ESSAYS ON BENEFIT INCIDENCE AND EFFICIENCY OF PUBLIC SPENDING ON EDUCATION AND TRAINING IN KENYA

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Declaration

This thesis is my original work. It has not been submitted for any degree award in any other University or academic institution. Acknowledgements have been duly made where work by other authors has been used.

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Dedication

This thesis is dedicated to my dear husband Bernard; and our children Carol, Lydia and Peter.

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Abbreviations and acronyms

ASAL	Arid and Semi-Arid Lands
AERC	African Economic Research Consortium
BIA	Benefit Incidence Analysis
CDF	Constituency Development Fund
CRS	Constant Returns to Scale
CTE	Career Technical Education
DEA	Data Envelopment Analysis
DEAP	Data Envelopment Analysis Programme
DGP	Data Generating Process
DMU	Decision Making Unit
ECDE	Early Childhood Development and Education
EFA	Education for All
EI	Education Index
EMIS	Education Management Information System
ERSW&EC	Economic Recovery Strategy for Wealth and Employment Creation
FDSE	Free Day Secondary Education
FDH	Free Disposal Hull
FPE	Free Primary Education
GER	Gross Enrolment Rate
GDP	Gross Domestic Product
GOK	Government of Kenya

GNP	Gross National Product
GPI	Gender Parity Index
HDI	Human Development Index
ICESCR	International Covenant on Economic, Social and Cultural Rights
IIEP	International Institute for Education Planning
KCPE	Kenya Certificate of Primary Education
KCSE	Kenya Certificate of Secondary Education
KESSP	Kenya Education Sector Support Programme
KIHBS	Kenya Integrated Household Budget Survey
KIPPRA	Kenya Institute for Public Policy Research and Analysis
KNBS	Kenya National Bureau of Statistics
KNEC	Kenya National Examinations Council
LATF	Local Authorities Transfer Fund
LP	Linear Programming
MBI	Marginal Benefit Incidence
MBIA	Marginal Benefit Incidence Analysis
MDGs	Millennium Development Goals
MOE	Ministry of Education
NER	Net Enrolment Rate
NIRS	Non Increasing Returns to Scale
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Squares
PCR	Pupil Completion Rate

PTR	Pupil Teacher Ratio
TE	Technical Efficiency
TFP	Total Factor Productivity
TTI	Think Tank Initiative
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
VRSLP	Variable Returns to Scale Linear Programming
VRS	Variable Returns to Scale
WCED	World Commission on Environment and Development

Abstract

Between 2002/03 and 2009/10 fiscal years, Kenya spent 6.4 percent of GDP and 26 percent of total public expenditure on education. Still, about 8.6 percent and 68 percent of primary and secondary school age children, respectively, were not in school during the period, and there were large disparities across regions in gross and net enrollments. Performance on national examination also varies widely across regions. In addition, many educated Kenyans are unemployed. This raises questions related to who benefits from public education spending; levels of technical efficiency and external efficiency of public education spending in Kenya. This thesis addresses these issues through three interlinked essays that empirically investigate the nexus between education inputs, outputs and labour market outcomes. The first essay estimates the average and marginal benefit incidence of public education spending and identifies the associated factors. The second essay uses a two-stage (DEA double bootstrap and regression) procedure to estimate technical efficiency of public education spending and to identify factors that explain disparities in technical efficiency. The analysis in the first two essays is at sub-national level (county level) so as to map inequalities in education benefit incidence and efficiency. The third essay examines external efficiency of education and links education and training to the country's labour market outcomes. The thesis uses the 2005/6 Kenya Integrated Household Budget Survey data. Data on public education spending and education sector indicators was also used.

The empirical evidence from the first essay indicates that children from medium and high income groups are more likely to benefit more from expansion in public education spending in Kenya. The results also indicate large differences in levels of benefit incidence across counties. The main factors that constrain households from benefiting from public education spending include poverty, residing in urban areas, being a female child and low schooling level of household head. The result from the second essay indicate that the average DEA double bootstrap technical efficiency scores were 1.24, 1.12 and 3.04, for primary, secondary and tertiary education levels, respectively. This implies that education outputs can be increased by 24 percent, 12 percent and 204 percent at the respective education levels, without increasing inputs. The magnitude of resource saving is estimated at 17 percent, 10 percent and 52 percent for primary, secondary and tertiary education, respectively. The proportion of education budget spent on personnel emoluments in the sector is a major

constraint on technical efficiency of education. The estimates in the third essay indicate that private rates of return to education increase with level of education and differ across employment sectors. Individual earnings are a function not only of their own education but the education of the household members and education of the region they live in. These education externalities exceed private rates of return to education. The results from the three essays imply that policies to address pre-labour market inequalities in access and benefit incidence of education across counties, gender and income groups should be pursued. Policies to improve technical efficiency of public education expenditures should also be pursued particularly with respect to the composition of spending on education inputs.

CHAPTER 1

1 BACKGROUND AND STUDY CONTEXT

1.1 INTRODUCTION

Investment in human capital development through education and training is important for sustainable development[1]. The human capital developed includes skills, knowledge, attitudes, behavior, competencies, values, and abilities in individuals that stimulate socioeconomic well being, need to protect the environment (Youndt et al., 2004 and Garavan et al, 2001) and need to reduce inequalities (Rodriguez and Loomis, 2007). Education empowers the population to alleviate poverty, promote responsible citizenship, democracy, good governance; and improved access to economic opportunities (UNESCO, 2006). Further, education and training contribute to greater economic productivity, better earnings, and economic growth (Psacharopoulos, 1984; Romer, 1986; Schultz, 1961a; Romer, 1990; and Rosen, 1999).

The potential benefits of education resulted into various international and national commitments such as education for all (EFA) and Millennium Development Goals (MDGs) (UNDP, 2000). The common goal is to increase access to education, enhance equity, improve quality; and ensure efficient resource allocation in the education sector. The Kenya government has since independence focused on eradicating ignorance, illiteracy and poverty among the population (GOK, 1965). The government has

[1] Sustainable development entails improvements in livelihoods that meets the human capital needs of the present and improves the quality of life without compromising the ability of future generations to meet their needs (WCED, 1987).

implemented policies and initiatives, notably free primary education (FPE) and free day secondary education (FDSE) to increase access to quality education (GOK, 2003a and GOK, 2008a). For instance, during the period between 2002/03 and 2009/10 fiscal years, 6.4 percent of GDP and 26 percent of total government outlays went to education and training. Households pay for boarding, user charges and private schooling costs.

High public education spending has yielded improved education sector access levels. Primary and secondary net enrolment rates were estimated at 91.4 percent and 32 percent respectively in 2011 (GOK, Various (c)) compared to 76 percent and 18 percent in 2002 (GOK, Various (c)). However, the rates in 2011 imply that close to 8.6 percent and 68 percent of primary and secondary school age children, respectively, were not in school. Enrolment rates at post secondary education are low. Only 2 percent of the pupils enrolled at primary grade one survived to first year in University; while about 6.5 percent and 13 percent of secondary education graduates enrolled in university and middle level (technical and teacher training) colleges, respectively (GOK, Various (c)). In 2010, tertiary education enrollment rate of 4.1 percent (UNDP, 2011) was lower than for some middle income countries such as Malaysia (32 percent), South Africa (15 percent), Mauritius (17 percent) and sub-Sahara Africa average of 5 percent (GOK, 2010a).

The UNDP reports an education index (EI) which combines primary, secondary and tertiary gross enrolment rates. The maximum value of the index is one. Kenya’s index was 0.403 compared to South Africa (0.558), Mauritius (0.570) and Korea (0.696) (UNDP 2011). Similarly, Kenya’s average adult literacy rate for the period 2005-2010

(87 percent) was lower than that of Korea (98 percent), South Africa (88.7 percent) and Malaysia (92.5 percent).

With a growing population demand for education and hence pressure to increase public spending are likely to rise. Estimates of Kenya’s population indicate a gradual increase from 33 million in 2004 to 38.6 million in 2009 (GOK, 2002) and about 41 million by 2010. The pre-primary (4-5 years), primary (6-13 years) and secondary (14-17 years) school age population was 2.9 million, 7.2 million and 3.3 million in 2010, respectively. By 2015, the respective school age population is projected to rise to 3.12 million, 10.7 million and 3.6 million respectively (GOK, 2010a).

The expected increase in demand for education may require either additional education resources or improved efficiency in utilization of available resources. Additional resources to the education sector have to be justified primarily on meeting distributional goals, sector specific equity objectives, alleviating poverty, reducing inequalities and knowledge accumulation for sustained growth (GOK, 2008a). This requires that education subsidies be targeted efficiently to benefit low income groups (Younger, 2003). This can be established through benefit incidence analysis. Whether education resources are used efficiently can be established through measurement of efficiency. Previously, the focus on resource mobilization has largely been limited to use of resources and increasing access to schooling (GOK, 2010a). Policy makers in developing economies have not paid adequate attention to equity in use of public education resources (UNESCO, 2009).

Education is associated with higher individual income (Schultz, 1961a and Mincer, 1974). Therefore, inequalities in access to education can be reflected in labour market outcomes and hence in individual socioeconomic wellbeing. However, education policy also rests on the existence of education externalities. An individual's productivity or earnings may depend not only on their education, but also on the education of others (Lucas, 1988). Economic analysis offers an explanation of individual education investment decisions; while estimating the private returns to education and testing for education externalities.

1.1.1 Research problem

Public spending on education in Kenya accounts for a substantial proportion of GDP and of public expenditure. On average, between 2002/03 and 2009/10 fiscal years, Kenya spent 6.4 percent of GDP and 26 percent of total public expenditure on education. Although enrollment rates increased, about 8.6 percent and 68 percent of primary and secondary school age children, respectively, were not enrolled during the period, and large disparities existed across regions in enrollment. Performance on national examination as indicated by KCPE and KCSE scores also varies widely across regions. In addition, there seems to be weak linkage between education and labour market as many educated Kenyans are unemployed. Public education subsidies rest on two policy objectives: improving education outcomes and efficiency; and eliminating poverty and inequalities (GOK, 2005a). The observed poor education sector indicators and sharp differences in the outputs across regions are not in line with government objectives for the sector. This raises questions about the efficiency and equity of public education spending in Kenya. The questions arise in the context of limited fiscal space to increase public education spending given competing budgetary demands and budgetary constraints (GOK, 2010).

Whether or not public education spending is pro-poor depends on how education spending benefits are distributed across income groups. Similarly, whether there is scope to improve performance without increased resource flow to the education sector depends on the degree of technical efficiency. However, there is limited empirical evidence on these issues in Kenya. In addition, while government spending on education can be justified on existence of external benefits, few studies estimate those benefits for Kenya.

This thesis therefore attempts to answer the following questions: To what extent has government spending on education in Kenya been equitable and efficient? Who benefits from public spending on education; that is, how are the benefits of education spending distributed across counties and income groups? What factors explain the incidence of benefits from public education expenditures? What factors influence technical efficiency of public education spending? How can public education spending be made more equitable and efficient? What is the level of education externalities and how do they compare with private returns to education?

1.1.2 Objectives of the thesis

The broad objective of the thesis is to examine benefit incidence and efficiency of public spending on education in Kenya with a view to identifying feasible policy options for enhancing equity and efficiency in education. The specific objectives are: i) estimate average benefit incidence and marginal benefit incidence of public spending on education across counties in Kenya; ii) identify the factors that influence variations in the benefit incidence; iii) estimate technical and external efficiency of public education spending; iv) determine factors that explain technical efficiency in Kenya's education sector; and v) draw policy suggestions for sustainable education spending.

1.1.3 Significance and relevance of the study

Estimates of benefit incidence and efficiency of public education spending can be used to develop an overall fiscal policy framework; to assess impact of education sector policy reforms; to inform decentralization in education services delivery; and to justify the need to improve resource utilization in public education sector.

Public subsidies for social sectors such as education rest on two policy objectives: improving outcomes and efficiency; and eliminating poverty and inequalities (GOK, 2005a). Public subsidy on education between 2002/03 and 2009/10 was 6.4 percent of GDP and over 26 percent of total public education expenditures (GOK, Various (c)). Increasing number of school age children and regional disparities in education outcomes remain key challenges. The findings of the study increase our understanding of mechanisms to enhance efficiency in resource utilization within the education sector. In addition, evidence on private returns to education and education externalities can inform education financing reforms, both at county and national levels.

Both the Kenya Constitution and the Kenya Vision 2030 emphasize the need to enhance decentralization in education management, to address education inequalities and expand tertiary education (GOK 2010b, GOK, 2008a and GOK, 2005a). Estimates of benefit incidence and efficiency of education expenditures and the factors that explain them can aid in effective targeting of public resources at local levels to the low income groups to improve education outcomes. This would inform any reforms targeted at reducing inequalities and designing public expenditure policies aimed at improving efficiency and effectiveness in utilization of public resources, while targeting the poor.

It is also important to know the degree of efficiency in the education sector because increasing public education spending is not a guarantee for attaining better education outcomes (Jarasuriya and Wodon, 2002 and Gupta and Verhoeven, 2001). It is not just the level of public spending that matters, but also efficiency of public education expenditures and the extent to which they are targeted to low income groups (Castro-Leal et al, 2000 and Manasan, Cuenca and Villanueva, 2007).

1.1.4 Theoretical framework

This thesis uses the human capital framework, which holds that education and training contribute to formation of human capital (Schultz, 1961b and Becker, 1964). Human capital consists of skills, abilities and knowledge of individuals that enhance productivity.

The role of human capital, particularly education is emphasized in endogenous growth theory (Romer; 1990). Education counteracts the growth reducing effect of diminishing returns in physical capital, thus ensuring long-run growth. The production technology is specified as Y(*t*) = F (K(*t*), A(*t*)L(*t*)) where Y is total output, K is the physical capital stock, H is human capital, L is the labour input and A is the labour augmenting technology (knowledge obtained through education, effectiveness of labour and technological innovation) at time *t*.

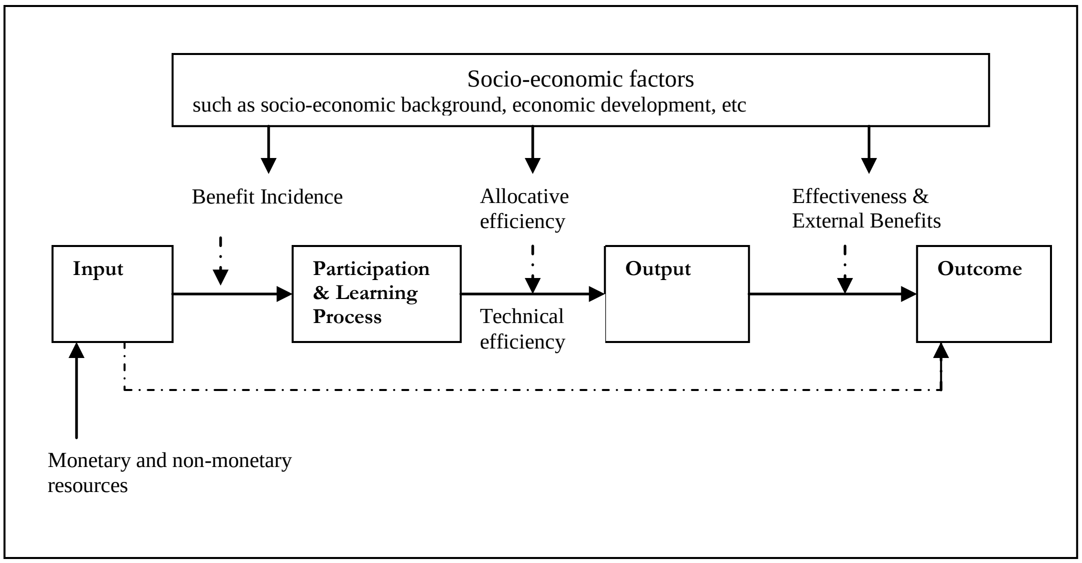
The growth effect of education can differ from private returns to education. This is because investments in education and training can have positive externalities or "neighbourhood effects" to education and training. The education of one person has benefits not only to the individual but also to the society or economy (Friedman 1962; Lucas, 1988 and Rodriguez-Pose and Vassilis, 2012).

However, to realize the benefits (private and external) of education and training and hence enhance economic growth, the government as a major investor in education must ensure adequate spending. However, spending must be equitable and efficient. Further, external efficiency of education should be high to realize the benefits. This current study is concerned with equity and efficiency of education spending benefits. It also investigates existence of education externalities on individual earnings.

1.1.5 Conceptual framework

The conceptual framework underlying this thesis is illustrated in Figure 1-1. It shows the links between educational inputs, enrolment and process of teaching and learning; and education outputs and outcomes. According to the human capital theory, investment in education and its rate of return constitute the link between labour market and education. Education inputs include monetary and non-monetary resources such as capitation grants by government to schools, provision of teachers and school infrastructure development.

Figure 1-1: Conceptual framework



Source: Adopted and modified from Mandl, Dierx and Ilzkovitz (2008) and Author's Conceptualization

However, for individuals or households to gain from public spending on education, they must participate in the schooling process through enrolment of the children in learning institutions at various levels. In addition, enrollees must attain some amount of output and outcomes such as level of learning achievement and effectively participate in the labour market through improved access to employment and increased earnings. The former constitutes benefit incidence while the latter constitutes external efficiency of schooling. Benefit incidence is a function of factors that influence household behavior with regard to schooling choice.

Outputs in the education sector include attainment measures such as performance in learning achievement tests or national examinations. However, education inputs must be efficiently used within an effective learning process to obtain more and higher quality outputs and outcomes. Technical efficiency is the ability to produce more output, given levels of inputs; or using lower level of inputs for a given output level (Mandl, Dierx and Ilzkovitz, 2008).

Closely related to the technical efficiency in education production is the effectiveness of the education system. Effectiveness measures the extent to which inputs or outputs are linked to the final education sector objective or outcome such as socio-economic welfare indicators for individuals, households, or country. Indicators of effectiveness of education show the benefits derived from resources spent in the education sector. The overall goal of such expenditures is to achieve national development objectives. In the education sector, outcomes include private returns and externalities of education and training.

Private returns refer to additional earnings that accrue to an additional year of schooling. It acts as a guide of education demand decisions, and hence link between the first and third essay. Thus high rate of return of a given level of education is expected to increase demand for the observed education level, assuming supply responds to demand.

1.1.6 Outline of the thesis

The thesis is organised as follows: following this introduction, an overview on how the education sector performed during the period 2002-2010 is provided. This review period was chosen since it covers the period when key reforms, notably FPE and FDSE were implemented. Essay 1 (Chapter 2) focuses on average and marginal benefit incidence analysis. It considers the extent to which different income groups benefit from public education spending. Factors explaining benefit incidence are also examined. An analysis of technical efficiency of public spending at county level in Kenya is presented in Essay 2 (Chapter 3). Essay 3 (Chapter 4) examines external efficiency of education. It examines the role of education in employment sector participation, private returns to education, and internal and external effects (externalities) of education in Kenya.

In each essay, measurement and conceptual issues are discussed. A critique of related literature is also presented. This is followed by presentation of estimation strategy, which covers the analytical framework, data and statistical issues. The estimation results are then presented and discussed followed by conclusions and policy options. The conclusion and policy implications are presented in Chapter 5.

1.2 EDUCATION SECTOR PERFORMANCE

In this section, a review of the performance of Kenya's education sector over the period 2002/3 to 2009/10 is presented. The review focuses on indicators of access, equity, internal efficiency, education outputs and outcomes at primary, secondary, technical and university education levels.

1.2.1 Access and equity

Kenya has made considerable progress in improving overall education enrolment levels. Nevertheless, marked disparities remain across levels of education and across regions. Primary school gross enrolment rate (GER)[2] increased from 88.2 percent in 2002 to 109.8 percent in 2010 (see Table 1-1). Over the same period, the net enrolment rate (NER) increased from 76.4 percent to 91.4 percent. Secondary GER increased from 25.7 percent to 47.8 percent in 2010 and NER increased from 17.8 percent in 2002 to 35.8 percent in 2009. It dipped to 32 percent in 2010, implying about 68 percent of the secondary education school age population were not in school at the time. Although transition from secondary education to university education increased from 4.5 percent in 2002 to 6.5 percent in 2008, the university education GER remained low at 4.1 percent compared to the national target of over 10 percent (GOK, 2007).

[2] GER is defined as total school enrolment in a respective level regardless of age divided by school age population. NER is defined as school enrolment of the specific school age at a given level divided by school age population for the education level under consideration. Primary school age population is 6-13 years; secondary school age population is 14-17 years while tertiary school age is estimated at 18-25 years. Gross enrolment can be more that 100 percent since both overage and underage students are included.

The increase in primary school enrolment can partly be attributed to the sector reforms implemented during the review period. The reforms include: emphasis on universal primary schooling within the Economic Recovery Strategy for Wealth and Employment Creation (2003-2007) (GOK, 2003) and Free Primary Education programme introduced in 2003. The FPE programme supports the expansion of public primary schools physical infrastructure and provides per capita grants for teaching and learning materials; operations and maintenance and teaching staff emoluments (GOK, 2005).

Table 1-1: Enrollment rates (%) (2002-2010)

Primary	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
GER	88.2	102.8	104.8	107.2	107.4	107.6	108.9	110.0	109.8
NER	76.4	80.4	82.1	83.2	86.5	91.6	92.5	92.9	91.4
Secondary									
GER	25.7	28.6	29.8	30.2	32.4	36.8	42.5	45.3	47.8
NER	17.8	18.6	19.4	19.8	23.2	24.2	28.9	35.8	32.0
Tertiary									
Transition from Secondary to public Universities	6.3	5.4	4.9	4.9	6.6	6.3	6	6.7	6.4
Transition from Secondary to public and private Universities	7.1	6.1	5.7	5.7	8.1	7.7	7.3	7.8	7.7
University GER*	..	..	..	..	..	3.5	..	..	4.1

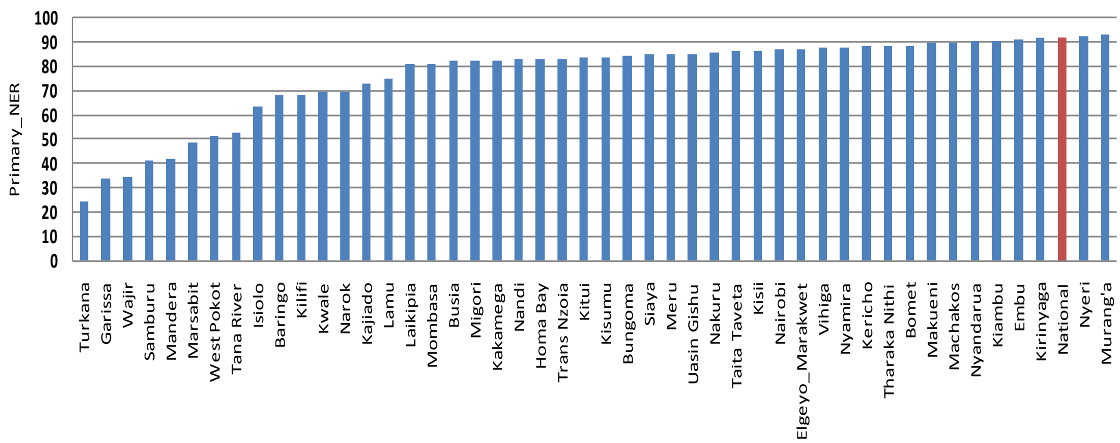
Source: GOK, Various; MOE EMIS Section; * UNESCO 2008; .. Tertiary and University education NER data and GER data for most years was not readily available.

