200 (0.4144)
Head-teacher's sex, =1 if female, 0 if male	0.2459 (0.4307)	0.1650 (0.3713)	0.1183 (0.3230)
Condition of school infrastructure	0 .2627 (0.4402)	0.16429 (0.3707)	0.1458 (0.3530)
Mathematics teacher living condition	0.6395 (0.4803)	0.5814 (0.4935)	0.5582 (0.4968)
School location	0.5096 (0.5001)	0.3464 (0.4760)	0.2941 (0.4558)

Source: Author's computation from the SACMEQ, 2007 data

4.4 Estimation Results and Discussion

This section presents and discusses the quantile regression results in Table 12. Three quantiles, 25th, 50th and 75th percentiles were used to represent the academically weak, average and academically strong pupils, respectively. The aim was to test the hypothesis that the relationship between school type and educational resources on test scores differs across the test score distribution.

Similar to the results in Chapter 2, the quantile regression results show evidence of unobserved heterogeneity in the Mathematics scores production function across all quantiles. For the reading score function, the OLS results are unbiased as there was no evidence of endogeneity or unobserved heterogeneity as observed in essay 2 of this thesis.

Private school is positively correlated with both reading and Mathematics scores in all quantiles. The correlations increase as you move from the 25th to the 75th percentile. In the reading achievement equation, private primary school correlation estimates are 4.05, 4.51 and 5.15 percentage points for pupils in the 25th percentile, 50th percentile and 75th percentile, respectively. In the Mathematics achievement equation, the corresponding private school correlations with the test scores are 4.19, 6.40 and 5.99 percentage points. This means that, on average, a pupil in a private primary school attains higher scores in both subjects than a pupil in a public primary school irrespective of the quantile.

Mother's education is positively correlated with reading test scores for pupils in the 50th percentile. Pupils of mothers with secondary education in the 50th percentile score 0.83 percentage points higher in reading than pupils in the same percentile whose mothers do not have secondary education. The result is insignificant for pupils in the 75th and 25th percentiles.

Quantile regression results indicate that class size is negatively correlated with the test scores. The magnitude of the class size effect is similar in all conditional quantiles. An increase in class size by one pupil is associated with a reduction in the pupil's score by 0.05 and 0.04 percentage points in reading and Mathematics, respectively. However, class size may be endogenous (Altinok and Kingdon, 2012), though this is not the focus in this study, and therefore we assume that class size is exogenous.

In the reading achievement equation, the quantile regression indicates a positive book-pupil ratio correlation for pupils in the 25th percentile only. A one-point increase in the book-pupil ratio (reduction in the number of pupils sharing a book by one pupil) is associated with an 0.22 percentage points increase in reading score for a pupil in the 25th percentile. A one-point increase in the book-pupil ratio is associated with an increase in Mathematics score by 0.16 and 0.18 percentage points for pupils in the 25th and 50th percentiles, respectively. The result is, however, insignificant for pupils in the 75th percentile. These results indicate that the academically weak pupils benefit more from availability of textbooks than other pupils. This is inconsistent with the findings by Glewwe et al. (2009) who found that textbooks improved only the scores of academically strong students and no statistically significant effect on the average test scores of all the students. The results in this study may be indicative of diminishing returns from textbooks, such that an additional book would be of greater benefits to an academically weak pupil than to an academically strong pupil.

Extra tuition does not significantly raise test scores over much of the distribution. The quantile regression results indicate that tuition is only statistically significant in explaining test scores for pupils in the 50th percentile. An extra tuition hour increases the reading and Mathematics score by 0.06 and 0.03 percentage points, respectively.

Teachers years of professional training improve reading test scores for pupils in all quantiles while the result is statistically insignificant on the Mathematics test score. There is no statistically significant association between teacher experience and pupils' reading scores across the three quantiles. However, the association between teacher's experience and Mathematics test scores is significant and negative for pupils in the 50th and 75th percentiles. An extra year of experience is associated with a reduction in the pupil's Mathematics score by 0.03 and 0.05 percentage points in the 50th and 75th percentiles, respectively.

The result on the relationship between the teacher's cognitive ability variable and reading achievement is statistically insignificant across all quantiles. However, a percentage point increase in the teacher's Mathematics score is associated with a 0.06 percentage points increase in the Mathematics score for pupils in the 25th and 50th percentiles.

Teachers employed on permanent contracts produce higher reading test scores than teachers on temporary contracts in all quantiles. This result is lowest at the 25^{th} percentile and highest at the 75^{th} percentile. As compared to a pupil taught by a teacher whose contract is temporary, a pupil taught by a teacher with a permanent contract scores 1.12, 1.94 and 2.59 points higher if in the 25^{th}, 50^{th} and 75^{th} percentiles, respectively. The relationship between teacher's contract and Mathematics score is statistically insignificant for pupils in all quantiles.

The quantile regression results show that the effect of the infrastructure condition on test scores varies across the conditional test score distribution. The result is insignificant on the scores of academically weak pupils for both reading and Mathematics. The reading score for a pupil in the 50^{th} and 75^{th} percentile is higher by 0.91 and 1.91, respectively, for a pupil in a school whose infrastructure is in good condition than for a pupil in a school whose infrastructure is in poor condition in the respective percentiles. For Mathematics, the score for a pupil in the 75^{th} percentile is 1.09 higher for a pupil in a school whose infrastructure is in good condition than for a pupil in a school whose infrastructure is in poor condition in the respective percentile.

A pupil taught by a female Mathematics teacher scores about 1 percentage point higher than a pupil taught by a male teacher in the same subject across all quantiles. The sex of the teacher has no significant result on the reading score. A pupil who attends a school with a female headteacher scores about 2 percentage points higher in reading across all quantiles compared to a pupil who attends a school with a male headteacher. For Mathematics, the sex of the headteacher is only statistically significant for pupils in the 75^{th} percentile, where a pupil who attends a school with a female headteacher scores about 1.1 percentage points higher compared to a pupil who attends a school with a male headteacher in the respective percentiles.

Table 12: Quantile regression results

	Reading score			Mathematics score		
	0.25 Quantile	**0.50 Quantile**	**0.75 Quantile**	**0.25 Quantile**	**0.50 Quantile**	**0.75 Quantile**
Generalised residual	-	-	-	2.1084*** (0.7925)	1.6332* (0.8786)	3.1393** (1.2695)
Generalised residual*school type	-	-	-	-2.9921** (1.4997)	-3.1302*** (0.9086)	-3.6805* (2.1346)
School type: =1 if private, 0 if public	4.0489*** (1.2034)	4.5053*** .9040816	5.1453*** (0.9750)	4.195*** (2.0208)	6.4032*** (1.4204)	5.9885*** (2.0877)
Pupils age	-0.1006*** (0.0092)	-0.0977*** (0.0074)	-0.0982*** (0.0116)	-0.0521*** (0.0064)	-0.0358*** (0.0074)	-0.0365*** (0.0089)
Pupil SES (base- low SES)						
Middle SES	2.0375*** (0.4523)	1.8290*** (0.3923)	1.7164*** (0.5268)	0.5553 (0.3545)	0.9910** (0.4101)	0.8509* (0.5021)
High SES	6.3375*** (0.9369)	7.1681*** (0.6152)	6.8199*** (1.0289)	2.6955*** (0.7215)	3.1040*** (0.4246)	4.8578*** (0.8490)
Parent's education (base-below secondary education)						
Mothers education	0.5034 (0.4810)	0.8257** (0.3607)	0.0297 (0.5915)	0.3352 (0.3518)	0.2140 (0.2956)	-0.2889 (0.5236)
Fathers education	0.5160 (0.4859)	-0.4657 (0.44027)	-0.2233 (0.3758)	0.3115 (0.3296)	0.3396 (0.3166)	0.3825 (0.5040)
Parents homework signing: =1 if yes, 0 if no	-1.2022*** (0.3934)	-0.4374 (0.3562)	0.0265 (0.3878)	0.3115 (0.3296)	-0.0337 (0.2622)	-0.2995 (0.3261)
Pupil absenteeism	-0.2579 (.0754)	-0.2915*** (0.0711)	-0.2336*** (0.0679)	-0.2726*** (0.0574)	-0.2326*** (0.0636)	-0.1559* (0.0844)
Class size	-0.0535*** (0.0105)	-0.0519*** (0.0109)	-0.0535*** (0.0199)	-0.0460*** (0.0119)	-0.0452*** (0.0082)	-0.0444** (0.0113)
Book-pupil ratio	0.2153** (0.1056)	0.1176 (0.0819)	0.0741 (0.0913)	0.1613*** (0.0466)	0.1823** (0.0655)	0.1129 (0.1081)
Number of tuition hours per week	(0.0224) (0.0306)	0.0612*** (0.0218)	0.0225 (0.0314)	0.03291 (0.0217)	0.0268* (0.2622)	0.0331 (0.0253)
Teacher's test score	0.0148 (0.0482)	-0.0266 (0.0388)	0.0030 (0.0514)	0.0587*** (0.0167)	0.0648*** (0.0179)	0.0122 (0.0386)