Despite these improvements, Kenya's enrolment rates are relatively lower compared to selected comparator countries in Asia and Africa as the following statistics from UNDP (2011) show. In 2010, Kenya's tertiary gross enrolment rate (4.1 percent) was lower than for Korea (96.1 percent), Egypt (31.2 percent), Ghana (6.2 percent) and sub Sahara Africa (5.5 percent). At secondary education level, Kenya's NER (32 percent) was slightly higher than the sub Sahara Africa (29.5 percent) but lower than for Egypt (71.2

percent), Ghana (46.4 percent) and South Africa (71.9 percent). Primary school NER for Kenya (91.4 percent) was higher than that of South Africa (87.5 percent) and close to that of Egypt (93.6 percent) and Korea (98.6 percent).

Further, within Kenya, regional disparities in access to education are evident (see Figure 1-2). In 2009, Turkana County recorded the lowest primary NER of 25 percent while Muranga County recorded the highest primary NER of 93 percent.

Figure 1-2: Primary education enrollment rates (%), 2009



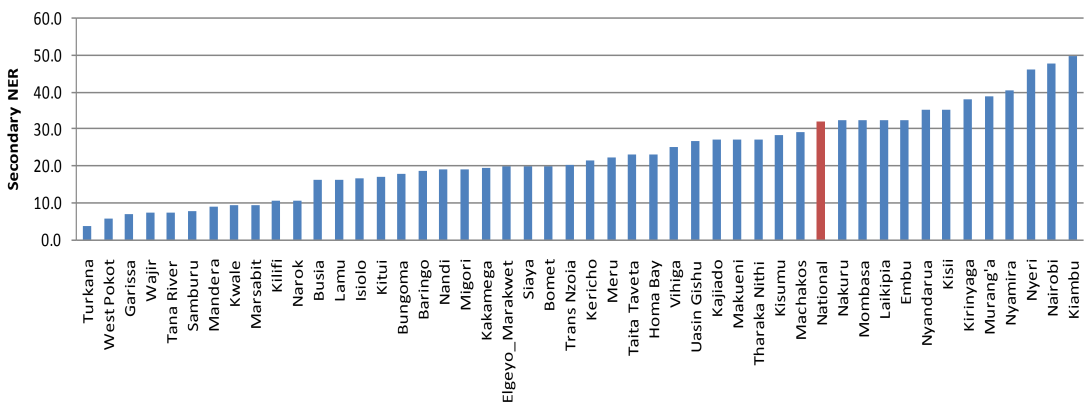
Data Source: Ministry of Education, EMIS section

Figure 1-2 shows that the 15 counties with relatively low primary NER (below 80 percent) are in arid and semi-arid parts of Kenya. Majority (32 counties) of counties have NER of between 80 percent and 90 percent. Thus although the national NER of 91.4 percent suggests that Kenya is on track to achieve the 100 percent MDG target, most counties will not meet the target unless targeted interventions are put in place.

Secondary education NER is very low and there are regional disparities also (see Figure 1-3). In 2009, the lowest secondary NER (3.5 percent) was recorded in Turkana County while Kiambu County recorded the highest NER (50 percent). All counties recorded an NER of less than 50 percent with a national average of 32 percent.

In almost one-quarter of the counties secondary education NER was very low (10 percent or less); slightly over half of the counties had NER of between 10 and 30 percent. The upper tail of the distribution comprises eight counties with NER of between 30 percent and 40 percent and four counties with NER of between 40 percent and 50 percent.

Figure 1-3: Secondary education enrollment rates (%), 2009

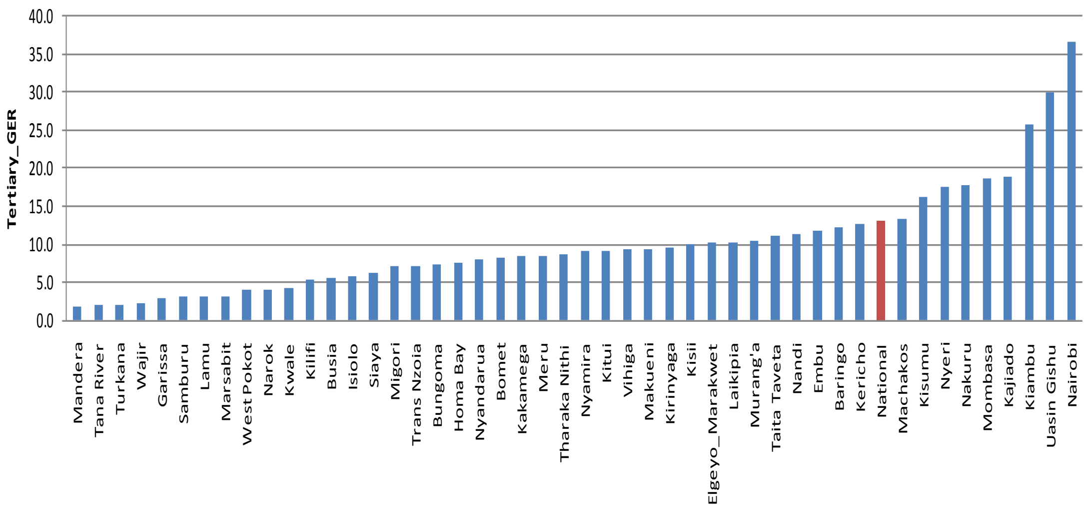


Data Source: Ministry of Education, EMIS section

School enrolment in Kenya has been boosted by private schools. However, enrolment in private schools as a percentage of total enrolment is relatively low. For instance, in 2010 about 5 percent and 8 percent of primary school pupils and secondary school students were enrolled in private schools, respectively (GOK 2010a).

Tertiary (technical and university) education GER ranged between 1.9 percent and 37 percent for the least (Mandera) and best (Nairobi) performing counties, respectively. Aggregate tertiary education GER (university and technical education) was estimated at 13.2 percent in 2009 (see Figure 1-4).

Figure 1-4: Tertiary education enrollment rates (%), 2009



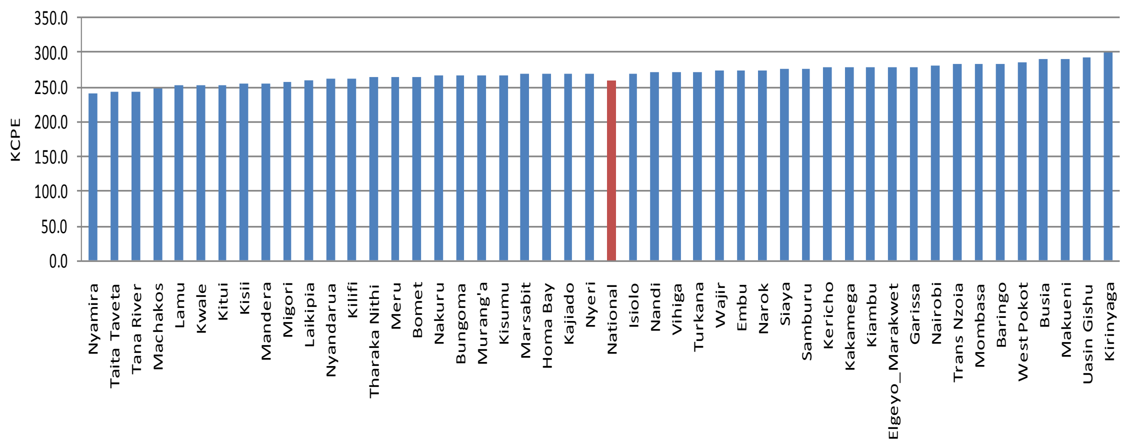
Data Source: Ministry of Education, EMIS section

Most counties (29) had GER of less than 10 percent while 10 counties had a GER of between 10 percent and 15 percent. Only 1 county had GER above 35 percent while 7 counties recorded GER of between 15 percent and 30 percent.

Regional disparities in the primary, secondary and tertiary enrolment levels may be explained by various factors, including long distances that children have to cover in order to get to school especially in Arid and Semi Arid Lands (ASALs), inadequate school infrastructure in informal settlements in urban areas, direct and indirect costs of schooling and retrogressive socio-cultural practices (Ngware et al 2006). Despite the establishment of boarding primary schools in ASALs, enrolment rates are low.

In terms of output, the number of Standard 8 completers and average examination scores has increased. The number of KCPE candidates increased by 24 percent from 587,961 pupils in 2003 to 727,045 pupils in 2009. Further, the national KCPE mean score also increased from 247.5 marks in 2003 to 271 marks in 2009, out of the possible maximum of 500 marks. This is perhaps due to provision of teaching and learning materials to schools under the FPE programme, implemented from 2003.

Figure 1-5: KCPE mean scores by County, 2009/10

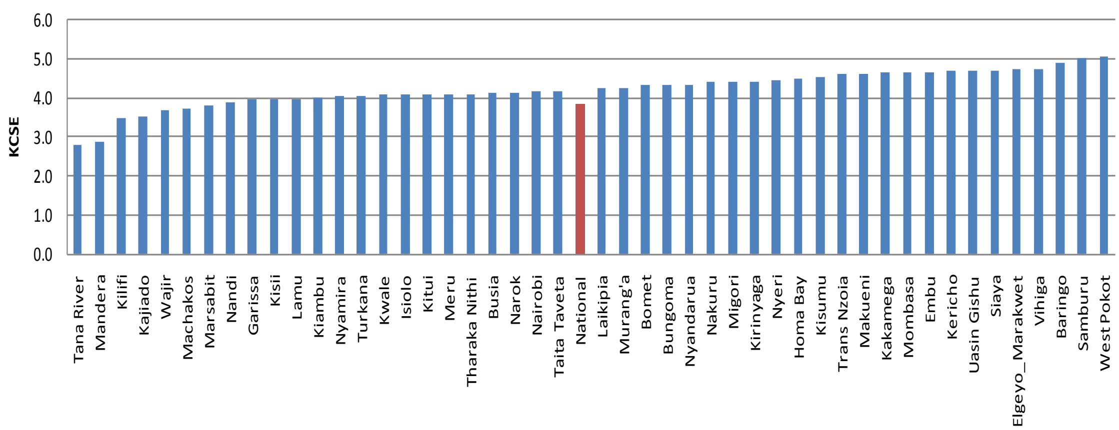


Data Source: Ministry of Education, EMIS section

There were no substantial regional disparities in KCPE mean scores. In 2009/10, KCPE mean score varied between a low of 241 marks (Nyamira County) and a high of 299 marks (Kirinyaga County) out of a maximum of 500 marks (see Figure 1-5). No County had a mean score of more than 60% of the maximum marks.

Expansion in enrolment also occurred at secondary education level. The number of Kenya Certificate of Secondary Education (KCSE) candidates increased from 207,730 students in 2003 to 356,015 in 2010. The share of students with grade A and A- increased from 1.5 percent to 1.8 percent during the period. Candidates who attained grade C+ and above increased from 24 percent in 2003 to 27 percent in 2010 (GOK, Various (c)).

Figure 1-6: KCSE mean scores by County, 2009/10



Data Source: Ministry of Education, EMIS section

The lowest KCSE examination average score of 2.81 out of a maximum of 12 points was recorded in Tana River and the highest score of 5.05 in West Pokot (see Figure 1-6). Majority (39) of the counties recorded a mean examination score of between 4 and 5 points while 8 counties reported a KCSE mean score of less than 4 points. An interesting observation from Figure 1-2 through Figure 1-6 is that counties with high NER are not the same counties with high KCPE and KCSE examination performance. As an example Murang'a and Kiambu recorded the highest primary and secondary education NER, respectively while Kirinyaga and West Pokot reported the highest KCPE and KCSE points. Identifying factors that explain variations in performance indicators is an empirical issue. Some of these issues are explored in the remaining parts of this thesis. The next section reviews the state of internal efficiency of the education in Kenya.

1.2.2 Internal efficiency

Internal efficiency is best measured in terms of indicators of progression through the education system among a given cohort over time. These indicators include cohort survival within the levels, and transition rates between levels. Table 1-2 shows that about 56 percent of pupils enrolled in Standard 1 in 1997 progressed to Standard 8 in 2010 while 48 percent made it to Form 1 compared to 43.9 percent in 2000. This indicates that although it is possible to increase enrolment rates at primary level of education, the sector's ability to sustain them through the system and at an increasing rate is weak.

Despite the increase in survival and transition rates during the review period, progression within the education system is still low. The number of pupils enrolled in Form 1 as percentage of respective cohort enrolled in Standard 1 was estimated at 27 percent in 2010 having increased from 20 percent for 2000 cohort. Survival within secondary education level is however relatively high (95 percent) implying high internal efficiency within secondary education level. However, only 25 percent of those enrolling in standard 1 progressed to form 4 and 2.2 percent progressed to university level. Transition from last grade of secondary education to first year university increased from 7 percent in 2000 to 8.8 percent in 2010.

Table 1-2: Survival rates (%), 2000-2010

Survival rates (%)	1987-2000 Cohort			1989-2002 Cohort			1994-2007 Cohort			1997-2010 Cohort		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
Survival (Completion) rate from Std 1 to Std 8	44.6	43.0	43.9	45.1	43.5	44.3	53.3	53.2	53.3	56.1	56.6	56.3
Survival rate from std 8 to Form 1	45.4	43.9	44.7	45.3	44.5	44.9	43.2	41.6	42.4	49.4	46.2	47.8
Survival rate from Std 1 to Form 1	20.3	18.9	19.6	20.4	19.4	19.9	23.0	22.1	22.6	27.7	26.2	26.9
Survival (Completion) rate from Form 1 to Form 4	85.7	83.1	84.5	100.8	96.9	99.0	98.2	96.0	97.1	98.4	91.6	95.2
Survival rate from Std 1 to Form 4	17.4	15.7	16.6	20.6	18.8	19.7	22.6	21.2	21.9	27.3	24.0	25.7
Survival rate from Std 1 to University level	1.6	0.7	1.2	1.5	0.8	1.2	1.7	0.9	1.3	2.8	1.7	2.2
Transition rate from Form 4 to University level	9.0	4.6	7.0	7.5	4.2	6.0	7.5	4.0	5.9	10.2	7.0	8.8

Source: (GOK, Various (d)) and Author's Computations

Transition rate increased across all regions during the review period but at different magnitudes. National transition rate between Standard 8 and Form 1 increased from 41.7 percent in 2002 to 66.9 percent in 2010 (Table 1-3).

Table 1-3: Primary to secondary education transition rate (%), 2002-2010

	2002	2003	2004	2005	2006	2007	2008	2009	2010	*% change*
Coast	30.4	31.0	52.1	34.0	39.0	40.0	45.1	52.1	48.2	*59%*
Central	57.3	58.5	59.6	63.7	64.7	57.4	64.2	67.3	79.8	*39%*
Eastern	47.5	48.9	51.2	49.4	53.5	46.8	51.2	70.1	73.1	*54%*
Nairobi	32.5	33.5	34.5	50.9	58.3	38.0	45.9	45.0	52.8	*62%*
R.Valley	21.1	21.6	41.7	48.5	54.3	42.5	46.7	57.1	56.4	*167%*
Western	52.6	53.7	55.8	52.0	59.8	49.5	60.1	74.7	67.7	*29%*
Nyanza	35.4	36.1	47.3	57.1	63.6	50.2	56.8	81.5	83.2	*135%*
N. Eastern	42.9	44.9	45.1	44.2	40.5	45.7	40.5	56.3	47.0	*10%*
National	41.7	42.6	42.7	56.0	57.3	59.6	59.9	64.1	66.9	*60%*

Source: (GOK, Various (d))

The highest increase in transition rates between 2002 and 2010 were recorded in Rift Valley province (167 percent) and Nyanza province (135 percent). North Eastern province recorded the lowest from 42.9 percent to 47 percent, a 10 percent increase. To some extent, transition rates are affected by lack of capacity in some regions, low educational attainments among some Standard 8 completers, affordability and socio-cultural factors (Ngware et al., 2006).

1.2.3 Levels of resource utilization

At both primary and secondary levels of education in Kenya, there is unequal distribution of schools. Using 2009/10 county level data, the average primary school size was 458 pupils. The smallest school had 245 pupils and the largest had 1,023 pupils. The average primary school density, defined as total primary school age population divided by the number of schools was 634 pupils with a maximum of 3,176 children per school and a minimum of 194 pupils per school (see Table 1-4, Figure 1-7 and Figure 1-9). The gap between the largest and smallest school is large indicating that there is scope to increase enrolment without necessarily building more schools.

In 2009/10, the average public secondary school size was 313 students with a minimum of 115 students, a maximum of 581 students and standard deviation of 75 pupils. The average secondary school population density was 1,422 with a maximum of 6,840 secondary school age children per school and a minimum of 306 children per school (Table 1-4 Figure 1-9 and Figure 1-7). The large gap between 1,422 and 6,840 in secondary school age population density indicated the problem of uneven provision of secondary schools in Kenya; which has partly contributed to the low enrolment levels.

Table 1-4: School density, school sizes and pupil teacher ratio, 2007 and 2009/10

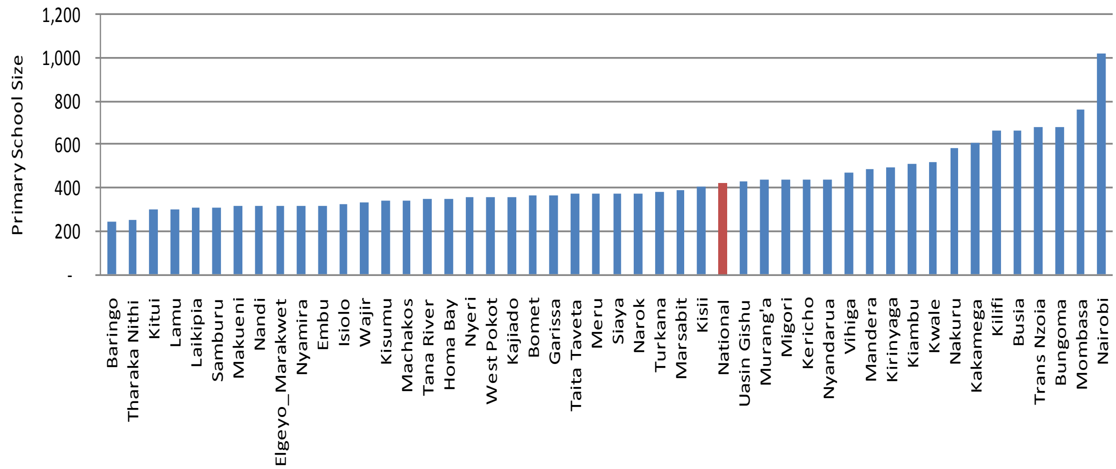
	2007				2009/10			
	Average	Std dev.	Minimum	Maximum	Average	Std dev.	Minimum	Maximum
Primary school density	574	608	90	3,510	634	580	194	3,176
Primary school size	458	242	215	1,414	428	151	245	1023
Primary class size	35	10	24	56	na	na	na	na
Primary PTR	34	9	26	56	39	10	23	65
Secondary school density	1,433	1,817	296	9,232	1,422	1,520	306	6,840
Secondary school size	263	142	107	901	313	75	155	581
Secondary PTR	16	2	12	22	24	7	12	45

Source: School mapping data, 2007 and 2009/10 MOE data base at County level; na- data not available

During the study period, majority of the counties were operating in a sub-optimal level. Assuming all primary schools had optimal enrolment of 50 pupils per class for 8 classes, enrolment could be 400 pupils per school. However, 29 counties recorded a school size of less than 400 pupils while 18 counties recorded a school size greater that the national mean of 400 pupils per school.

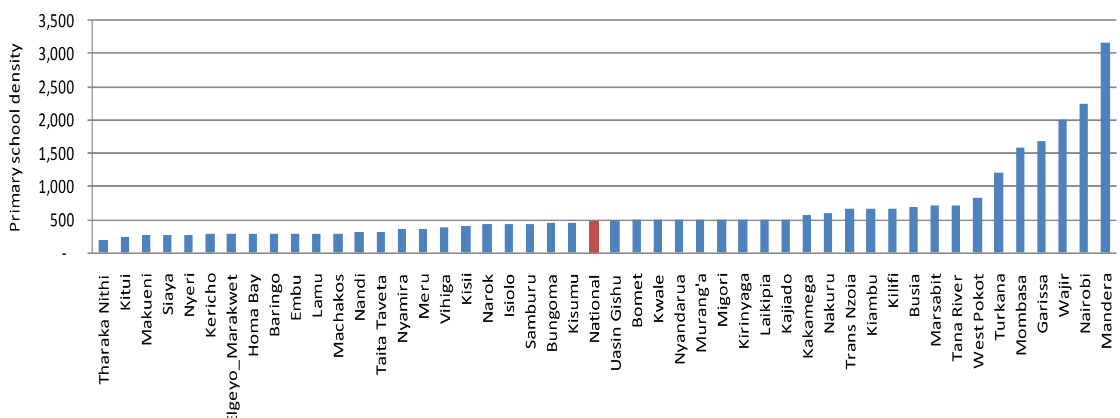
A substantial number of primary school going age children was still not in school despite some of the affected counties operating at a suboptimal level. As an example, Marsabit, Tana River, Turkana, Wajir, Nairobi and Mandela had large pupil school age population density but it is only Nairobi County which recorded a large school size implying shortage of schools relative to number of primary school age children in the county. The other counties (Marsabit, Tana River, Turkana, Wajir and Mandela) have extra capacity in the existing primary schools.

Figure 1-7: Primary school size by County (2009/10)



Data Source: Ministry of Education, EMIS section

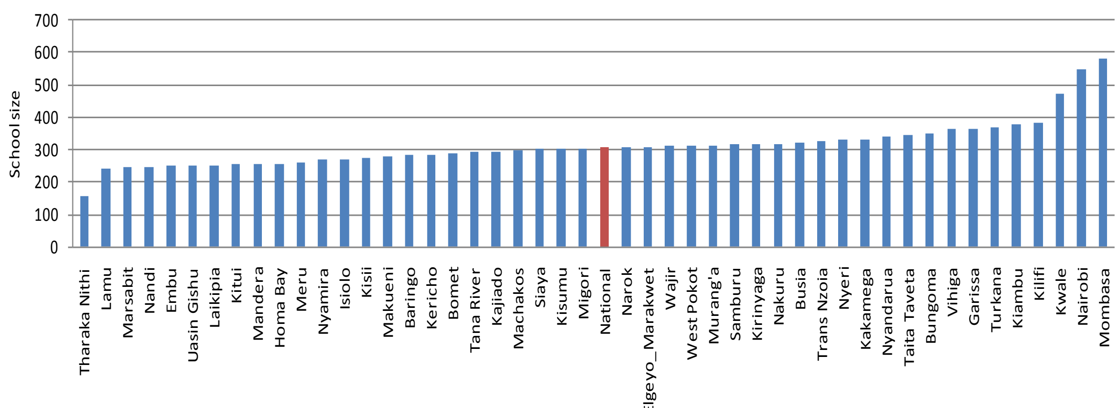
Figure 1-8: Primary school population density by County (2009/10)



Data Source: Ministry of Education, EMIS section

The coexistence of a high secondary school age population density and small school size indicates underutilization of available school infrastructure. The recommended school size for a secondary school is 540 students assuming each secondary school has least 3 streams per class of 45 pupils (GOK, 2005). This means that a large number of secondary schools are operating at a sub-optimal level yet a large number of school age youth are not in school. On the other hand, large school size and high secondary school density indicate shortage of schools in some regions of Kenya (Figure 1-9 and Figure 1-11) although a large number of school age youth are not in school

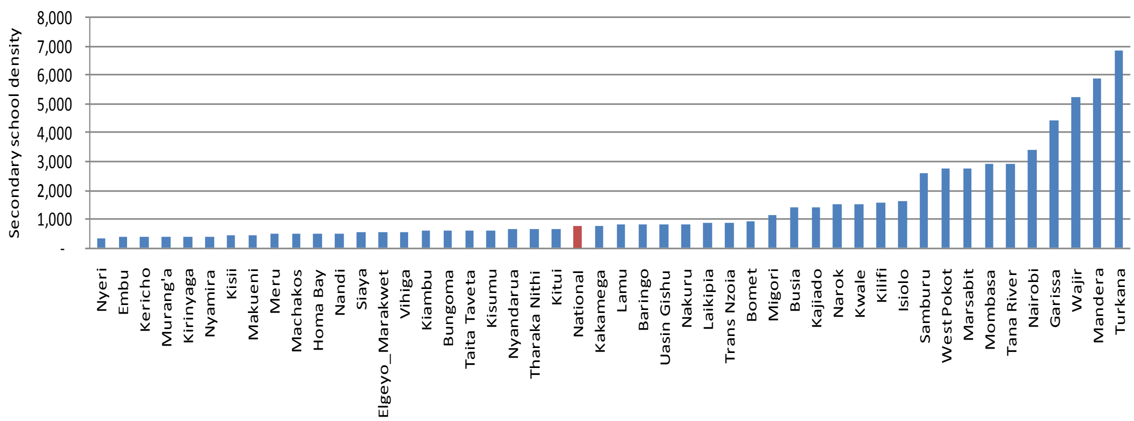
Figure 1-9: Secondary school size by County (2009/10)



Data Source: Ministry of Education, EMIS section (2012)

Figure 1-9 shows that 23 counties had secondary school size above the national average of 300 students per school and only two counties (Nairobi and Mombasa) were operating at an optimal level. Mombasa and Turkana counties had large school size and large school density indicating shortage of school infrastructure in these counties. 39 counties had secondary school density of less than 1000 (Figure 1-10). These counties also have small secondary school size that is below the optimal size of 540 students per school. These counties have potential of increasing secondary school enrolment using available school facilities without any expansion of school infrastructure.

Figure 1-10: Secondary school population density by County (2009/10)



Data Source: Ministry of Education, EMIS section (2012)

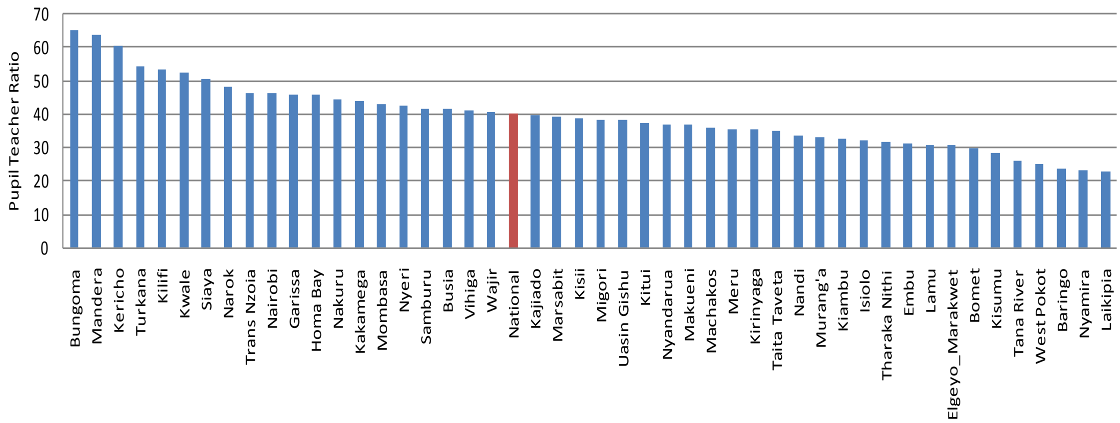
Based on other measures of education sector resource utilization such as pupil-teacher ratio (PTR), pupil classroom ratio (class size) Kenya's education sector is inefficient. The policy targets for primary school PTR and class size are 40:1 and 50:1 pupils, respectively, while for secondary level, the target for PTR and PCR are 35:1 and 45:1 students, respectively (GOK, 2003a). Table 1-4 shows that class size at primary level in 2007 was 35:1 for primary; clearly lower than the national target. Further, the maximum of 56:1 and minimum of 24:1 indicate a wide range. The existence of large classes alongside small classes at primary education level in Kenya suggests inefficient utilisation of education sector resources.

Table 1-4 also shows that in 2009, the average class size was 36 pupils almost the same as in 2007. The Eastern region had the lowest average class size (25 pupils) while Nairobi had the largest class size (60 pupils). Average PTR at primary education level increased from 34:1 in 2007 to 39:1 in 2009 due to increase in school enrolment. At secondary school level, the PTR was 24: 1 in 2010 up from 21:1 in 2005. This increase can be attributed to the implementation of the FDSE programme.

Availability of teachers as indicated by PTR varies widely across counties. In 2010 at primary school level, the largest PTR (65:1) was in Bungoma and the lowest (23:1) in Laikipia (see Figure 1-11). In addition, 20 counties had a PTR greater than the national target 40:1 while more than half (27 counties) had PTR below that national target.

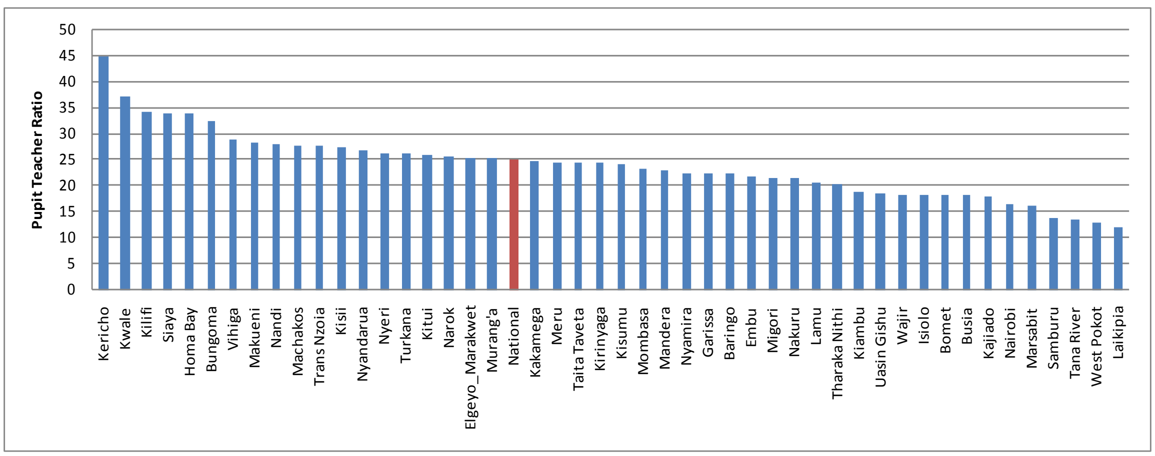
Similarly, at secondary school level disparities in PTR are observed. The highest PTR was 45:1 and the lowest was 12:1 (see Figure 1-12).However, there appears to be scope to increase enrollment with existing teachers at secondary level in most counties. All counties excepting Kwale county and Kericho County recorded a PTR lower than the national target of 35:1.

Figure 1-11: Primary education pupil teacher ratio by County (2009/10)



Data Source: Ministry of Education, EMIS section (2012)

Figure 1-12: Secondary education pupil teacher ratio by County (2009/10)



Data Source: Ministry of Education, EMIS section (2012)

The low PTR in most counties at secondary education level, suggest under-utilization of physical and human resources, leading to inefficiency and high unit costs. Clearly, there is scope for improving utilization of teachers at this level. On the other hand, PTR above the target of 40:1 was observed in several counties at primary school level. This implies overcrowding and or over utilization of available resources, which is likely to negatively affect the quality of education service delivery.

1.2.4 Transition from secondary to tertiary education

Transition to universities from secondary school level is relatively low. In the 2002/03 academic year, 7.1 percent of Kenya Certificate of Secondary Education (KCSE) students were admitted to public and private universities locally, perhaps due to supply constraints. This represented 26 percent of the students who qualified (attained grade C plus and above) (Table 1-5).

The situation has not changed markedly. In 2010/11, 27.3 percent of KCSE candidates qualified to join university but only 23.3 percent of those who qualified were admitted to local universities. This represented 7.7 percent (6.4 percent public and 1.3 percent private) of the total KCSE candidates during the previous academic year. Although, students who are not admitted to universities are expected to join other middle level colleges for certificate and diploma courses; only 7.8 percent got admission to these middle level colleges. Total enrolment in technical institutions increased from 63,823 students (46 percent female) in 2003 to 68,379 students in 2010 (GOK, Various (c)).

Table 1-5: Admission trends to public universities (%), 2002/03-2009/10

Academic Year	Form 4 enrolment	% Qualified (C+ and above)	University admission (% of qualified students)	Public University admission (% of Form 4 enrolment)	Private university admission (% of Form 4 enrolment*)	Proportion of Students admitted to technical training institutions	Proportion of Students admitted to teacher training colleges	Potential Non Placement
2002/03	176,018	24.0	26.2	6.3	0.8	12.4	5.1	56.3
2003/04	198,356	21.5	25.3	5.4	0.7	11.2	4.7	58.9
2004/05	207,730	24.0	20.5	4.9	0.8	10.9	4.5	64.1
2005/06	222,676	26.2	18.9	4.9	0.8	10.6	4.4	66.1
2006/07	241,643	26.2	25.3	6.6	1.5	9.8	4.1	60.8
2007/08	271,691	25.9	24.2	6.3	1.4	9.4	3.8	62.6
2008/09	301,400	24.1	24.8	6.0	1.3	9.4	3.1	62.7
2009/10	333,816	23.1	28.9	6.7	1.1	8.9	2.7	59.5
2010/11	356,015	27.3	23.3	6.4	1.3	7.8	2.8	66.1

Source: Joint Admissions Board; GOK, Various; and Author's computations. Note:* Due to data limitation, proportion of private universities admission as percentage of Form 4 enrolment is assumed at the same distribution level as aggregate private university enrolment as a proportion of total university enrolment over time.

1.2.5 Education and labour market outcomes in Kenya

The gains from educational investments may accrue to the individual worker; to the household he/she comes from and to the society. High external efficiency of education would entail high probability of access to employment and high earnings. It may be expected that unemployment should decrease with increase in education attainment ceteris paribus. However, this may not be the case because other factors apart from educational attainment might be influencing unemployment. The 1998/99 labour force survey data and 2005/6 Kenya Integrated Budget Household Survey provide evidence of these labour market dynamics in Kenya. In 2005/6 university education graduates' unemployment rate was 7.5 percent compared to 11.2 percent in 1998/99.

Table 1-6: Unemployment rates in Kenya, by education level (%), 1998/99 and 2005/6

	1998/9			2005/6		
Educational Attainment	**Males**	**Females**	**Total**	**Males**	**Females**	**Total**
Total	**8.4**	**11.9**	**10.1**	**11.2**	**14.3**	**12.7**
None	19.4	26.3	23.4	6.7	0	2.9
Primary	27.6	24.2	27.6	11.2	13.3	12.3
Secondary	15.3	29.1	19.8	10.6	18.3	13.9
University	7.7	18.9	11.2	5.6	12.2	7.5
Vocational institutions						
Total	**..**	**..**	**..**	**10.8**	**15**	**12.7**
Government college	..	..	..	5.1	10.8	7.1
Commercial college	..	..	..	7.7	19.9	13.2
Vocational/Village	..	..	..	7.5	12.3	9.4
None	..	..	..	12.3	14.7	13.5

Source: GOK (2003) and GOK (2008); .. data was not available during the study.

Unemployment rate among vocational training graduates was 12.7 percent (7.1 percent for government college graduates, 13.2 percent for commercial college graduates and 9.4 percent for village polytechnic graduates) in 2005/6. Unemployment among graduates may be because they are not equipped with necessary knowledge/skills or that technological advances have rendered them unemployable (GOK, 2002). It may also be that relatively well educated individuals queue for better jobs (Serneels, 2007).

Table 1-7: Labour force participation rates in Kenya, by education level (%), 2005/6

Education level	Male	Female	Total
None	0.05	0.08	0.07
Primary	51.57	53.49	52.50
Secondary	35.17	26.60	31.04
University	2.34	0.90	1.65
Other	0.62	0.08	0.36
Not stated	10.25	18.85	14.39
Population (Number)	6,576,865	6,108,281	12,685,146

Source: GOK (2008)

Labour force participation is higher among primary school graduates than among secondary school graduates. In 2005/6, the labour force participation rate was 52 percent among persons with primary education, 31 percent for secondary graduates and 1.6 percent for university graduates (see Table 1-7). The lower participation among the educated might be an indicator of external inefficiency of education in Kenya. Studying the link between education and labour market helps to assess the extent of external efficiency of the education system.

1.2.6 Education sector policy reforms

A wide range of education policy reforms have been implemented in Kenya since 1985, notably the introduction of the 8-4-4 system in 1985; introduction of free primary education in 2003 and free day secondary education in 2008. These reforms were intended to increase access to affordable, relevant and high quality education and skills development. The reforms came in the context of observed education inequalities as discussed in the earlier sections of this chapter.

The Constitution of Kenya (GOK, 2010b), Sessional Paper No. 14 of 2012 (GOK, 2012) and Vision 2030 provide the current policy directions guiding the provision of education and training in the country. The Constitution of Kenya provides guidance for education policy in several ways. First, it emphasizes the right to education. The provisions of the Constitution grant citizens the right to goods and services; education included, of reasonable quality and to information necessary for them to gain full benefit from goods and services. The Vision 2030 identifies quality and equitable education services delivery as key enablers for sustainable development. Every child has a right to free and compulsory basic education regardless of social, cultural, religious and physical differences and parents are required to ensure that every school-age going child attends school (GOK, 2010b).

Second, it recognizes international laws that Kenya is a signatory as part of laws of Kenya. In effect, the International Covenant on Economic Social and Cultural Rights (ICESCR, 1966) which emphasizes the right to the highest standard of education is applicable to Kenya. The ICESCR stipulates that education at all levels should exhibit four interrelated features: availability, accessibility, acceptability and adaptability.

Third, the Constitution introduced devolution of governance structures and transformation of key education institutions/organizations to ensure that all public services including education are accessed in all parts of Kenya. Under the devolved system of government, the national government is responsible for education policy, standards, curricula, examinations. It is also responsible for granting of university charters; administration of other institutions of research and higher learning; primary schools, secondary schools, and special education institutions. The county government on the other hand is responsible for pre-primary education, village polytechnics, home craft centers and childcare facilities. However most of the national government functions such as teacher management and quality assurance will need to be decentralized for equitable and efficient service delivery.

A successful decentralization process will however require among others: development and monitoring of quality standards, especially for the devolved functions; building clear accountability and transparency lines or requirements; development of transfer agreements between different tiers of government that take into consideration regional differences; design and implementation of an equalization scheme; adequate capacity development plans to prepare for such processes as the need to change long established behaviors or attitudes (GOK, 2012).

Most of the analysis in this study focuses on the county, which under the 2010 Constitution will be the focus of public service delivery. The findings from this study are intended at informing policy reforms, especially decentralization and efficient resource mobilization for sustainable financing of education and training in Kenya. The next section provides an overview of public spending on education in Kenya.

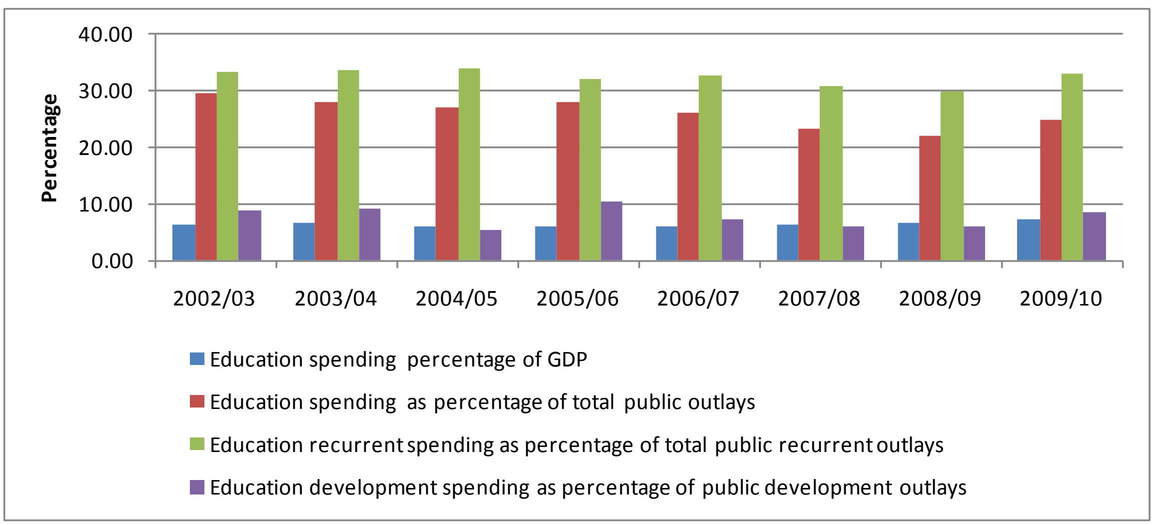
1.2.7 Public spending on education

Public subsidies for primary and secondary education in Kenya are in form of capitation grants for teaching and learning materials and physical infrastructure development; since 2003 and 2008, respectively. The subsidies cover infrastructure development, salaries, teaching and learning materials and operational costs in primary and day secondary education. Other public school costs such as boarding fees are met by households.

At technical and university levels, government grants are mainly spent on lecturers' salaries, student bursaries, scholarships and student loans (GOK, 2010a). Tertiary education institutions charge fees in order to meet operational costs. The private sector is also represented through individual education entrepreneurs and corporate contributions towards financing and providing education in the country. On the other hand, households (through fee charges) finance Early Childhood Development and Education (ECDE), and non-tuition expenses at all levels of education such as uniform, boarding expenses, transport, meals, among others. They also finance private education.

Education sector reforms have been accompanied with increase in public spending on the sector over time. For instance, public education spending increased from 6.2 percent of GDP in 2002/3 to 7.4 percent in 2009/10 (see Figure 1-13). This represented 29.7 percent and 26.3 percent of the total public spending in the respective years. The increase in education spending is attributable to a combination of factors key among them expansion in school enrolment rates, and personnel emoluments. Primary education takes the largest share of public education spending followed with secondary education, university education and technical education (see Table 1-8). However, the per capita education spending is skewed towards higher education.

Figure 1-13: Public education spending (%), 2002/3 – 2009/10



Sources: GOK, Various (a) and *printed estimates, 2009/10 (GOK, Various (b).

The Kenya government has continued to prioritize primary education in the education budget. The sub-sector was allocated about 46 percent of the education budget, 56 percent in 2006/7 and 47 percent in 2009/10 (Table 1-8) to cover FPE capitation grants and primary school teachers' salaries. Secondary education and university education sub-sectors spending remained relatively constant during the review period at 24 percent and 13 percent of total education budget, respectively. The share of the public education budget allocated to development increased from 4 percent in 2002/3 to 13.5 percent in 2009/10. This is partly due to increased allocation to schools infrastructure development and activities in Kenya Education Support programme (KESSP)[3] (GOK, 2005b). School infrastructure development is also financed by households, communities and external sources. This partly explains the distribution of schools in Kenya.

Non-wage recurrent expenditures can have significant impact on the level and quality of education outputs. Such expenditures represent resources allocated for operational activities that enhance quality of learning and maintenance of asset base. These expenditures include capitation grants to schools for instructional material, bursaries and loans for secondary and tertiary education, teacher training, physical infrastructure improvement, school feeding and health interventions, and support for Arid and Semi Arid Lands (ASAL) basic education projects, among others.

[3] KESSP (2005-2010) was a five year education investment programme implemented between 2005 and 2010 to enhance quality of education and ensure equity of access (GOK, 2005a).

Table 1-8: Actual expenditure (recurrent and development) (%), 2002/03-2009/10

	2002/3	2003/4	2004/5	2005/6	2006/7	2007/8	2008/9	2009/10
General Administration and Planning	16.00	6.90	6.86	10.88	9.27	9.85	7.38	12.96
Primary Education	46.28	57.59	55.75	53.70	56.03	52.01	49.81	46.60
Teacher Education	0.24	0.47	0.32	0.34	0.19	0.36	0.29	0.17
Special Education	0.19	0.24	0.26	0.21	0.34	0.35	0.43	0.13
Early Childhood Education	0.35	0.53	0.03	0.06	0.05	0.05	0.18	0.15
Secondary Education	24.29	21.97	22.02	19.26	16.98	22.97	24.67	23.98
Technical Education	1.40	1.59	2.14	2.17	2.71	3.46	4.85	4.73
University Education	11.25	10.72	12.61	13.39	14.43	10.94	12.39	11.28
Total (Ksh. Billion)	**63.71**	**74.07**	**81.04**	**92.60**	**103.86**	**121.32**	**136.89**	**160.33**
Recurrent expenditure (% of total expenditure)	95.64	92.57	95.38	93.04	92.43	91.88	91.05	86.46
Development expenditure (% of total expenditure)	4.36	7.43	4.62	6.96	7.57	8.12	8.95	13.54
Salaries (% of recurrent education expenditure)	88.8	89.6	90.2	83.4	85.1	79.3	75.0	76.9
Salaries (% of total education expenditure)	84.9	82.9	86.1	77.6	78.7	72.9	68.2	68.0
Non salaries (% of recurrent education expenditure)	15.8	18.5	14.7	24.1	23.1	29.5	34.9	36.1
Non salaries (% of total education expenditure)	15.1	17.1	14.0	22.5	21.3	27.1	31.8	32.0

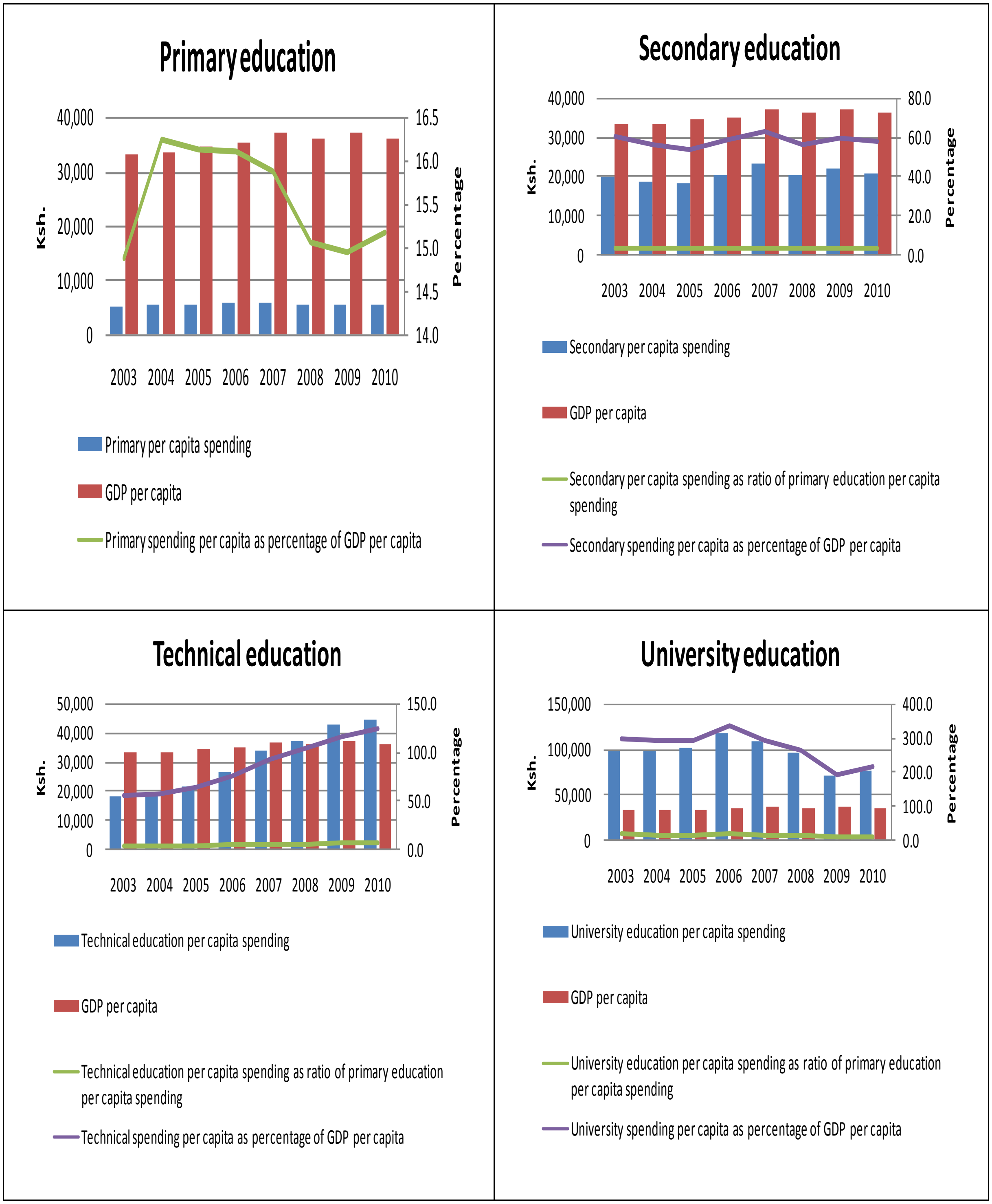
Source: GOK, Various (a), various and Author's Computations; * Estimates

There is evidence from Table 1-8 of substitution between wage and non-wage education spending during the review period. The share of non salary expenditure in total education expenditure increased from 15.1 percent in 2002/3 to 32 percent in 2009/10 while the share of total expenditure on personnel emoluments declined from 84.9 percent to 68 percent during the same period.