In-service teacher's training	-0.0022 (0.0021)	-0.0032 (0.0025)	-0.0024 (0.0024)	-0.0024 (0.0020)	-0.0030* (0.0017)	-0.0025 (0.0023)
Teacher years of professional training	0.7898*** (0.2502)	0.7651*** (0.2712)	0.7907** (0.3254)	0.1478 (0.1701)	-0.0392 (0.1404)	-0.2627 (0.2312)
Teacher experience	-0.0407 (0.0285	-0.0343 (0.0266)	-0.0135 (0.0399)	-0.0236 (0.0196)	-0.0320* (0.0165)	-0.0482** (0.0188)
Teacher contract; 1 if permanent, 0 if temporary.	1.1187* (0.6246)	1.9443*** (0.6556)	2.5895*** (0.7312)	-0.0586 (0.0020)	0.4595 (0.3982)	0.6778 (0.6653)
Living conditions, =1 if good, =0 if poor	-0.7342* (0.3999)	-0.2456 (0.4494)	0.3242 (0.4696)	-0.1039 (0.3003)	0.2846 (0.3674)	1.0911** (0.4306)
Teacher's sex =1 if female, 0 if male	-0.4298 (0.5051)	-0.2354 (0.4537)	-0.4134 (0.4234)	1.1222*** (0.2854)	1.3842*** (0.3156)	0.6999** (0.2927)
Head-teacher's sex =1 if female, 0 if male	2.1270*** (0.5227	1.8065*** (0.4899)	2.1638*** (0.5137)	0.6264 (0.4280)	0.2921 (0.4438)	1.1376*** (0.3925)
School infrastructure condition=1 if good,= 0 if poor	0.9828 (0.6061)	0.9131** (0.4259)	1.9086*** (0.6793)	0.4774 (0.5436)	0.8443 (0.5293)	1.0973* (0.6231)
School location; =1 if urban and 0 if rural	2.7921*** (0.4091)	3.358852 (0.4825)	3.4248*** (0.4349)	1.7096*** (0.3015)	2.0014*** (0.3653)	2.2546*** (0.4379)
Constant	63.5028*** (4.2887)	71.0287*** (3.7272)	73.5922*** (3.9857)	50.8665*** (1.9661)	51.3878*** (2.1201)	60.0929*** (2.9154)
n	4,191	4,191	4,191	4,068	4,068	4,068
R^2 / Pseudo R^2	0.1204	0.1368	0.1559	0.0734	0.0868	0.1046

*Standard errors in brackets.***, ** , *: significant at 1%, 5% and 10%, respectively*

4.5 Summary, Conclusion and Policy Implications

This section presents the summary of this essay on quantile regression approach in the estimation of the academic achievement production function, the conclusions made and the derived policy implications.