Another characteristic of public education spending in Kenya is that public spending per capita increases with the level of education. Expenditure per capita at primary education level increased from Ksh. 4,945 in 2003 to Ksh. 5,483 in 2010 at 2003 constant prices. The expenditure per capita at secondary level (Ksh. 20,879) was 3.8 times that of primary education in 2010. Technical and university education public expenditure per student (Ksh. 44,643 and 77,412) were 8 times and 14 times that of primary education; respectively (see Figure 1-14 and Table 1-9).

Overall, the average unit costs for the four levels of education in Kenya: primary, secondary, technical and university education provide the ratio of approximately 1:4:8:14 in 2010 fiscal year. The ratio means that university education is 14 times more costly than primary education; technical education was 8 times more expensive than primary education and secondary education per capita spending was 4 times more expensive than primary education. Per capita spending for technical and university education levels as proportion of GDP per capita was 124 percent and 214 percent, respectively. This means higher education is more expensive than primary education.

Figure 1-14: GDP per capita and public education spending per capita by education level at 2003 constant prices (2003-2010)



Source: GOK, Various (a), MOE, EMIS section and author's computations

As Table 1-9 and Figure 1-14 show primary and secondary education per capita spending remained relatively constant over the review period. On the other hand per capita spending at technical education level increased over time. Real per capita spending at university education increased gradually to Ksh. 118, 347 in 2006 before declining to Ksh. 77,412 in 2010. The decline in per capita spending can be attributed to the increase in enrolment resulting into better use of the available resources.

Table 1-9: Average real per capita spending on education by level, 2003-2010

Sub sector	2003	2004	2005	2006	2007	2008	2009	2010
Primary	4,945	5,425	5,563	5,665	5,863	5,440	5,548	5,483
Secondary	20,112	18,736	18,494	20,587	23,273	20,432	22,182	20,879
Technical	18,283	19,137	21,936	26,667	34,154	37,212	43,042	44,643
University	98,317	98,319	101,327	118,347	108,744	95,666	71,458	77,412
GDP deflator	100.0	107.1	112.4	121.1	127.3	143.9	149.7	155.7
GDP per capita	33,220	33,415	34,515	35,162	36,933	36,133	37,127	36,140
Per capita spending as ratio of primary education spending								
Primary	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Secondary	4.1	3.5	3.3	3.6	4.0	3.8	4.0	3.8
Technical	3.7	3.5	3.9	4.7	5.8	6.8	7.8	8.1
University	19.9	18.1	18.2	20.9	18.5	17.6	12.9	14.1
Public spending per capita as % GDP per capita								
Primary	14.88	16.24	16.12	16.11	15.88	15.06	14.94	15.17
Secondary	60.54	56.07	53.58	58.55	63.01	56.55	59.74	57.77
Technical	55.04	57.27	63.56	75.84	92.48	102.99	115.93	123.53
University	295.95	294.23	293.57	336.58	294.44	264.76	192.47	214.20

Source: GOK, Various (a), MOE, EMIS and author's computations

However, per capita spending at current prices varies across regions. In 2009/10 fiscal year, primary education per capita spending range from a low of Ksh. 1,392 for Garissa County to a high of Ksh. 11,628 (Kisumu County). Secondary education per capita spending range between Ksh. 6,846 (Moyale County) and Ksh. 50,616 for Kuria County.

1.2.8 Sources of education spending

The financing of education in Kenya remains a partnership between the government (national government, previously local government and county governments), private sector, development partners, households and communities, civil society organisations and individual institutions though internally generated fund.

In 2010, overall education spending was estimated at Ksh. 325 billion (12.7% of GDP) having increased by 74.9% (partly due to increase in school enrolments) from Ksh. 186,303 billion in 2006 (11.5% of GDP). Government spending during this period was estimated at Ksh. 188 billion while household spending was estimated at Ksh. 109.5 billion. In 2010, the government financed 58 percent of total education spending while households finance 33.6 percent (see Table 1-10). On the other hand, the private sector and individual institutions financed 0.03 percent and 4.7 percent of education spending either through direct funding and or operating learning institutions at various levels. NGOs and development partners financed 1 percent and 0.73 percent of total education expenditure, respectively. Support from local authorities through on-budget and project support was estimated at 2.2 percent of education budget in 2010.

Table 1-10: Aggregate education spending by source (%) (2006-2010)

	2006	2007	2008	2009	2010
Ministry of Education	93,023	107,531	121,334	132,924	147,092
Ministry of Higher education	15,582	16,653	19,687	24,562	29,177
Ministry of Youth Affairs and Sports	1,414	2,385	4,407	6,876	5,753
Other Ministries	3,635	4,247	5,038	5,504	6,219
Constituency Development Fund	3,566	4,379	4,356	4,437	5,199
Local Government Authorities	984	1,162	1,337	1,636	1,999
Household (Parents)	53,888	73,297	83,552	95,620	109,491
NGOs and Religious bodies	2,812	2,917	3,074	3,200	3,269
Companies	50	58	71	76	85
External Loans	-	-	164	248	83
External Grants	4,868	6,536	11,485	6,920	2,193
Internally Generated Funds	6,481	7,586	8,775	12,460	15,147
Total Education Expenditure (Ksh. Million)	**186,303**	**226,751**	**263,280**	**294,463**	**325,707**
Total Education Expenditure(% of GDP)	**11.5**	**12.4**	**12.5**	**12.4**	**12.8**
Shares of financing sources (%)					
Ministry of Education	49.9	47.4	46.1	45.1	45.2
Ministry of Higher education	8.4	7.3	7.5	8.3	9.0
Ministry of Youth Affairs and Sports	0.8	1.1	1.7	2.3	1.8
Other Ministries	2.0	1.9	1.9	1.9	1.9
Constituency Development Fund	1.9	1.9	1.7	1.5	1.6
Local Government Authorities	0.5	0.5	0.5	0.6	0.6
Household (Parents)	28.9	32.3	31.7	32.5	33.6
NGOs and Religious bodies	1.5	1.3	1.2	1.1	1.0
Companies	0.03	0.03	0.03	0.03	0.03
External Loans	-	-	0.06	0.08	0.03
External Grants	2.6	2.9	4.4	2.4	0.7
Internally Generated Funds	3.5	3.3	3.3	4.2	4.7

Source: MOEST, UNESCO and KNBS Draft report (2013)

1.3 CONCLUSION

This chapter provides the context for the analysis in the three essays presented in this thesis. Between 2002/03 and 2009/10 fiscal years, the government spent an average of 6.4 percent of GDP and 26 percent of total government outlays on education and training. Despite increases in both NER and GER at primary and secondary levels of education between 2002 and 2010, close to 8.6 percent and 68 percent of primary and secondary school age children, respectively, were not in school in 2010. In addition, there are large disparities across counties; and survival to tertiary level is relatively low. Further, differences in education performance tend to be mapped into differences in the labour market outcomes.

Low education sector performance is a policy concern because it can have negative impact on the country's national development goals such as reducing inequalities; ensuring effective public finance management though efficient resource use for improved education outputs; and poverty reduction.

This thesis attempts to examine the levels of inequalities in distribution of benefits from public education spending, technical efficiency of public education spending and externalities of schooling and training in Kenya. In chapter 2, the degree to which public education spending reaches the poor is analyzed.

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CHAPTER 2

2 WHO BENEFITS FROM PUBLIC SPENDING ON EDUCATION IN KENYA?

2.1 INTRODUCTION

Kenya has taken steps towards decentralization of education management and financing with the aim of ensuring that education spending benefits the poor while addressing inequalities in access to schooling across regions. This can be observed through the capitation grants to schools, notably through the free primary education, free day secondary education, constituency development funds and county spending on education. As a result, spending on education tends to be managed more at the county, district and school levels. Further, the Constitution of Kenya (2010) underscores and provides for devolution of systems for improved service delivery.

The Bill of Rights (Article 4) in the 2010 Constitution holds that every child of school going age has a right to high quality basic education irrespective of their socio-economic status. Benefits of decentralization relate to efficiency in service delivery and empowerment of communities (Ajwad and Wodon, 2002). First, an efficiency perspective assumes that local units such as schools, districts, provinces and counties have better information on programmes and policies to be implemented in order to benefit the low income group. Second, decentralization is associated with delegation of decision-making to local units while enabling local communities to participate in service delivery for the benefit of the target population.

Although financial management has been decentralized; accountability, monitoring and targeting of the poor are weak. As an example, although free primary education and free day education are based on set capitation grants to schools, there are policy gaps with regard to ensuring that the resources are appropriately spent to benefit low income groups. To measure the benefits from increased public spending on education, it is necessary to establish the proportion of beneficiaries who gain from overall spending on education (average benefit incidence) and those who gain from any additional increase in education public spending (marginal benefit incidence). While average benefit incidence analysis focuses on those who are the current beneficiaries of access to schooling, marginal benefit incidence provides information on effect of improvements in expansion of government education programmes.

Benefit incidence and efficiency of education spending in Kenya relates to estimating the impacts or benefits of education investments, comparing those benefits across regions, and using the resulting rates of return to make recommendations towards effective and sustainable financing and provision of education in the country. One of the main advantages of benefit incidence analysis especially at regional level is that it is more directly linked to the policy goals adopted by government with regard to ensuring equitable access to education services across regions and poverty reduction targets.

Further, the analysis of benefit incidence of schooling in Kenya is timely. The government is engaged in implementation of decentralization policies amidst budgetary constraints and unsatisfactory level of access to education in some counties. Benefit incidence of public education spending measures the extent to which individuals of the expected school age are able to enroll in a school and hence acquire intended learning outcomes, while benefiting from public spending on education (Younger, 2003).

In addition to measurement of benefit incidence, it is also important to understand differences in social, economic and region specific factors that influence the population’s level of benefit from education spending. This information is important for policies aimed at reducing inequalities, while enhancing targeting in public education services delivery and improving human capital development especially among the low income groups across regions. Moreover, spending more is not a guarantee that a country will obtain better education outcomes (Jarasuriya and Wodon, 2002 and Gupta and Verhoeven, 2001). Rather, it is the extent to which resources are targeted to benefit low income groups (Castro-Leal et al, 2000 and Manasan, Cuenca and Villanueva, 2007).

This chapter focuses on both the average benefit incidence and marginal benefit incidence of public spending on education; and the factors explaining variations in benefit incidence of public education spending at various education levels. Unlike Demery and Gaddis (2009) analysis on marginal benefit incidence, this study is conducted in the context of decentralization, within a broader social welfare framework with regard to one county’s performance relative to the neighbouring counties.

The research questions addressed in this chapter are: i) To what extent has public education spending in Kenya been equitable across socio-economic groups? ii) Who benefits from public education spending in Kenya? and iii) What factors influence the extent to which households benefit from public education spending.

The broad objective of this essay is to establish who benefits from public spending on education in Kenya with a view to identifying feasible policy options for enhancing equity in education service delivery. The specific objectives are:

(i) Estimate average benefit incidence of public education spending by county;

(ii) Estimate marginal benefit incidence of public education spending;

(iii) Analyze the factors that influence benefit incidence; and

(iv) On the basis of (i), (ii) and (iii), draw policy implications.

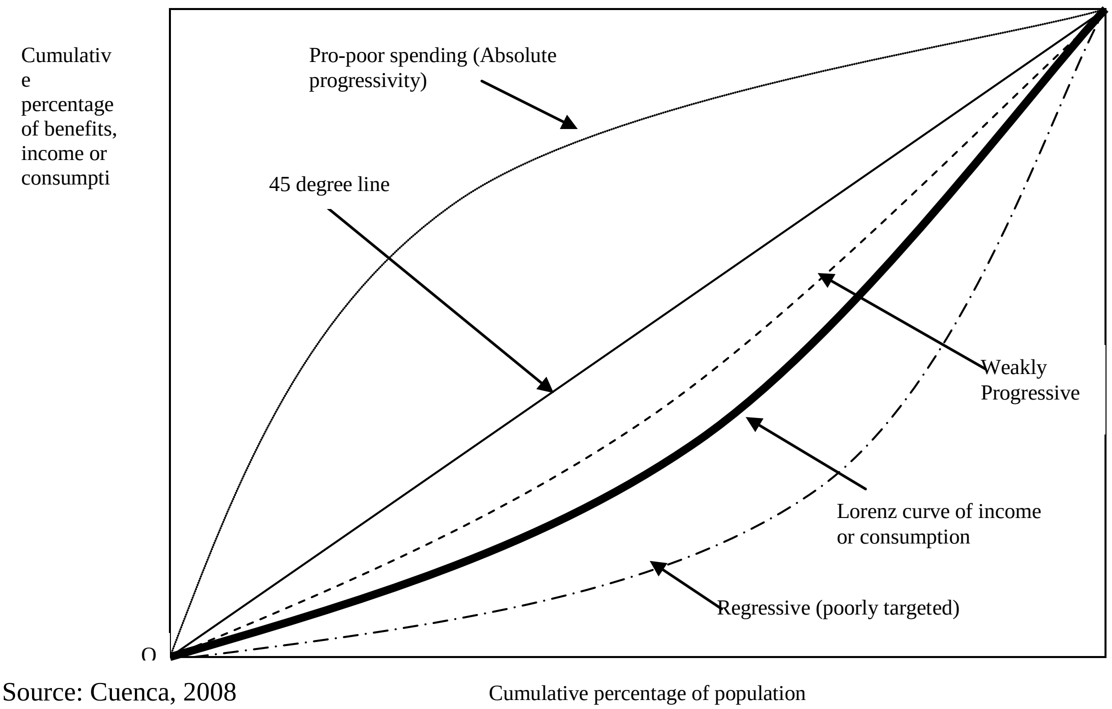
The essay is organized as follows: Section 2.2 reviews the literature. Section 2.3 discusses the methodology. Section 2.4 reports the empirical results. Section 2.5 provides conclusions and policy implications.

2.2 LITERATURE REVIEW

2.2.1 Theoretical literature

Benefit incidence analysis (BIA) of public spending on education examines how benefits of public expenditures on education and training are distributed across income groups. It indicates the effectiveness of government, targeting of scarce resources towards meeting the education needs of the population especially the poor. BIA involves assessment of household behaviour in utilizing education services and government behaviour in spending on the education services across regions and education sub sectors. It also involves assessment of whether public spending is progressive or regressive (Cuenca, 2008). Benefit incidence can also be measured using a concentration index.

Figure 2-1: Lorenz and concentration curves



Source: Cuenca, 2008

Public spending is progressive if it improves the distribution of welfare as proxied by household income or expenditures. In this case, the lowest income groups receive the larger share of the benefit from public spending than the high income group. Public spending is absolutely progressive or pro poor if the concentration curve lies above the equality (45 degrees diagonal) line and weakly progressive if the concentration curve lies between the Lorenz curve and the equality line (see Figure 2-1) In most cases this is achieved through efficient targeting of public spending.

On the other hand, public spending is regressive if public spending tends to benefit the high income group more than the low income group. In this case, the benefit concentration curve lies below the equality line and below the Lorenz curve of income distribution, indicating that the benefit incidence is more regressive than income.

Marginal BIA assumes that the budget is allocated among poor (P) and non poor (R), across regions, such that $E = E_R + E_P$, where E_R and E_P represent investments for expanding access to social services such as education among the rich and poor individuals across all regions (Cuenca, 2008). In this case, the household access rate in each region is $S_i = f_i(E_i)$, for i= 1,…,n regions. Marginal BIA enables assessment of region specific characteristics that have impact on education outputs and outcomes. Some of these factors include the children's socio-economic status, availability of school facilities, gender and age of the child (Alabi et al, 2010). The functions f_{Ri} and f_{Pi} are increasing and strictly concave, such that $f_i'(E_i)>0$ and $f_i''(E_i)<0$ for all regions, both rich and poor. Thus the access rate is expected to increase when investment expenditures increase but the marginal gains diminish with expenditures. For any given level of expenditure, it is assumed that $f_{Ri}(E) > f_{pi}(E)$ for all expenditure levels between 0 and E. In these instances corner solutions are avoided by assuming that the first shilling spent on the non poor increases the school enrolment rate by more than the last dollar added to the poor, such that f_{pi}' (E)< f_{Ri} (0). In effect, it is not possible to spend all the income on one income group, such as the non poor only or the poor only at any point in time.

2.2.1 Empirical literature

The technique that has been used to analyze distributional effects of public education spending in previous studies (e.g. Demery and Verghis, 1994; Castro-Leal et al, 1999; and Demery and Gaddis, 2009) is benefit incidence analysis (BIA). But this approach has weaknesses. BIA assumes that when pupils from both poor and non poor income groups are enrolled, they receive equivalent amount of per capita spending. Thus results could be biased when the two groups receive different per capita spending (Lassibille and Tan, 2007). An alternative is to use marginal BIA (Lanjouw and Ravallion, 1999; Younger, 2003 and Lassibille and Tan, 2007). Under Marginal BIA, variations in benefit incidence mimic differences in public spending in the sector under review and cross sectional variations can be used to predict changes in benefit incidence (Younger, 2003).

Following the work of Younger (2003) there has been growing interest in estimating marginal BIA of public education spending in developing economies. Manasan et al (2007) used marginal BIA approach to evaluate whether education expenditures in the Philippines benefited the poor and whether they had a redistributive impact. The study established that overall government education spending was progressive. However, using national averages, the distribution of education spending was found to be progressive at the elementary and secondary levels but regressive at the technical vocational education and training and college levels. Further, government spending was found to be more regressive when regional variations were introduced and more progressive in regions that catered for the needs of poorer households. The results showed that expansion of education by the Philippine government strengthened the national economy and improved the distribution of income and welfare through enabling the poor access basic education.

Assessment of distributional effects of public spending based on participation in a given programme by income group has been extended to include geographic variations while estimating marginal effects of programme spending (Lanjouw and Ravallion, 1999; and Younger, 2003). Lanjouw and Ravallion (1999) used 1993-94 household survey data for rural India in estimation of the marginal odds of participating in schooling and antipoverty programme. They found that non-poor population benefit more from schooling; and that the standard BIA approach tends to underestimate benefits for the poor from higher public spending.

Lassibille and Tan (2007) show that the standard BIA estimates of the distribution of public education benefits tend to be biased. This occurs when students from low income and high income households attend schools with different per pupil subsidy. Combining public spending per pupil and geographically/regionally disaggregated school level data removes the bias.

Some studies have found that public education spending is regressive. Based on cross sectional data for Bolivia and Paraguay, Ajwad and Wodon (2007) demonstrated that marginal benefit incidence of public education spending was lower for the poor than for the non-poor. That is, the poor tend to gain access to education once the non-poor have gained higher levels of access. The authors put a strong case for targeted pro-poor policies if the poor are to benefit from public education spending.

However, targeting of education subsidies is a major challenge. For example, Johannes and Noula (2011) found that subsidies for higher education in Cameroon were poorly targeted. Public spending benefited the non-poor more than the poor. In addition, there were large gender disparities in access to tertiary education but smaller at primary education level. The study also established that increasing subsidies to primary and secondary education would benefit the middle and high income groups.

Demery and Gaddis (2009) used BIA to analyze social spending, poverty and gender equality for Kenya. They found that public primary education spending benefited the poor more than the non-poor. But the non-poor were the main beneficiaries of public education spending at secondary and tertiary levels. However, the study did not provide estimates of benefit incidence at county level and associated inequalities. Neither did the study consider the factors explaining benefit incidence of public education spending at various education levels.

The present study uses the most recent nationally representative household survey data collected in 2005/6 to fill these gaps in the literature by linking demand for schooling with benefit incidence analysis. The study provides new estimates of marginal BIA for

Kenya and establishes the factors that constrain potential beneficiaries from accessing schooling despite the government interventions towards increasing access to education.

2.3 METHODOLOGY

2.3.1 Measurement of benefit incidence of public education spending

This study adopts a technique that shows who benefits from public education spending. It describes how education subsidies affect welfare of different income groups, using data on school attendance (measure of public education spending benefit) and unit recurrent costs. Recurrent expenditures are used because they benefit current beneficiaries while capital or development spending is assumed to benefit future beneficiaries and hence may yield different estimates of benefit incidence if included (Castro-Leal et al, 2000).

Initially, the benefit incidence approach (Demery, 2000 and Cuenca, 2008) is used to establish how benefits of public education spending are distributed across population and individuals. Households are grouped into 3 income terciles across counties. This enables us to determine if the distribution of education expenditure incidence is either regressive or progressive. Income groups are based on household per capita expenditure. Thus benefit incidence of public spending on education can be computed as:

$$X_j \equiv \sum_{i=1}^{3} E_{ij} \frac{S_i}{E_i} \equiv \sum_{i=1}^{3} \frac{E_{ij}}{E_i} S_i \qquad \text{…………………A1}$$

Where: X_j is amount of public education spending that benefits group j and j=1,…., 3

S_i refers to the government spending on education level *i*, where i=1,…..,3, representing the three levels of education: primary, secondary and tertiary (technical and university) education; E_{ij} refers to public school enrolment in education level *i* from income group *j;* E_i depicts total public school enrolment in a given education level from all income groups; and Ratio S_i/E_i is the mean unit subsidy or cost per pupil of providing education at education level i.