4.5.1 Summary and conclusion

Much of the empirical evidence on student educational outcomes has focused on the effect of educational inputs and school type on conditional expected achievement. There is limited empirical evidence on inequalities of effects of education inputs across the test score distribution. Such inequalities could lead to inequality of access to productive activities. This essay addresses this gap by using quantile regressions to test the hypothesis whether the relationship between educational inputs and school type and the pupils' test scores differ across the test score distribution.

The descriptive statistics suggest that the characteristics and resources available to class six pupils in Kenya differ according to their academic ability, thus justifies the need to estimate the education production function using quantile regressions. The conditional quantile regression estimates provide evidence that there is a positive association between private school and test scores across all quantiles. The association is highest for pupils in the highest percentile (0.75) and lowest for pupils in the lowest percentile (0.25). Further, the returns from different educational resources also differ across the test score distribution. It can be concluded that estimates of the mean effect of educational resources are likely to miss the heterogenous effects of the resources on the test scores along the distribution of the scores. These heterogenous effects or associations are uncovered by quantile regressions. The conclusion from the results is that some educational resources benefit the academically strong pupils more while others are of more benefit to the academically weak pupils.

4.5.2 Policy implications

The study shows that academically strong pupils benefit most from private school enrolment. Further, these pupils are more likely to be enrolled in private schools compared to the academically weak pupils. This means that inequality in academic achievement is further aggravated by access of better schools by the academically strong pupils compared to the academically weak pupils. The implication is that in the assessment of programmes that are intended to benefit all pupils and improve average test scores, the assessment should be based on quantiles to give a clear implication of who the programmes are benefitting or intended to benefit. The assessment of the impact of programmes on average test scores may understate or overstate the benefits when some students are benefitting more or less than others depending on their academic abilities. These differences in the returns to programmes are uncovered by the use of quantile regression.

For example, policy should be formulated to have different books developed for the same curriculum. The different books would address different levels of knowledge. This would ensure that different pupils along the test score distribution can access books that they can easily read and understand. The current curriculum review process in Kenya includes development of textbooks for the new curriculum. The findings in this essay imply that different books should be developed for a particular subject in such a way that they address different pupils' needs and learning abilities.

CHAPTER FIVE: SUMMARY, CONCLUSIONS AND POLICY IMPLICATIONS

5.1 Summary and Conclusions

Motivation

Education and health are the key human capital components Schultz (1961). According to Becker (1962), schooling is one of the ways of enhancing human capital. Primary school education forms the basis for secondary and tertiary education. In Kenya, more than 90% of all primary school pupils attend public primary schools, leaving private schools to serve less than 10% of the pupils (Republic of Kenya, 2017).

There are disparities in performance scores between private and public schools' pupils. Pupils in private primary schools achieve higher test scores compared to public primary school pupils (KNEC, 2017). This points to the inequality in academic achievement between pupils in private schools and those in public schools. There also arises a question of whether attendance in private primary school is associated with higher scores. While literature exists on the effect of inputs on academic achievement, most of the studies are based on one school type, mainly public schools. These studies, therefore, do not address whether there is an association between attending a private school and test scores. Apart from the gap in academic achievement between private and public primary schools, there is a gender gap in test scores and academic achievement gap between academically strong pupils, average pupils and academically weak pupils.

The first essay examined the relationship between school type and test scores. The second essay estimated and decomposed the gender test score gap in Mathematics in public and private primary schools. The third essay examined whether the relationship between school type and educational resources and academic achievement differs across the test score distribution in primary schools.

School type and academic achievement

The first essay estimated the academic achievement production functions for both literacy and numeracy. According to Glewwe and Kremer (2006) and Das et al. (2011), households make choices that maximize their utility. Parents will therefore choose to take their children to private or public school based on what school will maximize their utility, which is subject to academic achievement. This essay examined whether after controlling for the pupil characteristics, school resources and home characteristics, there is any correlation between private school attendance and test scores.

Since the placement in either school type is non-random, school type is potentially endogenous, thus estimating the education production function using OLS may give biased results. To control for endogeneity and unobserved heterogeneity, this study used the two-stage residual inclusion method and the control function approach, respectively.

A probit school type model was estimated in the first stage. The results indicate that pupils from middle and high SES backgrounds were more likely to be in private primary schools compared to those from low SES backgrounds. The results of the estimated academic production function indicate that there is a positive correlation between private schools' attendance and test scores. Further, some school resources enhance performance scores. These include good condition of buildings, a high book-pupil ratio, small class sizes and teachers with permanent contracts. This study contributed to literature by providing evidence of the relationship between school type and academic achievement.

Gender gaps in Mathematics achievement in private and public primary schools

Essay two estimated and decomposed the gender test score gap in Mathematics in private and public primary schools. According to Klasen (2002), gender inequality in education adversely affects economic growth by lowering the level of human capital. Despite continuous effort by the Government of Kenya to provide all-inclusive basic education, for example through FPE, male pupils continue to perform better than girls, and specifically in Mathematics.

Separate academic achievement production functions were estimated for boys and girls in each of the school types, private and public primary schools. Following Aslam (2009[a]), OLS estimators are likely to be unbiased so long as many variables that account for school type selection are controlled for. These include the pupil's socio-economic status and the parent's level of education. Further, there is no choice in gender allocation. And therefore the estimation of the separate Mathematics function for boys and girls does not suffer from non-random selection bias. This essay further used the Oaxaca (1973) decomposition approach to decompose the gender gap in Mathematics scores.

The results show that the Mathematics score gender gap is higher in private than in public schools. There is an indication of equality in resource allocation between boys and girls in private primary schools, since the gender gap explained by the differences in resource endowment between boys and girls is statistically insignificant. In public schools, there is an indication that girls have greater access to educational resources than boys. In both private and public primary schools, boys take better advantage of educational resources than girls, and therefore girls' score can be improved by better utilization of the resources. Measures to improve girls' utilization of the educational resources may thus close the gender gap more effectively that increasing the resources to girls.

The essay contributes to literature by providing evidence on what explains the gender gap in Mathematics score beyond the differences in resources between boys and girls; that is, the differences in resource utilization between boys and girls.

Academic achievement across the test score distribution

The final essay estimated the relationship between school type and educational resources and test scores of Standard six pupils across the test score distribution by use of quantile regressions. According to Koenker and Basset (1978) and Koenker and Hallock (2001), quantile regression enables the estimation of effects of the independent variables on the distribution of the dependent variable.

The results from the descriptive statistics reveal that pupils differ in their characteristics according to their academic ability, thus justifies the need to estimate the education production function using quantile regressions. The positive private school correlation with test scores is highest for the academically strong (75^{th} percentile) pupils and lowest for the academically weak (25^{th} percentile) pupils.

The essay contributes to literature by providing evidence that pupils who differ in their academic ability also differ in other characteristics such as their socio-economic backgrounds, and access to school resources. It also provides evidence that the association between inputs and academic achievement differs across different pupils depending on their academic ability, and therefore estimation of an education production function using OLS may not give conclusive results.