The benefit incidence of total education expenditure imputed for income tercile j is given by primary school enrolment from the tercile (E_{pj}) times the unit cost of the primary school places; plus secondary school enrolment from the tercile (E_{sj}) times secondary school unit cost, plus tertiary education enrolment from the tercile (E_{tj}) times the unit cost of tertiary education. Average benefit incidence of public education spending for income group j (X_j) is computed as:

$$X_j \equiv \sum_{i=1}^{3} \frac{E_{ij}}{E_i}\left(\frac{S_i}{S}\right) \equiv \sum_{i=1}^{3} e_{ij} s_i \qquad \text{…………………A2}$$

This is the share of public spending benefiting a given quintile and it depends on: i) household schooling behavior, e_{ij}, the share of income group in total service use or proportion of students enrolled in public schools; and ii) government resource allocation behavior, s_i, captured by the share of public spending on different levels of education.

To account for regional disparities in benefit incidence of public education spending, Equation A1 can be specified as:

$$X_j \equiv \sum_{k=1}^{47}\sum_{i=1}^{3}\frac{E_{ijk}}{E_i}S_{ik} \qquad \text{…………………A3}$$

where k denotes region specified in the unit cost estimates. In this study, *n* is 47 counties. The share X_j of total education subsidy (S) accruing to each income group equals:

$$X_j \equiv \sum_{k=1}^{47}\sum_{i=1}^{3}\frac{E_{ijk}}{E_i}\left(\frac{S_{ik}}{S}\right) \equiv \sum_{k=1}^{47}\sum_{i=1}^{3} e_{ijk}s_{ik} \qquad \text{…………………A4}$$

The share of education subsidy represents the overall inequality in benefit incidence as determined by the share of the income group in total enrolments at each level of education and in each region (e_{ijk}); and the share of each level of education and region in total education spending (s_{ik}) (Cuenca, 2008). The e's and s's denote households' enrolment decisions and government budget allocations across regions and levels of schooling, respectively.

The standard BIA technique described above has several limitations. Demery (2000) points out three limitations. First, the technique cannot be exhaustive since most government spending is not assignable and is non-rival in nature. Secondly, it does not account for long-term effects of government spending on the beneficiaries. Thirdly, although standard BIA provides an indication of targeting efficiency, the basis for such targeting is limited to current income distribution. Younger (2003) notes another limitation of standard BIA. That it describes average participation rates which may not necessarily guide marginal changes in public spending. To address these limitations, the present study applies marginal BIA technique.

2.3.2 Marginal benefit incidence analysis using single cross-sectional data

Marginal BIA is used to measure the distributional impacts and or incidence of actual changes (increases or cuts) in education public spending and programmes (Demery, 2000). The results of marginal BIA augment those from the standard BIA. Most studies have used panel data to estimate marginal BI of spending on public services such as education. Assuming, each child enrolled at education level *i* receives same amount of subsidy, the change in income tercile specific participation in education between any two years can be expressed as:

$$\frac{E_{ij}}{E_{it}} - \frac{E_{ijt}}{E_{it}} = \frac{E_{ij} - E_{ijt}}{E_{it}} \qquad \text{…………………A5}$$

Where j=1,2…k; E_{ijt} is the number of children in a given level of schooling *i* in income tercile j, at time t=1,2,..k, and E_{it} is total school enrolment in that level of education at time t. Thus E_{jt}/E_t represents the share of total enrolment of education spending that goes to tercile j through school attendance of its children. However, this measure of marginal benefit incidence is only possible with panel data indicating spending on education between any two time periods.

However, lack of panel data precludes estimation of marginal BIA in the present study using the above approach. Instead, the study Uses the approach proposed by Lanjouw and Ravallion (1999). The approach uses a single cross-sectional dataset to establish the benefit distribution is affected by increasing access to public services at the margin. The marginal BIA approach uses variation in access rates across regions in a country to capture the expected evolution of access to schooling over time. The approach assumes that the distribution of new access in lagging regions will follow the pattern observed in regions where access levels are greater (Lanjouw and Ravallion, 1999).

Following Ajwad and Wodon, 2001; Demery and Gaddis, 2009; and Lanjouw and Ravallion, 1999; this study estimated models of the following relationship:

$$p_{ikq} = \alpha_q + \beta_q p_k + \mu_q \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{A6}$$

Where *i* represents a district, *k* represents the province (larger unit) and *q* represents the income tercile where q=1…3. The dependent variable is the enrolment rate (*p*) for the given district in a given province and income tercile. The explanatory variable is the enrolment rate for the province in which the district is located. β_q is the measure of marginal benefit incidence. It represents the marginal effect of an increase in the enrolment rate of the beneficiaries in a given province and income tercile on district enrolment.

However, p_k is potentially endogeneous because it includes information from district enrolment rate p_{ikq} in each income tercile. As a result the estimates of β_q might be biased upwards. Districts are preferred to counties for purposes of increasing number of observations. A total of 72 districts in the 47 counties were covered in the sample. Following Lanjouw and Ravallion (1999) and Younger (2003), we instrument p_k with the left-out mean, that is mean enrolment rate for all provinces except those enrolments for the district and income group being observed (district *i* and income tercile *q),* to address the endogeneity problem. In other words, district enrolment rate in any given income tercile is regressed on the enrolment rate across all income terciles except for the district and income tercile for which the regression is being performed.

Intuitively, by observing variations in regional level enrolment rate, we can understand effects of increased enrolment levels of different population groups. If β_q is greater than 1, expansion of the given level of education in coverage district is correlated with a disproportionately large increase in participation for the province and income tercile.

Further, various socio-economic groups: poor and non-poor, are assumed to have different political power and experience different costs and benefits from a given public service. The approach permits interaction between factors influencing relationship between the programme size, amount spent and share of benefits accruing to each group.

However, like the standard BIA, marginal BIA does not reveal the factors associated with the incidence patterns. This requires estimation of household schooling choice model to establish the underlying factors. This will also assist in delineating regional differences that may affect overall benefit incidence of public education expenditure.

2.3.3 Explaining benefit incidence in education

To establish factors that explain benefit incidence in education, correlates of household schooling choice have to be estimated. The household head *h* is assumed to derive utility from the human capital (attained through schooling) of his/her children and consumption of other goods and services (Glick and Sahn, 2005). Parents choose the schooling alternative with highest utility among the available options: non-schooling and public school enrolment. Thus net consumption is given as: $c = y_i - p_{ij}$, j=1,..,2. Where y_i= household income; P_{ij} = cost to the household *i* of choosing schooling option j.

Further, assuming S_{ij} is the increment added to the child's human capital following a one year's enrolment in selected schooling option; following Gertler and Glewwe (1990) the quadratic utility schooling equation takes the form:

$$V_{ij} = a_o S_{ij} + a_1(y_i - p_i) + a_2(y_i - p_i)^2 \qquad \text{.....................B1}$$

Where V_{ij} is a utility function. The model enables interactions between income and prices. The functional form of the utility model specified (Gertler and Glewwe, 1990) is:

$$V_{ij} = a_o S_{ij} + a_1(y_i - p_{ij})E_1 + .. + a_5(y_i - p_{ij})E_k + e_{ij} \qquad \text{.....................B2}$$

Where e_{ij} is the random disturbance term; E_k (*k*=1,..,3) is an income tercile dummy variable and equals 1 if expenditure per capita of the individual's household falls in tercile *k* otherwise 0. This allows separate price responses for each expenditure tercile.

The utility derived from human capital S_{ij} is expected to vary across various school alternatives. However, since this change is not directly observed, $a_0 S_j$ is replaced by a reduced form utility equation of the form:

$$a_0 S_{ij} = \gamma Q_j + \partial_j X_i + \eta_{ij} \qquad \text{…………………B3}$$

Where Q_j is vector of schooling quality variables; and X_i is vector of household and individual characteristics. Substituting equation B3 into B2 yields the following equation:

$$V_{ij} = \gamma Q_j + \delta_j X_i + \sum_k \alpha_{1jk} y_i E_k + \sum_k \alpha_{2jk} P_j E_k + \varepsilon_{ij} \qquad \text{…………………B4}$$

Where α_{1jk} is coefficient on y_i and it differs from the price coefficient (α_{2jk}) for each income tercile and both coefficients are indexed at j. ε_{ij} is an additive error term and comprises of e_{ij} and η_{ij}. The functional form of the conditional utilities and decision rule enables the derivation of the demand function and hence probabilities of choosing each of the school options.

Thus, for a parent or household head *h* to send a child to a public school at any given level, other factors constant, the direct costs *c* associated with school attendance must be lower than the opportunity cost of schooling (Bedi, *et al.,* 2004). By extension, it is a household that enrolls a child at any given level of public education institution that benefits from public spending. To this end the study borrows from a schooling choice model in Gertler and Glewwe (1990).

The probability that parents send their children to a public learning institution can therefore be derived by specifying a linear conditional schooling utility function (Gertler and Glewwe, 1990) as follows:

$U_1 = \beta_1 b_1 + \beta_2 c_1 + \varepsilon_1$ ………………………………..………………B5

Where U_1 represents utility from schooling, b_1 denotes benefits derived from schooling, c_1 represents household consumption, β_1 and β_2 denote coefficients for respective variables to be estimated. ε_1 is the error term assumed to be normally distributed, with zero mean and positive variance. Letting c=y-p, where y is household income and p is total cost of schooling, equation B5 can be rewritten as:

$U_1 = \beta_1 b_1 + \beta_2 (y-p) + \varepsilon_1$ ……………………………………..…………B6

The utility function for non-schooling and hence not benefiting from public education spending can be specified as:

$U_0 = \beta_2 y + \varepsilon_0$ ……………………………………..…………B7

In other words a household decides to send a child to public school (G=1) if U_1-U_0>0 or $\beta_1 b_1 - \beta_2 p + \varepsilon_1 - \varepsilon_0 > 0$; assuming the composite error term ε_a $(\varepsilon_a = \varepsilon_1 - \varepsilon_0)$ is normally distributed. The probability of sending a child to public school then is:

$Pr\ [G=1] = Pr[\beta_1 b_1 - \beta_2 p_1 + \varepsilon_a > 0]$ …………………………………………B8

The probability that a student enrolls for a given level of education is given as:

$\Pr ob(G = 1 | X) = \Pr ob(X_i \beta + \varepsilon_a > 0) = \Phi(X_i \beta)$ …………………B9

Where X would be factors related to b_1 and p. β is the associated set of parameters to be estimated. $\Phi(.)$ is the evaluation of the standard normal cumulative distribution function (CDF). The model is estimated by maximum likelihood estimation method.

The dependent variable is based on the fact that a household enrolling at least one child in public school or tertiary institution has demand for public schooling at that given level. Thus, the dependent variable is a dummy, which takes the value of 1 if in a given household there is at least one school age child for the respective levels, that is, age between 6 and 13 for primary, between 14 and 17 years for secondary, who are enrolled in a respective level of education and 0 if not enrolled. Tertiary education has no strict age limit, but we assume population aged 18 to 25 years. The household decision depends on such factors as education costs (school fees, outlays for textbooks, transport and boarding costs, among others), socio-economic background of potential beneficiaries, household income, household size, gender and age of both children and household heads and schooling environment.

In the probit equation (B9) the marginal change associated with a given continuous explanatory variable in probability of enrolling in a public school is given as:

$$\partial \Pr(G=1|X)/\partial X_i = \phi(X\beta).\beta_i \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textit{B10}$$

The discrete change in the probability of enrolling in a public school for a change in dummy explanatory variable from o to 1 is given by:

$$\Delta \Pr(G=1/X)/\Delta X_i = \Pr(G=1/X, X_i = 1 - \Pr(G=1/X, X_i = 0) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{B11}$$

2.3.4 Data description and summary statistics of variables

This essay uses data drawn from the KIHBS 2005/6 survey. The survey covered over 72 districts in the eight provinces in Kenya. The sample consists of 13,430 households, 1,800 clusters and about 66,725 observations. The dataset contains detailed information on schooling demand side variables, including individual characteristics (age, sex, school attendance and reasons for non-attendance); households' social and economic characteristics (household income, expenditures, gender of all household members, highest level of education attainment, education expenditures and employment status, among others). Total expenditure on schooling is constructed from household expenditures on school fees, transportation costs, boarding, *harambee,* books and other related expenditures. Other variables include reason for being out of school and type of learning institution (public or private) attended.

The survey data was complemented by the district level education indicators and expenditure data for the same period from the Ministry of Education. The major variables in the education indicators data included accessibility to learning institution proxied with the density of schools per district, availability of teachers and public spending on education.

While the primary and secondary education spending data was disaggregated by district, technical and university education spending was only available at national level. Thus it was not possible to compute tertiary education unit subsidy at district level. Since this study focuses on households with school age children (6-13 for primary, 14-17 years old for secondary and 18-25 years old for technical and university education), the restricted sample constituted 1,339 clusters and 13,212 households. The study sample size consists of 11,597, 2,073 and 5,535 households for primary, secondary, tertiary (technical and university) education, respectively.

Table 2-1 presents descriptive statistics for the study sample. On average 98 percent of all children of primary school age (6-13 years) were in school during the survey period and the rate increases with the household income. About 61 percent and 8 percent of secondary school age (14-17) and tertiary school age (18-25) population were enrolled. On average, most children in primary schools were from low income groups while at secondary and tertiary education, more children from non-poor households are represented. The average household spending per child was estimated at Ksh. 3,317; and Ksh. 17,052 for primary and secondary education levels, respectively. Annual household spending on tertiary education ranged between Ksh. 34,517 and Ksh. 1.8 million. The mean age for primary, secondary and tertiary education levels was 10 years, 16 years and 22 years, respectively.

Table 2-1: Summary statistics

Variable name	Mean	Std Dev.	Minimum	Maximum
Primary education, n=11,597				
Primary school dummy	0.986	0.118	0	1
Age	9.778	2.171	6	13
Age squared	100.327	42.337	36	169
Gender (male=1)	0.494	0.500	0	1
Own child	0.404	0.491	0	1
Child with disability	0.010	0.099	0	1

Orphan	0.025	0.156	0	1
Household expenditure per adult equivalent (Ksh.)	2,609	4,337	45	191,734
Share of children in a household aged 0-5 years	0.152	0.135	0.000	0.667
Share of children in a household aged 6-13 years	0.357	0.136	0.063	0.857
School fees (Ksh.)	3,317	18,979	0	642,000
Primary school density per $3KM^2$	1.023	0.232	1	3.375
Pupil class size	36.060	6.267	15.284	57.931
Pupil teacher ratio	44.988	9.634	18.367	71.618
Household size	7.135	2.759	2	29
Household's marital status (married=1)	0.948	0.222	0	1
Household's gender (male=1)	0.706	0.456	0	1
Household head's highest level of education (Primary)	0.565	0.210	0	1
Household head's highest level of education (Secondary)	0.121	0.166	0	1
Household head's highest level of education (Tertiary)	0.006	0.041	0	0.67
Secondary education, n=2073				
Secondary school dummy	0.611	0.488	0	1
Age	15.989	0.998	14	17
Age squared	256.641	31.328	196	289
Gender (male=1)	0.459	0.498	0	1
Own child	0.367	0.482	0	1
Household expenditure per adult equivalent (Ksh.)	3,689	5,792	40	96,895
Child with disability	0.013	0.113	0	1
Share of children in a household aged 14-17 years	0.26	0.126	0.067	1
Orphan	0.036	0.187	0	1
Secondary school density per $5KM^2$	1	0	0.5	1
Pupil class size	35.910	4.030	13.235	46.739
Pupil teacher ratio	19.716	2.769	15.624	30.778
School fees (Ksh.)	17,052	45,966	0	960,000
Household's marital status (married=1)	0.928	0.258	0	1
Household's gender (male=1)	0.685	0.464	0	1
Household head's highest level of education (Primary)	0.507	0.242	0	1
Household head's highest level of education (Secondary)	0.281	0.256	0	1
Household head's highest level of education (Tertiary)	0.017	0.065	0	1
Tertiary education, n=5535				
Tertiary education dummy	0.08	0.272	0	1

Age	21.517	1.624	19	24
Age squared	465.637	69.852	361	576
Gender (male=1)	0.469	0.499	0	1
Own child	0.191	0.393	0	1
Household expenditure per adult equivalent (Ksh.)	3,389	4,358	42.939	93,996
School fees (Ksh.)	5,916	34,517	0	1,802,000
Household's marital status (married=1)	0.887	0.317	0	1
Household's gender (male=1)	0.716	0.451	0	1
Household head's highest level of education (Primary)	0.498	0.274	0	1
Household head's highest level of education (Secondary)	0.246	0.282	0	1
Household head's highest level of education (Tertiary)	0.015	0.073	0	1

Source: Author’s computations based on KIHBS 2005/06 dataset

Household’s consumption expenditure is used as a measure of welfare status. Expenditure per adult equivalent for a household with at least one child in primary and secondary education spent an average of Ksh. 2,609 and Ksh. 3,689, respectively. Availability of school infrastructure across regions was proxied by number of schools per square kilometer. On average there were 1.023 primary schools per 3 square kilometer and 1 secondary school per 5 square kilometer.

Two estimation issues are worth noting (Gertler and Glewwe, 1990; and Kabubo-Mariara and Mwabu, 2007). One of them is the potential correlation between ability of a child and household investment in education. The other problem is that student ability is unobserved. There could also be correlation between household wellbeing and school inputs. This challenge emerges from the fact that parents may not send their children to school and hence the intensity of schooling may become an omitted variable that may be correlated with the regressors in the model. However, it is not possible to address these issues due to data limitations.

2.4 ESTIMATION RESULTS AND DISCUSSIONS

This section presents estimates of enrolment rates, average benefit incidence, marginal benefit incidence and factors influencing benefit incidence at various education levels.

2.4.1 Distribution of school enrolment rates

Appendix Table 1 shows gross enrolment rates for primary, secondary, technical and university education by income tercile across counties. The gross enrolment rate is a measure of enrolment at a given education level as a proportion of the respective school going age population. This measure is computed for all levels of education. Average enrolment rate represents the percentage of a given tercile population that participates and by extension benefits from public education expenditure.

There were disparities in enrolment rates across terciles in all levels of education. Enrolment rates are lower for the poor at all education levels except primary level. Over 90 percent of the primary school age children were in school during the survey period. Primary education enrolment rate was 110 percent for low income group; 107 percent for middle income group and 93 percent for high income group (see Appendix Table 1).

Enrolment rates in post primary education level increase with household expenditure. About 14 percent, 34 percent, and 50 percent of secondary school age students were from low income, middle income and high income groups, respectively. Less than 1 percent of the target school age children from low income group were enrolled in tertiary (technical and university) education institutions. The tertiary enrolment rate for high income group was estimated at 3 percent for both technical and university education.

There were variations in enrolment rates across counties and income groups. Taita Taveta (135 percent) county recorded the highest primary education enrolment rate while Tana River (62 percent) recorded the lowest primary education enrolment rate for the lowest income group. For the medium and high income groups, Nairobi County recorded the highest primary and secondary education enrolment rates of 153 percent and 155 percent respectively. Nandi county (71 percent) and Nyamira (61 percent) county recorded the lowest primary education enrolment rates among the medium and high income groups.

At secondary level of education, Nakuru County recorded the highest enrolment rate for low and high income groups of 38 percent and 61 percent, respectively. Narok County (71 percent) recorded the highest enrolment rate among the high income group. Nandi, Tana River and Siaya counties recorded the lowest secondary education enrolment rate of about 1 percent for low, medium and high income groups, respectively.

Enrolment rates are much lower at tertiary education across all counties. Nairobi county (8 percent) and Taita Taveta County (6 percent) recorded some of the highest enrolment rates in technical education for the middle income group while Tharaka Nithi recorded a high of 15 percent for the high income group. Nairobi County recorded the highest university education enrolment rate of 5 percent and 12 percent, for middle and high income groups, respectively. Most of the counties recorded enrolment rate of about 1 percent (see Appendix Table 1).

2.4.2 Average unit subsidy by level of education and district

Appendix Table 2 shows that the average subsidy (public spending per child) increases with level of education. Nationally, the subsidy was Ksh 5,952 for primary; Ksh. 16,645 for secondary; Ksh. 16,549 for technical education and 167,479 for university education. The average subsidy for tertiary education, that is, technical and university education combined was 69,698. However, there were large regional disparities. Public spending per pupil at both primary and secondary education in Garissa district was low at Ksh. 1,392 and Ksh. 7,079, respectively. In contrast the highest per capita subsidy at primary education was Ksh. 11,628 (Kisumu district) and Ksh. 50,616 (Kuria district) for secondary education. About 34 districts received a per capita subsidy above the national average at primary while 35 districts recorded per capita subsidy below the national average. At secondary education level, 36 districts received a per capita subsidy above the national average of Ksh. 16,146 whilst 33 districts recorded per capita subsidy below the national average. It was not possible to compute district level subsidies for tertiary education owing to data limitations.

2.4.3 Average benefit incidence of public spending on education

Table 2-2 presents estimates of the average benefit incidence by income tercile based on equation A4. The results show that public education spending is pro-poor at primary education level. The poorest tercile gained 42 percent and the richest tercile 22 percent of public spending on primary education. Public spending on secondary and tertiary education is less pro-poor. Only about 19 percent and 6 percent of public spending on secondary and tertiary education, benefits the poorest tercile compared with about 42 percent and 78 percent for the richest tercile.

Table 2-2: Average benefit incidence by income tercile, 2005/6

Income tercile	**Total**	**Male**	**Female**
Primary education			
Low income group	0.42	0.21	0.20
Middle income group	0.37	0.18	0.18
High income group	0.22	0.11	0.11
Total	1.00	0.51	0.49
Secondary education			
Low income group	0.19	0.10	0.09
Middle income group	0.38	0.22	0.17
High income group	0.42	0.21	0.21
Total	1.00	0.53	0.47
Tertiary education			
Low income group	0.06	0.04	0.02
Middle income group	0.16	0.11	0.05
High income group	0.78	0.43	0.34
Total	1.00	0.58	0.42
Overall Education			

Income tercile	**Total**	**Male**	**Female**
Low income group	0.38	0.20	0.18
Middle income group	0.36	0.19	0.18
High income group	0.26	0.13	0.13
Total	1.00	0.51	0.49

Source: Author's computations based on KIHBS, 2005/6 dataset

The results in Table 2-2 indicate gender disparities in average benefit incidence. Female pupils receive smaller shares of the benefits from public spending on education than male pupils at all education levels. However, the gender gap in benefits is highest at tertiary education. Female students gained 42 percent and male students 58 percent of total spending at this level compared. The gender gap in benefit incidence is lowest at primary education level. The share of benefits for female pupils is 49 percent while the share of benefit for male pupils is 51 percent. The gender gap in benefit incidence at tertiary education level varies by household expenditure. Female students from the lowest tercile gained 2 percent and male students 4 percent of total spending. On the other hand female pupils in the top income tercile gained 34 percent and males 43 percent.

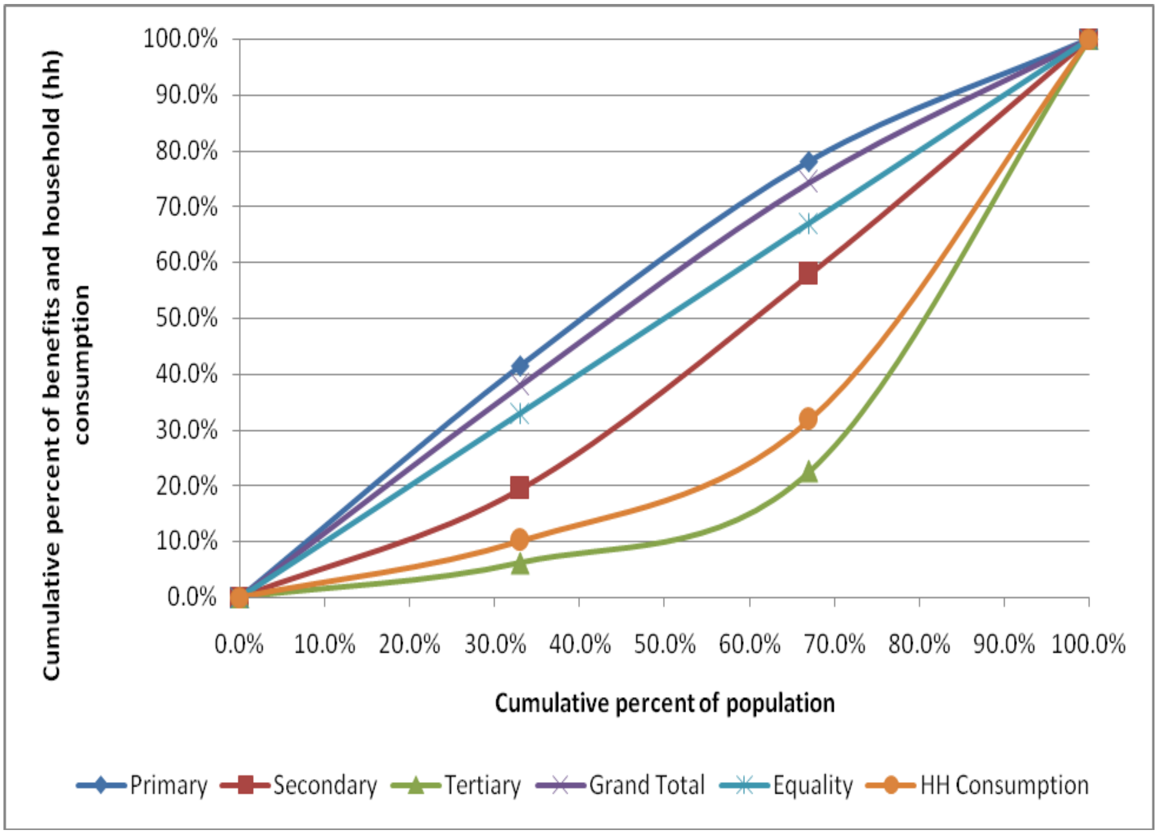
Overall, the estimates indicate that government subsidies for post-primary education are poorly targeted. The top income tercile benefits more than the lowest income tercile. Average benefit incidence is unevenly distributed between districts (Appendix Table 3). In Taita Taveta County, 84 percent of public spending on primary education went to low income group. In Kajiado County only 4 percent went to low income group. About 57 percent of primary education public subsidy goes to medium income beneficiaries in Bungoma County and in Baringo County about 72 percent of the primary education subsidy goes to the high income group. The top income tercile receives only 3 percent of the primary education subsidy in Machakos County.

At secondary education level disparities in average benefit incidence are also present. About 90 percent of public subsidy in Lamu County goes to bottom income tercile. In contrast, the bottom income tercile received 3 percent of the secondary education subsidy in Bungoma County. The middle income tercile received the largest share (63 percent) of the subsidy in Trans Nzoia Counties.

The top income tercile gained 98 percent of the tertiary education subsidy in Meru, Nyeri and Nyandarua Counties. At the other extreme, the bottom income tercile in Wajir, Samburu and Nandi Counties received just 1 percent of public spending on tertiary education. About 62 percent and 60 percent of the tertiary education subsidy went to the middle income tercile in Muranga and Kisumu Counties.

The concentration curves support these patterns of benefit incidence. The curve showing primary education benefit incidence lies above the equality (45 degrees) line (see Figure 2-2). This means public spending on primary education is pro-poor or strongly progressive. Thus on average, the poor benefit more than the non-poor. Perhaps this is because more children from low income group are enrolled in public primary schools following the implementation of free primary education programme.

Figure 2-2: Lorenz curves for per capita education expenditures, equality and benefit incidence concentration curves by education levels, 2005/6.



Source: Author's estimations using KIHBS (2005/6) data and Distributive Analysis Stata Package (DASP)

At post primary education level, the high income group benefit more than the low income group from public subsidy on education. More precisely put, the concentration curve lies between the equality (45 degrees) line and the Lorenz (household consumption) curve implying that education spending at secondary is weakly progressive. Public spending at tertiary education is regressive. The concentration curve for tertiary education level lies below the household consumption curve. Therefore, generally, average benefit incidence in higher education favours the middle and high income groups. Thus the concentration curves confirm that government subsidies at higher education are poorly targeted.

2.4.4 Marginal benefit incidence of public spending on education

Table 2-3 shows estimated marginal benefit incidence of education using marginal odds of participation at various levels of schooling and income terciles from estimating Equation A7. The marginal benefit incidence coefficients are interpreted as the gain in subsidy incidence per capita for each tercile from one shilling increase in aggregate spending on specified level of education (Younger, 2003). The estimates are based on the two-stage least squares (2SLS) estimation technique that uses provincial level left out mean participation rate as the instrumental variable for mean district participation rate as a way of addressing the endogeneity problem. The left out mean participation rate is a good instrument. First, it is strongly correlated with the endogeneous variable as evidenced by the large first-stage F-statistics. The IV relevance statistics are 756 ($F>10$) for primary education model and 719 ($F>10$) for secondary education level. The partial R^2 (Bound et al, 1995 and Shea, 1997) of 97 percent and 96 percent for primary and secondary education partial regressions, respectively indicate that the left out mean participation rate is strongly correlated with the mean provincial participation rate (endogeneous variable).

Table 2-3: Marginal benefit incidence, 2005/6

Tercile			Low income	Medium income	High income
Primary Education	**Male**	**Coefficient**	**0.009 (0.03)**	**0.512*** (2.93)**	**0.755*** (3.91)**
		Constant	0.301** (4.42)	0.133*** (3.23)	0.004 (0.10)
		Observations	67	71	72
		F statistics (p-value)	0.001(0.974)	8.856(0.005)	15.3(0.000)
		Adj. R^2	0.014	0.151	0.204
	Female	**Coefficient**	**0.415 (1.43)**	**0.459** (2.51)**	**0.72*** (5.79)**
		Constant	0.176** (2.52)	0.133*** (3.07)	0.002 (0.08)
		Observations	69	71	71
		F statistics (p-value)	2.04(0.158)	6.29(0.014)	15.3(0.000)
		Adj. R^2	0.316	0.116	0.348
	All	**Coefficient**	**0.228 (0.94)**	**0.491*** (3.32)**	**0.749*** (5.21)**
		Constant	0.234*** (4.02)	0.132*** (3.77)	0.002*** (0.06)
		Observations	69	71	72
		F statistics (p-value)	0.89(0.349)	11.05(0.001)	27.15(0.000)
		Adj. R^2	0.015	0.191	0.306
Secondary Education	**Male**	**Coefficient**	**0.147 (0.64)**	**0.810 ** (2.33)**	**0.623* (1.47)**
		Constant	0.143 (1.77)	0.150 (1.25)	0.260* (1.79)
		Observations	65	66	69
		F statistics (p-value)	0.41(0.524)	5.45(0.023)	2.15(0.147)
		Adj. R^2	0.003	0.119	0.045
	Female	**Coefficient**	**0.305 (1.15)**	**0.682** (2.13)**	**0.995** (2.20)**
		Constant	0.006 (0.65)	0.007 (0.71)	0.011 (0.76)
		Observations	66	69	69
		F statistics (p-value)	1.33(0.252)	4.52(0.037)	4.82(0.032)
		Adj. R^2	0.326	0.084	0.092
	All	**Coefficient**	**0.188 (0.99)**	**0.819*** (3.89)**	**0.905** (2.61)**
		Constant	0.011* (1.70)	0.007 (0.79)	0.014 (1.24)
		Observations	66	71	72
		F statistics (p-value)	0.98(0.327)	8.36(0.005)	6.80(0.011)
		Adj. R^2	0.028	0.154	0.127

Source: Author's computations based on KIHBS, 2005/6. T-values in parentheses; *** Significant at 1 percent, ** significant at 5 percent and * significant at 10 percent.

The results show that the marginal benefits of public education spending increase with income tercile. Thus the gain derived from a one shilling increase in aggregate public spending on primary education level benefits the middle and high income groups more than the low income group. The marginal benefit incidence from primary education for middle income group is 0.491 and significant. This means that an extra shilling per capita spent on primary education will increase the public spending per capita going to the middle income group by 0.491. The marginal benefit incidence for the high income groups is 0.749 and significant.

The marginal odds in Table 2-3 imply that the poorest tercile could obtain about 7.6% (0.228*1/3) of an increase in the total subsidy allocated to primary education and the marginal benefit incidence is insignificant. This means that the average benefit incidence overestimates the level of benefits going to the poor at this level of education.

At secondary school level marginal benefit for middle and high income groups is significant. A one shilling increase in education spending for the sector would increase benefits for middle income group by 0.819; and 0.905 for high income group. This means that an extra shilling per capita spent on secondary education increases public spending per capita going to the middle and high income group by 0.819 and 0.905, respectively.

There are gender disparities in marginal benefit incidence at secondary education level. The marginal benefit incidence for female (0.995) for high income group is higher than for male counterparts (0.682). Perhaps this is because high income groups are enrolling more girls at secondary school level compared to the low income groups. However, males in middle income group benefit more at the margin (0.810) compared with their female counterparts (0.682). Due to district level data limitations for technical and university education, marginal benefit incidence was not estimated at these levels.

To summarize, four points emerge concerning distribution of public spending on education in Kenya. First, the average and marginal benefit incidence in education spending in Kenya are not equitably distributed. Second, average benefit incidence tends to overestimate level of benefit incidence going to the low income groups. Third, high income groups benefit more than the low income households. Fourth, the marginal benefit incidence coefficients indicate that expansion of public spending at primary and secondary education levels is not pro-poor, that is, additional spending at primary and secondary education level shall be associated with an incremental increase in the tercile specific participation rate in the medium and high income groups.

A limitation of both the average benefit incidence analysis and marginal benefit incidence analysis is that none of them reveals the factors responsible for the benefit incidence patterns. Given this limitation, it is important to analyze the factors responsible for the inequalities in levels of benefits obtained from public education spending in Kenya. In the next section, findings on factors that explain the benefit incidence at the various education levels are presented.

2.4.5 Explaining the benefit incidence of public education spending

In the preceding section, the average and marginal benefit incidence of public spending on education are analyzed. The levels of benefit incidence, however, depend on household decision to enroll their children in school and government spending behavior concerning resource allocation. This section focuses on estimation of demand for schooling to identify factors explaining the benefit incidence of public spending on education at various levels.

2.4.5.1 Factors explaining benefit incidence

Results on coefficients and marginal effects from a probit model equation B9 and B10 on demand for primary, secondary and tertiary education using KIHBS 2005/6 are presented In Table 2-4. Household level data is merged with the district level data on school density and pupil teacher ratio. The dependent variable is a response choice between enrolling and not enrolling a child in a public institution in the respective level of schooling.

A male child has a higher probability of enrolling in each level of education than a female child with the same characteristics. The effects were estimated at 0.5 percentage points, 28 percentage points and 6 percentage points for primary, secondary and tertiary education, respectively. Having a direct relationship to the household head (own child) increase the likelihood of enrolling at primary, secondary and tertiary education by 0.7

percent, 39 percent, and 15 percent; respectively. Thus male and own children are more likely to benefit from public spending on education.

The probability of primary school enrolment increases with age but at a decreasing rate. The concave relationship between age and probability of enrolment suggests low enrolment among over-age children at primary school level. This may also be associated with behavioural changes among adolescents, who when they find themselves enrolled in a lower grade compared to that for their age cohort can develop negative attitudes towards schooling. The finding is consistent with Kabubo-Mariara and Mwabu (2007) who found that enrolment increases with age at a decreasing rate using 1997/8 Welfare Survey data. Higher opportunity cost associated with child labour as a child becomes older may also explain lower enrolment among over age children. Furthermore, over-age children enrolled at any particular class in relation to a given class cohort have a higher likelihood of dropping out of school and being discouraged from enrolling in school. The effect of age is however insignificant at secondary and tertiary education.

Household welfare status is important in determining demand and thereafter benefit incidence of public education spending. The level of household welfare measured by annual consumption per adult equivalent has a positive and significant marginal effect on schooling enrolment. In other words, households from high income group are more likely to enroll their children at all levels of schooling and hence benefit from public education spending at all levels. A one shilling increase in household consumption per adult equivalent which is a proxy for income holding other factors constant will increase the probability of enrolment at primary, secondary and tertiary education levels by 0.2 percentage points, 24.3 percentage points and 5.7 percentage points, respectively. This is perhaps because poor households are less likely to meet the indirect cost of schooling such as uniform and other basic needs. Household head's levels of education, especially secondary and tertiary education have positive and significant effect on enrollment.

In Kenya, the government covers most of the direct schooling costs, notably teachers' personnel emoluments, cost of learning materials and operational costs in public primary schools and day secondary education institutions under the FPE and free FDSE programmes, respectively. Households cover such costs as boarding expenses, transport, meals, supplementary material and uniforms, among others. Such schooling costs tend to increase with the level of education. Thus as costs of education rise, children from poor households are constrained and may fail to enroll in the various levels of education and hence are not able to benefit from the public spending on education.

Table 2-4: Probit estimates and marginal effect for school enrolment in Kenya, 2005/6

Variable name	Primary education	Primary education marginal effects	Secondary education	Secondary education marginal effects	Tertiary education	Tertiary education marginal effects
Age	0.609***	0.0137***	1.312	0.472	0.684	0.074
	[0.186]	[0.004]	[1.390]	[0.500]	[0.690]	[0.0745]
Age squared						
	-0.0313***	-0.0007***	-0.047	-0.0169	-0.0164	-0.018
	[0.0094]	[0.0002]	[0.0442]	[0.0160]	[0.0160]	[0.0017]
Sex of child(1=Male)	0.234*	0.005**	0.803***	0.278***	0.536***	0.061***
	[0.121]	[0.003]	[0.127]	[0.042]	[0.101]	[0.011]

Own Child	0.342***	0.0073***	0.883***	0.294***	0.884***	0.145***
	[0.129]	[0.0027]	[0.130]	[0.039]	[0.113]	[0.024]
Log Consumption per adult equivalent (Welfare measure)	0.071	0.0016***	0.294***	0.105***	0.260***	0.028***
	[0.0582]	[0.0013]	[0.0710]	[0.027]	[0.0627]	[0.006]
Disability	-0.203	-0.005	0.0894	0.031		
	[0.289]	[0.0503]	[0.280]	[0.096]		
Share of children (6-13)	0.649**	0.0146				
	[0.287]	[0.007]				
Orphan (Orphan=1)	0.217	0.0039	-0.197	-0.073		
	[0.225]	[0.004]	[0.223]	[0.085]		
Availability of primary school (Density)	-0.0368	-0.0008				
	[0.201]	[0.0045]				
Primary school class size	-0.0211	-0.0005				
	[0.0179]	[0.0004]				
Primary Pupil Teacher Ratio	0.00334	0.00007				
	[0.0122]	[0.00027]				
Location (Rural=1)	0.234**	0.0064**	0.509***	0.190***	-0.016*	-0.018*
	[0.102]	[0.003]	[0.122]	[0.046]	[0.0105]	[0.013]
Marital status for household head (married=1)	0.24	0.007	0.168	0.062	0.300**	0.027**
	[0.181]	[0.0068]	[0.185]	[0.070]	[0.136]	[0.009]
Gender for household head (male=1)	0.031	0.007	-0.0186	-0.007	-0.0357	-0.039
	[0.0964]	[0.0023]	[0.0965]	[0.034]	[0.0790]	[0.0088]
Household head level of education (Secondary)	1.395***	0.031***	2.670***	0.960***	1.026***	0.111***
	[0.355]	[0.007]	[0.230]	[0.077]	[0.122]	[0.014]
Household head level of education (Tertiary)	2.408	0.054	1.931**	0.694**	3.407***	0.370***
	[1.737]	[0.039]	[0.915]	[0.329]	[0.460]	[0.055]
Central	-0.201	-0.0055	-0.105	-0.038	0.0533	0.0059
	[0.392]	[0.0126]	[0.270]	[0.099]	[0.168]	[0.019]
Coast	-0.431	-0.0151	-0.191	-0.070	0.131	0.155
	[0.389]	[0.0195]	[0.270]	[0.103]	[0.182]	[0.023]
Eastern	-0.177	-0.0046	-0.231	-0.085	0.338**	0.044**
	[0.387]	[0.011]	[0.276]	[0.105]	[0.164]	[0.025]
North Eastern	-0.325	-0.010	0.174	0.060	-0.198	-0.0183
	[0.414]	[0.018]	[0.342]	[0.112]	[0.272]	[0.021]
Nyanza	-0.306	0.009	-0.138	-0.051	0.380**	0.051**
	[0.395]	[0.014]	[0.290]	[0.108]	[0.170]	[0.027]
Rift Valley	-0.376	-0.010	0.0517	0.0184	0.307**	0.038**
	[0.381]	[0.014]	[0.273]	[0.096]	[0.156]	[0.021]
Western	-0.0289	-0.0007	-0.3	-0.112	0.365**	0.049**
	[0.406]	[0.009]	[0.293]	[0.114]	[0.173]	[0.028]
Share of children (14-17)			-0.195	-0.070		

			[0.382]	[0.137]		
Availability of Secondary school (Density)			0.655	0.235		
			[0.820]	[0.294]		
Secondary school class size			-0.387	-0.139		
			[0.347]	[0.124]		
Secondary Pupil Teacher Ratio			0.7	0.251		
			[0.438]	[0.157]		
Constant	-1.365		-14.01		-12.45*	
	[1.379]		[11.02]		[7.474]	
Pseudo R^2	0.067		0.15		0.165	
Observations	11,518	11518	2,061	2061	5,495	5495
Wald χ^2 (23)	100.35***		193.83***		251.53***	
Log likelihood	-689.57		-1163.57		-1353.98	

Notes: Dependent variable: In school (1=in school; 0=not in school); df/dx is for discrete change of dummy variable from 0 to 1. Estimates based on KIBHS (2005/6). Standard Errors are in Parenthesis.
***Significant at 1% level; ** Significant at 5% level; *Significant at 10% level.

Pupil teacher ratio, school accessibility proxied by school density and location of residence (rural, urban, province) were the main supply factors in the estimation. These are captured by number of primary schools within 3 kilometer square area and secondary schools within a 5 kilometer square area, and region characteristics.

There is a negative relationship between school density and demand for schooling but the effect is insignificant. Pupil teacher ratio and class size at the primary and secondary school levels also have statistically insignificant effect on primary education schooling.
Perhaps this is because there could be adequate number of schools, teachers and classrooms across regions. However, there could be other factors such as demand side factors constraining access and by extension constrain benefit incidence from primary education schooling. Further, the insignificant effect of school availability on secondary

education enrolment can be explained by the fact that at secondary education levels, learners can stay in school and do not have to cover long distance to school daily. The results corroborate those of Ngware et al. (2006).

Residing in rural areas increases the probability of enrolling in primary and secondary school while residing in urban areas reduces the probability of enrolling for a primary and secondary school education implying reduced respective benefit incidence. The marginal effects are positive and significant. This can be interpreted to mean that the opportunity cost of schooling in urban areas is higher than in rural areas, as the youth perceive returns for formal and non-formal employment to be higher than the expected benefits associated with schooling. In addition, most of the population in urban areas is concentrated in informal settlements, where school infrastructure is either lacking or inadequate, which exposes vulnerable school age youth to opportunities of paid, unpaid or informal jobs. In the contrary, the probability for tertiary education schooling is high in urban areas. This is probably because of improved accessibility to tertiary learning institutions in urban areas relative to rural areas. Household head education especially secondary education has a positive effect on tertiary education enrolment.

2.5 CONCLUSIONS AND POLICY IMPLICATIONS

2.5.1 Conclusions

The main objective of this essay was to assess average and marginal benefit incidence of public spending on education in Kenya using cross sectional data. Two questions were addressed: i) who benefits from public education expenditures in Kenya? and ii) what factors explain the benefit incidence? The standard benefit incidence technique was applied to measure average benefit incidence. Then marginal benefit incidence approach was implemented to evaluate the benefits from public spending on education at the margin while addressing the potential problem of endogeneity of the province level enrolment rate in a district level school enrolment equation. Finally, schooling demand function were estimated using cross-sectional household data and district level data to identify the factors that explain levels of benefit incidence of public education spending.

The results lead to several conclusions. First, the estimates of marginal benefit incidence demonstrate that expansion in public education spending would benefit middle and high income groups more than to low income group. Average benefit incidence overestimates benefits that go to low income group. This finding is contrary to the policy makers' expectations in 2003 and 2008, when for example the government introduced FPE and FDSE programmes. Although the programmes have contributed to the overall increase in access levels, there are still a number of eligible youth who are not benefiting from public education spending. Second, there are gender inequalities in enrolment rates across all education levels. Households tend to enroll male children in school relative to female students. Factors constraining access to education at various levels include poverty and overage enrolment due to high likelihood of dropping out of school.

2.5.2 Implications for policy

Even though the government is implementing free primary and free day secondary education programmes, public spending in the sector should be targeted at the poor. Improving household earnings would enable households meet schooling costs; otherwise any marginal increase in basic education spending will continue to benefit the middle and high income groups relative to the low income group. This is because the middle and high income groups are able to place a larger premium on schooling and hence record higher demand and benefits from public education spending.

Concerning reducing the cost of schooling, it will be important for the government to establish the unit costs of schooling across all levels. This could guide the level of per capita grants to schools and the amount to be charged in form of levies. Otherwise, whilst government continues to subsidize schooling, schools might still be charging additional school levies, increasing the schooling cost burden to households. Additional user fees might have a spillover effect on households and discourage poor households from enrolling their children in school. Increasing household income through pro-poor policy interventions and promoting income generating activities among the low income group is likely to have a positive effect on schooling. Further, the findings imply that expanding spending on education cannot fully tackle gender inequalities in access to schooling. Policies that address the schooling constraints with a special focus on girls have potential to reduce gender differences in enrolment at various education levels.

Given the large disparities in benefit incidence across counties and education levels, public education spending should target counties and education levels with low benefit incidence and low education outcomes among the poor. This would require the development of a needs based resource allocation framework and modality. There is need for accelerated pro-poor targeted policies and programmes in education in order for the poor to benefit from the expansion of public education in the country. Potential areas for improvement include increasing access to schooling at post primary education level especially among the low income groups across regions. The estimates can serve as baseline in the context of current efforts to decentralize education service delivery and reduce inequalities in education attainment across regions.

This essay contributes to the literature by applying the most current techniques (marginal benefit incidence technique using cross sectional data) in estimating benefits of public education spending. Second, it estimates the average benefit incidence at county level. Third, the study examines benefit incidence of public spending on education together with demand for schooling at all education level.

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CHAPTER 3

3 TECHNICAL EFFICIENCY OF PUBLIC EDUCATION SPENDING IN KENYA

3.1 INTRODUCTION

Kenya has invested substantial resources in education sector. Between 2002/3 and 2009/10, public spending on the sector was estimated at 6.4 percent of GDP and 20 percent of total government outlays (GOK, 2010a). Public spending on education and training has been justified on the grounds that high level of education attainment is associated with low unemployment levels, poverty reduction, low levels of inequalities, higher productivity and economic growth (Rodriquez and Loomis, 2007 and Romer, 1986). Sustainable human capital development however requires that available resources are equitably and efficiently allocated and utilized. Further, efficient resource utilization contributes to achievement of sector goals and objectives, including high learning outcomes; skilled and productive labour force and better socio-economic well-being.