5.2 Policy Implications and Recommendations

There is evidence of a significant positive private school correlation with test scores. The increased private schools' enrolment is consistent with the belief by wealthy parents that private schools are of better quality, meaning that low quality public schools increase the demand for private schools. Reduction of inequalities between public and private schools is crucial as more than 90% of all primary school pupils attend public schools. In the wake of curriculum reforms, these reforms should include efforts in reducing the private-public schools achievement gap. This may include more research to uncover the factors that lead to the positive association between private school and test scores beyond the differences in resources between private and public primary schools. The government should also invest in more educational resources in public schools. These include more teachers and school infrastructure to reduce the class sizes, and therefore reducing the resource gap between public and private primary schools.

Further, in addition to funding FPE, the government and school owners should derive measures of reducing the academic achievement gender gap. These should include ways to improve resource utilization by girls, which may be more cost effective than increasing the amount of resources. Concentration on increasing the resources may reverse the gender gap, thus disadvantaging boys in future. Lastly, the government should formulate policies to reduce the gap between academically strong and academically weak pupils. These include improvements in public primary schools where the highest proportion of academically weak pupils attend.

5.3 Study Limitations

In the estimation of the academic achievement production function in the three essays, there were several limitations to the study. First, the school types in this study are divided into two categories, public and private. However, private schools can be classified as religious versus non-religious, high cost versus low cost, non-governmental versus individually-owned, among other categorization. This distinction is not made in this study.

Secondly, the instrumental variables used in the study in the first essay are distant from school to the nearest market and to the nearest secondary school. However, better measures that would explain selection of a private school include distance from home to the school or availability/

concentration of the school in a certain area. These measures were, however, not available in the data.

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APPENDIX 1

Table A1: Reduced-form probit school choice model

	Reading	Mathematics
Pupils age	-0.0016 (0.0020)	0.0006 (0.0023)
Pupil SES (base- low SES)		
Middle SES	0.2671** (0.1060)	0.4563*** (0.1234)
High SES	0.8286*** (0.1598)	1.1053*** (0.1825)
Parent's education (base-below secondary education)		
Mothers education	0.8286 (0.1598)	-0.1183 (0.1120)
Fathers education	0.0779 (0.0998)	-0.0027 (0.1096)
Parents homework signing: =1 if yes, 0 if no	-0.2610*** (0.0875)	0.5596*** (0.1011)
Pupil absenteeism	0.0176 (0.0154)	0.0266 (0.0178)
Class size	-0.0252*** (0.0030)	-0.0317*** (0.0033)
Book-pupil ratio	0.0500*** (0.0172)	0.0719*** (0.0198)
Number of tuition hours per week	-0.0097 (0.0068)	-0.0174** (0.0073)
Teacher's test score	0.0244*** (0.0070)	-0.0484*** (0.0072)
In-service teacher's training	-0.0041*** (0.0013)	-0.0194*** (0.0059)
Teacher years of professional training	-0.4041*** (0.0561)	-0.5523*** (0.0699)
Teacher experience	0.0086 (0.0058)	0.0140** (0.0064)
Teacher contract; 1 if permanent, 0 if temporary.	-0.8040*** (0.1226)	-0.9259*** (0.1467)
Living conditions, =1 if good, =0 if poor	-0.3893*** (0.0883)	0.7413*** (0.1085)
Teacher's sex =1 if female, 0 if male	-0.3039*** (0.0911)	0.0403 (0.1046)
Head-teacher's sex =1 if female, 0 if male	0.3529*** (0.0950)	0.6425*** (0.1144)
School infrastructure condition=1 if good,= 0 if poor	0.8201*** (0.0870)	0.4777*** (0.1048)
School location; =1 if urban and 0 if rural	0.5309*** (0.0970)	0.2016* (0.1181)
Distance from school to nearest secondary school	-0.2406*** (0.0402)	-0.2353*** (0.0490)

Distance from school to nearest market	0.1746*** (0.0370)	0.1886*** (0.0483)
Constant	-1.0143 (0.7279)	3.4883*** (0.7442)
n	4,191	4,071
R^2	0.4154	0.5081

*Standard errors in brackets.***, ** , *: significant at 1%, 5% and 10%, respectively*