The Constitution of Kenya (GOK, 2010b) and Kenya Vision 2030 (GOK, 2007) emphasized provision of free and compulsory basic education in Kenya. Effective implementation of these policies calls for efficient resource utilization for attainment of set policy targets in the education sector. These targets include high quality skills development; eliminating inequalities in education outputs and outcomes; and effective implementation of the decentralization policy amidst budgetary constraints. Other policies that the government has pursued over time that have direct impact on education efficiency include provision of teachers, capitation grants to primary and secondary education public schools and expansion of school infrastructure.

Despite the substantial resources spent in the sector and expansion of the education sector in the country, sector performance indicators show that, the outcomes and outputs are low and large differences exist across regions. It may be that efficiency levels in the sector are low, resulting in poor education outcomes and outputs. To ascertain this, there is need to assess efficiency levels in the education sector. This is because public resources are inadequate to meet increasing demand of education services, brought about by increase in school going age population, policy commitments and increasing cost of education.

In the Constitution of Kenya (GOK, 2010b) and the Kenya Vision 2030 (GOK, 2007); the government of Kenya desires to produce adequate human capital for sustainable development. The policy target is to be achieved partly through an efficient utilization of available resources to maximize expected outputs and outcomes. However, little empirical evidence is available on the level of technical efficiency of public education spending both at national and county levels, and the factors determining efficiency.

Furthermore, increasing public spending on social sectors such as education is not a guarantee for better education outcomes (Jarasuriya and Wodon, 2002 and Gupta and Verhoeven, 2001). It is not just the level of public spending that matters, but also efficiency of government outlays and extent to which they are targeted to benefit the low income groups (Castro-Leal et al, 2000 and Manasan et al, 2007). There is limited evidence on productive efficiency in education sector in Kenya particularly at county level, which is the focal point of devolution and service delivery under the 2010 Constitution. The analysis presented in this essay will attempt to address this gap by examining and analyzing technical efficiency for primary, secondary and tertiary education across counties.

Previous studies of efficiency in education sector (for example Ruggiero, 1995; Alexander and Jaforullah, 2004) mainly focused on developed economies and emerging economies and used the DEA two-step procedure. Simar and Wilson (2007) observe that the technical efficiency estimates obtained from this procedure might be serially correlated; and that the approach ignores the underlying data-generating procedure (DGP). These limitations hinder statistical inferences (Balcombe et al, 2008). Simar and Wilson (2007) propose the application of the DEA double bootstrap estimation procedure to address the limitations of the standard DEA efficiency estimation technique.

A growing literature examines technical efficiency in Kenya using frontier approach to measure technical efficiency. However, the focus has been on Nairobi City Council health Clinics (Mutinda, 2008); sugar factories (Nyokabi, 2008 and Mulwa et al, 2009); orphaned and vulnerable children programmes (Nalianya, 2009); manufacturing (Lundvall and Battese, 2000; Ngui, 2008 and Ngui et al, 2007); banks (Kamau, 2009); and health facilities (Kirigia et al, 2011). There is little attempt to estimate technical efficiency in education sector.

This essay fills this gap by addressing the following research questions: 1) How efficient are counties in public education spending? To what extent do efficiency levels of public education spending differ across counties? What explains variations in efficiency of public education spending across counties in Kenya? How can technical efficiency in education spending be enhanced?

Estimates of technical efficiency can inform policies to improve and monitor education sector performance. Further, the study demonstrates the application of the DEA double bootstrap procedure and addresses some limitations in application of the standard DEA efficiency estimation technique.

3.1.1 Objectives of the study

The broad objective of this essay is to examine the technical efficiency of public education spending in Kenya. The specific objectives of the study are to:

(i) Estimate technical efficiency of public spending of primary, secondary and tertiary education levels in Kenya;

(ii) Estimate technical efficiency change in public education spending;

(iii) Identify some of the factors that are likely to explain technical efficiency of public education spending; and

(iv) Draw policy implications.

3.1.2 Organization of the chapter

The chapter is structured as follows: Section 3.2 reviews key concepts in measurement of technical efficiency. Section 3.3 reviews the related literature associated with the analytical framework. Section 3.4 describes the methodology of the study; section 3.5 describes the data; section 3.6 presents and discusses the results; and section 3.7 presents conclusions and recommendations.

3.2 MEASUREMENT AND CONCEPTUAL ISSUES

3.2.1 Technical efficiency measurement

Measurement of efficiency in the context of education consists of: internal efficiency, productive efficiency and external efficiency. Internal efficiency concerns utilization of resources to produce a set of education outcomes within a given levels of education (Winkler and Sondergaard, 2008). Internal efficiency indicators in Kenya's education sector are presented in chapter 1 of this thesis.

Assessment of external efficiency of education includes analysis of rates of return to different levels of education; and external benefits of schooling. It concerns relationship between education completed and labour earnings. Analysis on external benefits of schooling is the subject of Chapter 4 of this thesis.

Productive (economic) efficiency can be categorized into two components: technical efficiency and allocative efficiency (Debreu, 1951 and Farrell, 1957). Technical efficiency entails use of productive resources in the most technologically efficient manner to produce highest possible output from a given set of inputs (Worthington, 2001; Ruggiero, 1995 and Coelli, 1996). In the context of education, technical efficiency measures the ability to combine inputs (such as teaching staff/labour, learning materials, equipment, and capital/class rooms) to produce maximum outputs (such as enrolment, graduates, standardized assessment scores. Technical efficiency is input or output oriented Coelli, 1996). Input oriented technical efficiency is attained when fewer inputs are used to achieve same level of outputs. Output oriented technical efficiency is achieved when same amount of inputs or resources are used to produce more output.

Allocative efficiency is the ability to choose among various technically efficient combinations of inputs to produce highest possible amount of outputs. It concerns the ability of decision making unit to produce inputs in optimal proportions assuming given level of prices and technology.

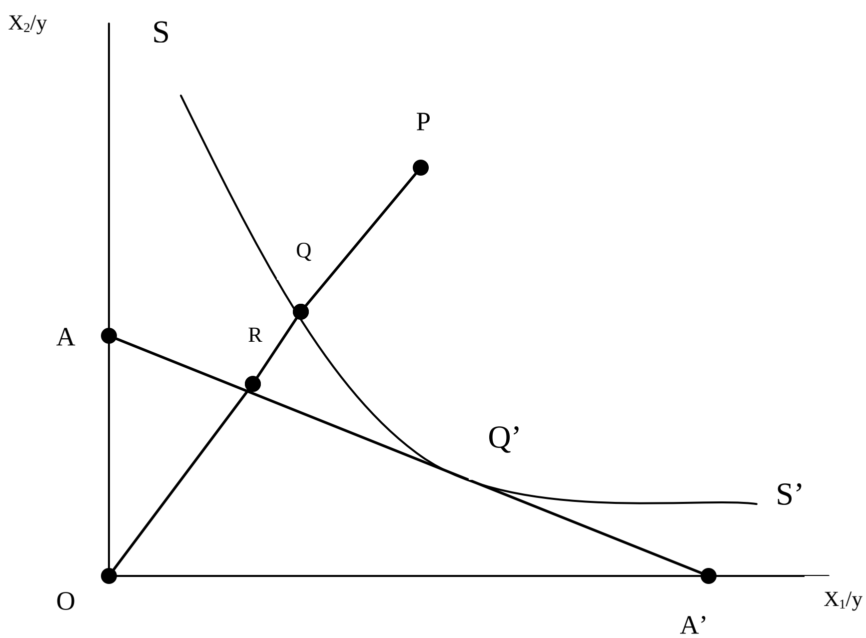
The quantitative methods of measuring total economic efficiency can also account for multiple inputs and outputs (Farrell, 1957). Economic efficiency is the combination of technical and allocative efficiency. Output-oriented economic efficiency is a product of the respective technical and allocative efficiency measures. Technical, allocative and total economic efficiency are bounded between 0 and 1.

The term Decision Making Unit (DMU) describes the unit of analysis in efficiency measurement. In the case of education, the DMU can be a learning institution, district

(Rugiero et al, 1995; Rassouli-Currier, 2007; Chakraborty, 2003; and Worthington, 2001), country (Herrera and Pang, 2005; Worthington, 2001; and Jarasuriya and Wodon, 2002), province, or county among others. In this study, the county is the unit of analysis.

Measurement of productive efficiency is illustrated in Figure 3-1. Assume that the decision making unit uses two inputs (x_1 and x_2) to produce one output (y) with constant returns to scale technology (that is relationship between outputs and inputs does not change as inputs increase or decrease) (Coelli, 1996). Thus $1=f(x_1/y, x_2/y)$ represents a unit isoquant.

Figure 3-1: Technical, allocative and economic efficiency from an input orientation



Source: Coelli, 1996 and Worthington (2001)

AA' represents the technically efficient production frontier. The unit isoquant SS' represents a fully technically efficient DMU and hence permits measurement of technical efficiency. Input oriented technical efficiency (TE_I) is given as 0Q/0P or one minus ratio QP/0P. The ratio represents the proportion of inputs (x_1 and x_2) necessary to produce optimal output y*. If a DMU produces at point P, then the extent of technical inefficiency is the distance QP or ratio QP/0P. Technical inefficiency represents the amount by which optimal input levels (x_1*and x_2*) could be reduced holding the input ratio (x_1 / x_2) constant without a reduction in output y*. A technical efficiency value of about 1 implies the DMU is highly technical efficient. Full technical efficiency level is attained at point Q. A technical efficiency value less than 1 depicts deviation from the fully efficient production frontier, hence inefficiency measure (Green, 1993; Coelli, 1996; Ngui, 2008; Coelli et al, 1998a, Coelli et al, 1998b; and Chirwa, 2007).

From the same illustration, input allocative efficiency (AE_I) (that is ability of a DMU to use inputs in optimal proportions given the input price) is given as: AE_I = 0R/0Q.

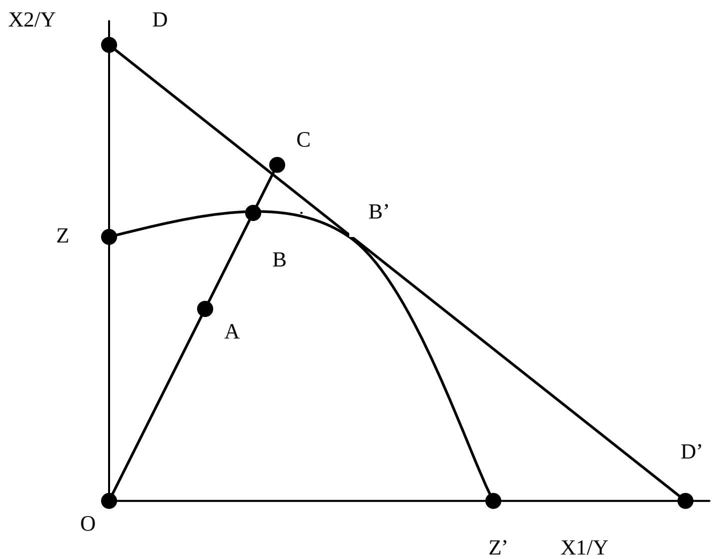
The distance RQ represents the possible reduction in production costs that will occur assuming production at an allocatively and technically efficient point Q' instead of Q. At point Q, the DMU is technically efficient but allocatively inefficient. Allocative inefficiency in thus 1 minus 0R/0Q. Total economic efficiency (EE) is the product of technical efficiency and allocative efficiency: EE_I = 0R/0P.

For the DMU producing at point P, total economic inefficiency is 1 minus 0R/0P. The distance between P and R represent the possible cost reduction if the DMU was to produce at the cost minimizing point Q.

In Figure 3-2, DD' represents the technically efficient production frontier and isoquant ZZ' represents a fully technically efficient DMU. AB represents output oriented technical inefficiency or amount by which output could be increased without requiring more inputs. Output-oriented technical efficiency (TE_o) is given as: $TE_O = 0A/0B$.

Given price levels of inputs, the allocative efficiency is defined as: $AE_I = 0B/0C$. Total output-oriented economic efficiency is a product of the respective technical and allocative efficiencies: $EE_O = 0A/0C$.

Figure 3-2: Technical and allocative efficiencies from an output orientation



Source: Coelli, 1996

However, the efficiency points described above are rarely observed. They can be measured using either non-parametric (such as Data Envelopment Analysis) or parametric functions such as Stochastic function and Cobb-Douglas production function (Worthington, 2001). The approaches work in such a manner that they envelop the data while at the same time making assumptions on the flexibility of the production technology and the random term.

3.3 LITERATURE SURVEY

The literature on measurement of technical efficiency employs parametric and non-parametric approaches (Coelli, 1996, Coelli et al, 1998a and Coelli et al, 1998b). Parametric approach uses econometric methods of estimation while non-parametric function utilizes mathematical programming techniques. Parametric approaches are based on functional form of the production function; and assume linearly distributed error term (Tybout, 2000). It involves estimation of the contribution of individual factor inputs to outputs. Changes in outputs not explained by changes in inputs are assigned to technical inefficiency (Coelli et al, 1998a).

Non-parametric frontier approaches do not impose any error term on the production function. They instead utilize factor shares or weights to construct total factor indices (Tybout, 2000). Non-parametric approaches combine the individual factor inputs and net them out from growth indices. Technical efficiency constitutes the measure of factor changes due to growth in output which cannot be assigned to factor inputs.

Most of the studies on efficiency in the public sector (e.g. Herrera and Pang, 2005; and Badescu, 2006) have used non-parametric approaches, notably DEA two-step procedure and Free Disposal Hull (FDH). DEA accommodates multiple inputs and outputs but it does not account for random variations in the input and output data. It attributes the deviations from the maximum production frontier to technical inefficiency (Lundvall and Battese, 2000). Standard DEA uses linear programming to estimate and construct production frontier against which the relative performance of DMUs is gauged (Coelli, 1996). A DMU is said to have performed better or worse, depending on their position relative to the frontier. FDH involves the identification of an efficiency frontier using the information on a combination of observed input-output measures. The FDH enables ranking of efficiency measures (both in terms of inputs and outputs/outcomes) by comparing individual performance with the production possibility frontier or the highest possible level of output or outcome for a given level of input.

However, standard DEA efficiency measures may be serially correlated leading to invalid statistical inferences (Simar and Wilson, 2007). Further, the approach takes no account of the underlying data-generating procedures (DGP). To overcome these problems Simar and Wilson (2007) recommend the DEA double bootstrap procedure to estimate and examine the sources of efficiency. An example is Balcombe et al, (2008) application to rice farming in Bangladesh. This procedure enabled consistent inference to be drawn when estimating and explaining efficiency measures, while simultaneously producing their confidence intervals and standard errors.

Another weakness when using the standard DEA procedure is that it can be difficult to allocate common weights when inputs and outputs are valued differently. To address this problem, a relative efficiency ratio that allows for differences in weights across decision making units can be constructed (Charnes, Cooper and Rhodes, 1978). DEA also assumes that all DMUs are operating at an optimal scale hence the constant returns to scale (CRS) assumption. However, market imperfections and financial constraints may hinder DMUs from operating at an optimal scale (Banker, Charnes and Cooper, 1984 and Coelli, 1996). Hence the CRS DEA model is extended to account for variable returns to scale.

Several studies have measured efficiency of public spending on education (e.g. Ruggiero, 1995; Alexander and Jaforullah, 2004; Coelli, 1996). However, most of them focus on Europe, Australia, New Zealand and the United States of America.

With regard to resource allocation to the education sector, the widely held view is that increased public spending on education will result into improved outputs and outcomes. However, this may not be the case. Increased budgetary allocations do not necessarily mean higher levels of education attainment. For example, Gupta and Verhoeven (2001) utilized the input-oriented FDH approach to assess the efficiency of government spending on education and health in 37 African countries for the period between 1984 and 1995. The study found that African countries are inefficient in providing education and health services. The study also found a negative relationship between the level of public spending and input efficiency measures. The result implies that increased budgetary allocations do not necessarily mean higher education outputs.

Using panel data for 76 countries for the period 1990-1998, Jarasuriya and Wodon (2002) using stochastic frontier and DEA approach also found no relationship between expenditure and education or health outputs when per-capita GDP was included. They concluded that spending more on education and health does not necessarily mean improved outcomes when using net primary enrolment and life expectancy as education and health attainment or output indicators.

In a study on efficiency potential in lower secondary schools in Norway, Borge and Naper (2005) used DEA with assessment grades adjusted for family background as outputs and teaching hours as inputs. The study established that the schools were relatively efficient; high level of municipal revenue contributes to both high student performance and high resource use per student. The study also established that students from municipalities with relatively low resource use per student, performed better than some of their counterparts with almost same number of students.

At tertiary level, efficiency can be measured by ranking decision making units according to computed efficiency scores given differing levels of financing. In a study on efficiency of public expenditure in Portuguese universities in 2001, Afonso and Santos (2004) applied the DEA methodology with a sample of 45 public universities and a sub-set of 36 faculties or institutes. The study computed efficiency scores for each DMU (universities) using number of graduates as the output measure and level of financing as input measure. The estimated average input efficiency was 0.34 and average efficiency score was slightly higher (0.37) when both number of graduates and number of postgraduates were used as output measures. The estimates imply that the sample universities could have achieved the same level of performance by only using 34 percent of the actual resources.

In a study of science undergraduate public spending, Johnes and Johnes (2005) estimated a multi-product cost function for higher education institutions using panel data. They found that cost efficiency of science undergraduate public spending was two to three times that of spending on non-science undergraduates.

Afonso and Aubyn (2004) estimated both input-oriented and output-oriented efficiency measures for education and health sectors in OECD countries. They found that OECD had low sector spending and low education attainment results. In an earlier study of a sample of 23 OECD countries using both DEA and FDH approaches (Afonso, Schuknecht and Tanzi, 2003) constructed a single-input and single output FDH to rank the expenditure efficiency. They found that countries with small public sector spending exhibited the highest overall efficiency measures. The study used quality of administration, education enrolment and health attainment and as outputs. Total public spending was used as an input.

Alexander and Jaforullah (2004) attempted to establish factors that influence technical efficiency of schools in New Zealand using DEA bootstrap procedure. They established that school environmental factors, socioeconomic status of the school community, school size and teacher experience were the main factors explaining variation in technical efficiency of secondary schools.

Studies of technical efficiency of education spending at sub-national level are rare, and where they exist, they tend to focus on developed economies which have decentralized systems of education management. As an example, Eff (2002) estimated efficiency levels for public education in Tennessee counties in the United States of America and in 262 high school supply regions using stochastic frontier and DEA approaches. The study used performance in examinations as outputs and education spending as input. The estimated DEA efficiency score ranged between a low of 0.70 and a high of 1 while the estimated efficiency score based on the stochastic frontier ranged between 0.84 and 0.99.

Chakraborty et al (2001) established substantial variations in efficiency measure among school districts in Utah State in the United States of America. The study estimated stochastic frontier and DEA frontier separately. The empirical analysis was based on data from 40 school districts in Utah State for the 1992/93 academic year.

Herrera and Pang (2005) applied DEA approach to estimate efficiency of public education spending of 140 countries using two models. The estimate of output oriented technical efficiency 0.7 in the single input (education spending as percentage of GDP)-single output (gross primary school enrolment) model. This means that education outputs could be increased by 30 percent without increasing inputs. A multiple input-output framework with three inputs (public spending, pupil teacher ratio and adult literacy rate) and three outputs (first level completion rate, second level completion rate and average years of schooling) was also estimated. The developing countries' score of output oriented technical efficiency was 0.9. This means that the developing countries could increase education outputs by 10 percent without increasing inputs.

Herrera and Pang (2005) found that countries with higher expenditure levels, large wage bill share as proportion of total government budget, higher ratios of public to private financing of services provision, higher aid dependency, higher income inequalities and countries plagued by high incidence of HIV/AIDS epidemic register had lower education technical efficiency scores than other countries.

Rugiero et al (1995) applied a multiple production frontier reflecting different production environments in calculating technical efficiency of school districts in New York State in the Unites States of America. They estimated a mean technical efficiency level of 16 percent with 68 inefficient districts. Ruggiero, Duncombe, Miner (1997) analyzed correlates of efficiency in New York state school districts. Existence of city school district was negatively associated with higher efficiency scores. Other factors negatively affecting efficiency measure were size of a school district bureaucracy, percent of tenured teachers, low district wealth, non residential property value, and proportion of households with school age children, number of students enrolled in private schools and level of labour intensity in education service delivery. Proportion of educated adults in a school district had positive impact on technical efficiency across school districts.

Rassouli-Currier (2007) estimated a tobit regression in assessing the efficiency of Oklahoma public schools. Chakraborty (2003) estimated an education cost function using 3 year panel data from school districts in Kansas State of United States of America. They found that schools were operating at mean of 89.6 percent cost efficiency level; and that the total factor productivity during the study period had declined by 1.5 percent. They also found significant economies of scale for Kansas school districts.

In conclusion, most studies use enrolment rate and standardized test scores as output. Inputs included in technical efficiency studies include student-teacher ratio, proportion of qualified teachers, teacher experience, instructional and non-instructional expenditure per student and proportion of teachers' salaries in total education spending.

The empirical evidence shows that spending more does not necessarily improve efficiency (Eff, 2002). Better socioeconomic status, adult (such as teachers, librarians, counselors and parents)-student contact; moderate administrative support and competition from private schools promote technical efficiency and effectiveness among school districts. Other factors were teaching and learning environment (Chakraborty, *2003* and Rassoulin-Currier, 2007), family income, geographic location (rural/urban), percentage of pupils receiving free and subsidized lunch, teacher salaries, district size and school management (Ruggiero, 1995 and Worthington, 2001).

The current study extends the literature by: i) applying DEA double bootstrap procedure in order to obtain robust estimates unlike the standard DEA approach; ii) examining and analyzing technical efficiency of Kenya's public education spending at county level; iii) establishing the correlates of technical efficiency in education.

3.4 METHODOLOGY FOR ESTIMATING EFFICIENCY IN EDUCATION SPENDING

3.4.1 Data envelopment analysis (DEA)

As indicated above, the concept of 'technical efficiency' refers to the ability of producers to transform inputs in a system into outputs from that system (Worthington, 2001). An education system is said to be technically efficient if maximum output is obtained from a given set of inputs, or if a given output is obtained with the minimum possible input. In education sector, inputs and outputs have to be valued so that they may be aggregated; and usually prices are used to perform this valuation function. However, there are potential problems of measuring technical efficiency in education. They originate mainly from difficulties in measuring educational inputs and outputs, as well as from quantifying the relationship between them. Measurement of education outputs is based on the objectives of the education system. Some of the objectives include improving internal efficiency, access, participation, quality, equity and efficiency in education provision and financing.

Relative efficiency is defined as the ratio of output to input (Herrera and Pang, 2005). However, this measure is inadequate to deal with the existence of multiple inputs and outputs. It is possible to modify the relative efficiency for all DMUs, *j=1,…,n*, as the ratio of weighted outputs to weighted inputs, which can be specified as (Coelli, 1996):

$$\text{Relative efficiency} = \frac{\sum_{r=1}^{s} \mu_r \gamma_{rj}}{\sum_{i=r}^{m} \nu_i \chi_{ij}} \quad \text{………………D1}$$

where x and γ are inputs ranging from 1,…,m and outputs ranging from 1,….s, respectively, and μ and v are the common weights assigned to outputs and inputs, respectively. However it is difficult to allocate common weights, given that inputs and outputs are valued differently. To address this problem in this study, and following Charnes, Cooper and Rhodes (1978) a ratio that allows for different weights across decision making units is used as follows:

$$\text{Max} \quad h_0 = \frac{\sum_{r=1}^{s} \mu_r \gamma_{ro}}{\sum_{i=r}^{m} v_i \chi_{io}}$$

Subject to:

$$\frac{\sum_{r=1}^{s} \mu_r \gamma_{rj}}{\sum_{i=r}^{m} v_i \chi_{ij}} \leq 1, \; j=1,\ldots,n$$

$$\mu_r \geq 0, r=1,\ldots.,s$$

$$v_i \geq 0, \; i = 1,\ldots,m \qquad \ldots\ldots\ldots\ldots\ldots\ldots..\text{D2}$$

This model is the foundation of DEA. In the model, there are $j=1,\ldots, n$ observed DMUs which employ $i=1,\ldots, m$ inputs to produce $r=1,\ldots, s$ outputs. One DMU is singled out each time, designated as DMU_0, and evaluated against the observed performance of all other DMUs. Model (D2) aims to find the most favorable weights, μ_r *and* v_i, for DMU_0 to maximize the relative technical efficiency. The constraint, though is that, the same weights will make the relative efficiency ratio for every DMU to be less than or equal to unity. The optimal value of the ratio must lie between zero and one, $0 \leq h \leq 1$. DMU_0 is fully efficient if and only if $h_o=1$ and inefficient to some extent if otherwise.

The optimization problem in D2 yields an infinite number of solutions: if μ_r *and* v_i are solutions to D2, so are $\alpha\mu_r$ and αv_i , $\forall \alpha > 0$. In maximizing the objective function in D2 it is the relative magnitude of the numerator and the denominator that really matters and not their individual values. It is thus equivalent to setting the denominator to a constant of, for example, 1, while maximizing the numerator. This transformation leads to a unique solution besides converting the fractional formulation of model (D2) into a linear programming problem as presented in model D3.

Max $\sum_{r=1}^{s} \mu_r \gamma_{rj0}$

Subject to:

$$\sum_{i=1}^{m} v_i \chi_{ijo} = 1$$

$$\sum_{r=1}^{s} \mu_r \gamma_{rj} - \sum_{i=1}^{m} v_i \chi_{ij} \leq 0, \; j=1,\ldots,n$$

$$-\mu_r \geq 0, \; r=1,\ldots,s$$

$$-v_i \geq 0, \; i=1,\ldots,m \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots D3$$

The formulation in Model D3 facilitates direct economic interpretation of the outcome. In this case the objective is to maximize the weighted output per weighted input under various conditions, including the assumption that the virtual output does not exceed the virtual input for any DMU. One can convert the maximization problem into a minimization problem, e.g. a *dual* problem, since model D3 is a linear programming, by assigning a dual variable to each constraint in the *primal* model D3. In this case, the dual variables $\theta, \lambda_j, s_r^+ s_i^-$ are assigned as follows.

Max $\sum_{r=1}^{s} \mu_r \gamma_{r0}$

Subject to:

$\sum_{i=1}^{m} \nu_i \chi_{io} = 1$ $\qquad\theta$

$\sum_{r=1}^{s} \mu_r \gamma_{rj} - \sum_{i=1}^{m} \nu_i \chi_{ij} \leq 0$, $j=1,\ldots,n$ $\qquad\lambda_j$

$-\mu_r \geq 0$, $r=1,\ldots,s$ $\qquad s_r^+$

$-\nu_i \geq 0$, $i= 1,\ldots,m$ $\qquad s_r^+$ ………………...D4

A *dual* minimization problem is then derived as model D5. Model D5 has *m+s* constraints while model D3 has *n+m+s+1* constraints. Since *n* is usually considerably larger than *m+s*, the dual DEA significantly reduces the computational burden and is easier to solve than the primal.

Min $\theta - \varepsilon \left[\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+ \right]$

Subject to:

$\theta \chi_{io} - \sum_{j=1}^{n} \gamma_{rj} \lambda_j - s_r^+$

$\lambda_j \geq 0, s_r^+ \geq 0, s_i^- \geq 0$

i=1,…,*m*, r=1, …, *s*, j=1,….,*n* …………….D5

At this point, it is important to note that the duality theorem of linear programming states that the solution value to the objective function in model D4 is exactly equal to that in model D3. In addition, the dual multipliers $\lambda_{1,}\lambda_{2,...,}\lambda_n$ can be interpreted just like the Lagrange multipliers. It is also true that, from constrained optimization problem, $\lambda_j \geq 0$ normally when the constraint in model D4 is binding and $\lambda_j = 0$ if constraint in model D4 is not binding. In this case, the binding constraint in model D3 implies that the corresponding DMU is efficient. The efficient units are identified by positive $\lambda's$ while inefficient units are given $\lambda's$ of zero. The DMU in question in model D5 is thus compared with the efficient DMUs only, named as comparison *peers* in the literature (Coelli, 1996). The solution values of $\lambda's$ reflect the exact weights assigned to each peer in the evaluation of DMU_0.

Since only efficient DMUs exert effective constraints in model D4, the input-output bundle $\left(\sum_{j=1}^{n}\chi_{ij}\lambda_j, \sum_{j=1}^{n}\gamma_{rj}\lambda_j\right)$, is the most efficient combination for i =1,…,m and r = 1,…, s . To achieve an output level γ_{ro}, which is as close as possible to $\left(\sum_{j=1}^{n}\gamma_{rj}\lambda_j\right)$, DMU_0 has to use an input bundle to meet the minimum requirement, $\sum_{j=1}^{n}\chi_{ij}\lambda_j$. This further implies that the solution θ^* is the lowest proportion of the current input bundle, χ_{io} used by DMU_0, that is actually required to meet the minimum input requirement and produce target output, γ_{r0}. In interpreting the estimated results, the solution θ^* is defined as the efficiency score for DMU_0. For instance, if θ^*=0.70, it implies that 30 percent of current input is a waste of resources. Model D4 offers the basis for naming the formulation the data envelopment analysis (Farrell, 1957). The first constraint in D4 defines a lower limit of inputs and the second constraint represents an upper limit of outputs for DMU_0, and within the limits θ is minimized. The set of solutions to all DMUs forms an upper boundary that envelops all observations.

3.4.2 Malmquist productivity index

The Malmquist Total Factor Productivity (TFP) index measures total factor productivity (TFP) change between data points. Productivity change can be decomposed into technical change and technical efficiency change. Following Coelli (1996), the output based Malmquist productivity change between periods *t* and *t+1* is specified as:

$$M_0(y_{t+1,}x_{t+1,}y_t, x_t) = \left[\frac{d_0^t(x_{t+1,}y_{t+1})}{d_0^t(x_t, y_t)} \times \frac{d_0^{t+1}(x_{t+1,}y_{t+1})}{d_0^{t+1}(x_t, y_t)} \right]^{1/2} \quad \text{……….D6}$$

Where M denotes Malmquist productivity index, subscript $_0$ denotes that this measure is an output-oriented measure. d_o denotes an output distance function. The measure is a geometric mean of two output based Malmquist TFP indices. The measure represents the productivity of the production point (x_{t+1}, y_{t+1}) relative to the production point (x_t, y_t). A value greater than 1 means positive TFP growth from period t to period t+1 (Coelli, 1996) where one index uses period t technology and the other period t+1 technology. The first component in the right hand side of equation D6 is technical change while the second component is technical efficiency change.

The Malmquist productivity measure is calculated using four linear programming problems which yield results for technical efficiency change relative to constant returns to scale technology; technological change; pure technical efficiency change relative to variable returns to scale technology; scale efficiency change and total factor productivity (TFP) change (Coelli, 1996). The LP to calculate $d_0^t(x_t, y_t)$ assumes constant returns to scale and excludes the convexity assumptions or assumes that the variable returns to scale restriction have been removed:

$$\left[d_o^t(x_{t,} y_t\right]^{-1} = \max_{\phi} \lambda\phi,$$

Subject to:

$$-\phi y_{it} + y_t\lambda \geq 0,$$

$$x_{it} - X_t\lambda \geq 0,$$

$$\lambda \geq 0, \qquad \text{……..…………D7}$$

The other three LP problems (D8, D9 and D10) are variants of D7 and are specified as:

$$\left[d_o^{t+1}(x_{t+1,} y_{t+1}\right]^{-1} = \max_{\phi} \lambda\phi,$$

Subject to:

$$-\phi y_{i,t+1} + y_{t+1}\lambda \geq 0,$$

$$x_{i,t+1} - X_{t+1}\lambda \geq 0,$$

$$\lambda \geq 0, \qquad \text{……..…………D8}$$

$$\left[d_o^t(x_{t+1,}y_{t+1}\right]^{-1} = \max_{\phi} \lambda\phi,$$

Subject to:

$$-\phi y_{i,t+1} + y_{t+1}\lambda \geq 0,$$

$$x_{i,t+1} - X_t\lambda \geq 0,$$

$$\lambda \geq 0, \qquad \text{……..………..D9}$$

$$\left[d_o^{t+1}(x_{t,}y_t\right]^{-1} = \max_{\phi} \lambda\phi,$$

Subject to:

$$-\phi y_{it} + y_{t+1}\lambda \geq 0,$$

$$x_{it} - X_{t+1}\lambda \geq 0,$$

$$\lambda \geq 0, \qquad \text{…….…………D10}$$

For model D9 and model D10, the production points are compared to technologies from different time points and ϕ <1. It may lie above the feasible production set especially in LP D9 where a production point from period t+1 is compared to technology in period t. A point where ϕ <1 is possible when technical progress occurs. ϕ and λ may take different values. The four LP equations are estimated for each decision making unit. For instance, assuming 47 counties and 3 time periods, then 141 LP equations are computed. Any additional time period added means additional 3 LP for each county in order to construct a chained index (Coelli, 1996). In other words, if one has T time periods and N DMUs, one must calculate N(3T-3) Linear Programming Equations (LPs). In this study, since we have 47 counties or decision making units and 3 time periods (2005/6, 2007/8 and 2009/10), the number of LP to be computed is: 421.

As indicated above, technical efficiency of a DMU is the distance between the production point using the given level of input-output combination of a DMU, in this case county and the maximum possible efficiency frontier. DEA allows the selection between input orientation and output orientation. Input orientation aims at minimizing inputs while maintaining the level of outputs. Output orientation aims to achieve efficiency by maximizing outputs while maintaining input levels (GOK, 2007). In this study, input orientation is preferred because education input choices are more under the policy makers' control compared to outputs. Given budgetary constraints it could be critical to ensure input efficiency in terms of reducing inputs to achieve a given level of education outputs.

3.4.3 Variable returns to scale model and scale efficiency

It was then necessary to decompose the returns to scale into scale efficiency, and variable returns to scale efficiency components. This is important because the CRS assumption is only appropriate when all DMUs are operating at an optimal scale, that is an equivalent of flat long run average cost curve (Coelli, 1996) and the results in measures of TE are likely to be affected by scale efficiencies (SE). However, imperfect competition, constraints on finance among other factors may impede DMUs from operating at an optimal scale (Banker, Charnes and Cooper, 1984 and Coelli, 1996) hence need to extend the CRS DEA model to account for variable returns to scale while estimating TE measures that are devoid of scale efficiency effects.

The variable returns to scale linear programming (VRS LP) model is modified into constant returns to scale linear programming (CRS LP) equation by adding a convexity constraint: N1’ γ =1 to models D8 and D7. The CRS LP model is specified as follows:

Min $_{\phi}$ $\lambda\theta$,

Subject to:

$$-y_i + Y\lambda \geq 0,$$

$$\theta x_i - x\lambda \geq 0$$

$$N1'\lambda = 1$$

$$\lambda \geq 0 \qquad \text{……….………D11}$$

Where, N1 is an Nx1 vector of ones. Assuming N decision making units and T time periods, the decomposition will increase the number of linear programming models to N(4T-2). According to Coelli (1996), the VRSLP approach forms a convex hull of intersecting planes which envelop the data more tightly than the CRS hull.

The technical efficiency scores obtained from the CRS DEA are decomposed into those due to scale inefficiencies and then, those due to pure technical inefficiency. If there is a difference between the two scores for a given DMU, then it means the DMU has scale inefficiencies which is equivalent to the difference between the two scores. However, one weakness with this approach is that it does not indicate whether the DMU is operating under increasing or decreasing returns to scale. To address the constraint, an additional DEA problem is specified with the non-increasing returns to scale (NIRS) imposed. This is done by substituting the restriction N1’ γ =1 in model D11 with N1’ $\gamma \leq 1$ to provide the following specification:

Min $_{\phi}$ $\lambda\theta$,

Subject to:

$-y_i + Y\lambda \geq 0,$

$\theta x_i - x\lambda \geq 0$

$N1'\lambda \leq 1$

$\lambda \geq 0$ …………..………..D12

Using the estimated NIRS DEA frontier, increasing returns to scale exist for a DMU if the NIRS TE score is not equal to the VRS TE score. When the NIRS TE score and the VRS TE score are equal, the DMU is experiencing decreasing returns to scale.

However, the technical efficiency estimates from the standard DEA approach explained above are likely to suffer from econometric problem of serial correlation (Simar and Wilson, 2007). Further, they do not consider the underlying data-generating procedures (DGP) which hinders statistical inference (Simar and Wilson, 2007). To address the limitations, this study applies the DEA double bootstrap to estimate and explain the technical efficiency in Kenya's education sector.

3.4.4 DEA double bootstrap approach

Data Envelopment Analysis double bootstrap procedure is a two stage semi-parametric approach linking inputs to outputs while correcting estimates for bias. In the first stage, a specific bootstrap procedure is used. In the second stage, the bias corrected efficiency scores are regressed on a set of environmental variables using a truncated regression (Simar and Wilson 2007) to establish the correlates of technical efficiency.

The DEA double bootstrap procedure generates a true sampling distribution by imitating the data generating process using the DEA scores for estimating statistical properties of a non-parametric frontier estimator (Simar and Wilson, 2007). The process combines DEA with bootstrapping techniques in generating bias corrected DEA efficiency measures.

It enables estimation and explanation of technical efficiency; while simultaneously estimating standard errors and confidence intervals for the efficiency measures (Balcombe, et al 2008; and Simar and Wilson, 2007). Besides, since the sampling distribution may not be available, the bootstrap procedure simulates the sampling distribution of interest by following the data generating process to generate a pseudo data set from the original data set. The DEA model is then re-estimated using the new data that gives an estimate of the sampling distribution which facilitates inference procedures. In this study the efficiency estimators were computed for 100 bootstrap replications.

The output-oriented double bootstrap model is specified as:

$$\hat{\theta} = \max\{\theta > 0 \mid \theta yi \le \sum_{i=1}^{n} \gamma_i y_i ; x_i \ \ge \sum_{i=1}^{n} \gamma_i x_i ; \sum_{i=1}^{n} \gamma_i \ = 1; \gamma_i \ge 0, i = 1,..., n\} \qquad \text{………..E1}$$

Where $\hat{\theta}$ is the output-oriented DEA efficiency estimator for any data point (x_i,y_i) and $1 \le \hat{\theta}_i$. x_i, and y_i are observed inputs and outputs, respectively and *i* is the specific DMU, ranging from i=1,….,n. When $\hat{\theta}_i = 1$ DMUs are technically efficient and inefficient when $\hat{\theta}$>1. $\hat{\theta}_i - 1$ represents the potential output expansion (proportional increase in outputs that can be achieved by the i^{th} DMU with input quantities, *x*, , held constant); and γ is a non-negative intensity variable used in scaling individual observed activities for constructing the efficiency measure. The input-orientation equation is specified in E2.

$$\hat{\theta} = \min x\{\theta > 0 \mid \theta yi \le \sum_{i=1}^{n} \gamma_i y_i ; x_i \ \ge \sum_{i=1}^{n} \gamma_i x_i ; \sum_{i=1}^{n} \gamma_i \ = 1; \gamma_i \ge 0, i = 1,......, n\} \qquad \text{………..E2}$$

Where $\hat{\theta}$ is the input-oriented DEA efficiency estimator for any data point (x_i,y_i) and $1 \le \hat{\theta}_i$. x_i, and y_i are observed outputs and inputs and *i* is the specific DMU, ranging from i=1,….,n. $\hat{\theta}$ is a scalar and γ is a non-negative vector. The scalar is the technical efficiency score for the *i*th county for the respective level of education and the county is considered efficient when the scalar equals one. It gives the value by which inputs can be decreased while producing the same level of outputs.

The double bootstrap DEA procedure assumes variable returns to scale (VRS) but constant returns to scale (CRS) restriction can be imposed by excluding the constraint $\sum_{i=1}^{n} \gamma_i = 1$.

3.4.5 The bootstrap truncated regression model

To identify the determinants of education sector technical efficiency, a second-stage analysis is conducted. The technical efficiency scores generated through the bootstrap DEA analysis are regressed on a set of explanatory variables. The efficiency scores $\hat{\theta}_i$ are truncated below 1 and are employed as dependent variable in the truncated regression model which is used to estimate the factors that explain efficiency in education. The model (Keramidou, Mimis and Pappa, 2010) was specified as follows:

$$\hat{\theta}_i = Z_i \beta + \varepsilon_i \quad , \text{i=1,…,n} \qquad \text{………..E3}$$

Where Z_i is a vector of explanatory variables assumed to explain variations in technical efficiency across counties; β is a vector of coefficients to be estimated and ε_i is a continuous independent and identically distributed (*iid)* random variable, distributed $N(0, \sigma_\varepsilon^2)$ with left-truncation at $1 - Z_i \beta$ for each *i*, and assumed independent of Z_i. Estimation used maximum likelihood (ML) estimator because it is consistent and asymptotically efficient.

The dependent variable for the second stage truncated regression model is the estimated DEA double bootstrap bias corrected technical efficiency estimate. Explanatory variables which were hypothesized to influence the primary education technical efficiency score include county level total spending at primary education level (Herrera and Pang, 2005), personnel emoluments for teachers, pupil teacher ratio, female and male literacy rates, access to social amenities such as water, roads and electricity; teacher absenteeism, poverty level, urbanization, respective school age population. Poverty level was used to control for level of socio-economic status in this estimation.

3.5 DATA

3.5.1 Data sources

Data used in this chapter was obtained from the Kenya National Examinations Council (KNEC), Ministry of Education and Appropriation Accounts (Various issues). Average education spending was computed using data for three years (2005/6, 2007/8 and 2009/10) annual spending at the various education levels. Education indicators data (pupil teacher ratio, class size, proximity to learning institutions, enrolment rate) was obtained from the Ministry of Education. Data on poverty level, literacy rate for household heads by gender, household size, access to social amenities (electricity, water, road network) and proximity to learning institutions was obtained from the Kenya Open Data Base (http://opendata.go.ke using the Kenya National Bureau of Statistics datasets). All indicators were computed at county level.

3.5.2 Outputs and inputs

At primary level, inputs consisted of per capita spending, pupil teacher ratio and class size. At secondary education level inputs consisted of pupil teacher ratio, class size and per capita spending. The per capita spending covers aggregate free primary education spending; Constituency Development Fund (CDF) spending and Local Authorities Transfer Fund (LATF) education spending; teacher personnel emoluments and sub-national allocation for administration and operations divided by total respective school enrolment. The per capita public spending was computed for primary, secondary and tertiary education.

The outputs included primary education net enrolment rate and KCPE scores for primary education; and secondary education NER and KSCE scores for secondary education. KCPE and KCSE scores represent a measure of learning achievements. Net enrolment rates are computed from total enrolment of respective school age divided by the respective school age population (that is 6-13 for primary and 14-17 for secondary education).

One input (per capita spending) and one output, GER, were used at tertiary education level. GER is computed by dividing total enrolment at this level, regardless of age divided by the respective school age population and 18-25 (years). The NER and GER provide measures of access and participation across various levels of education. Data on resource utilization includes pupil or student teacher ratio, class size and per capita spending for respective levels.

In this study, the DEA requirement that the number of decision making units in DEA analysis should be more than three times the total number of input and outputs (Keramidou, Mimis and Pappa, 2010) is satisfied at each education level. At all levels there were 47 DMUs. At primary level there were three inputs and two outputs. The corresponding number at secondary level was three inputs and two outputs. At tertiary level the number was one input and one output.

3.6 ESTIMATION RESULTS AND DISCUSSION

The technical efficiency analysis consists of two parts: measurement technical efficiency scores using DEA, DEA bootstrap procedure and the Malmquist efficiency scores; and the bootstrap truncated regression results. The analysis covers primary, secondary and tertiary education.

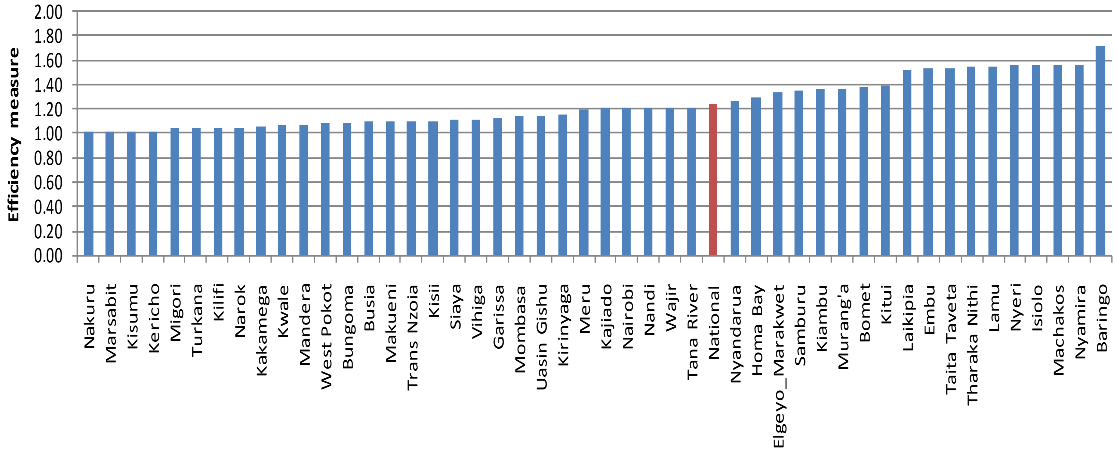
3.6.1 Technical efficiency measures

Technical efficiency estimates were obtained by county and level of education using the standard DEA procedure and the DEA bootstrap procedure. A multiple inputs and multiple outputs model was developed and estimated taking the input orientation. From the standard DEA estimates, an efficiency score of 1 indicates that the county is fully technically efficient, while a score tending to 0 indicates that the county is inefficient. The two stage DEA bootstrap variable returns to scale (technical) efficiency scores are presented in Appendix Table 4 and Figures 3-3, 3-4 and 3-5. Note that the DEA bootstrap efficiency measure is larger or equal to 1 (Simar and Wilson, 2007). Estimates closer to 1 indicate a highly efficient DMU while those further away from the frontier are less efficient.

The bias-corrected DEA estimates show that the average technically efficiency score are 1.24; 1.12 and 3.04 for primary, secondary and tertiary education, respectively. The results indicate that counties are operating above input efficiency level by 24 percent at primary, 12 percent at secondary education level; and 204 percent at tertiary education level. For all education levels, the bias estimate is larger than the standard deviation suggesting that bias corrected DEA efficiency scores are preferred to the standard DEA scores (see Appendix Table 4). The bias-corrected technical efficiency score for primary education across counties was between 1.72 and 1.01. Ten counties recorded an efficiency measure greater than 1.40 while 17 counties recorded efficiency measure of between 1.01 and 1.10.

The results show that some counties could have been more efficient and could have produced the same outputs using fewer inputs. Counties can increase the primary, secondary and tertiary education outputs (as measured by NER, KCPE and KCSE scores and tertiary GER) by 24 percent, 12 percent and 204 percent without increasing inputs, if they are technically efficient.

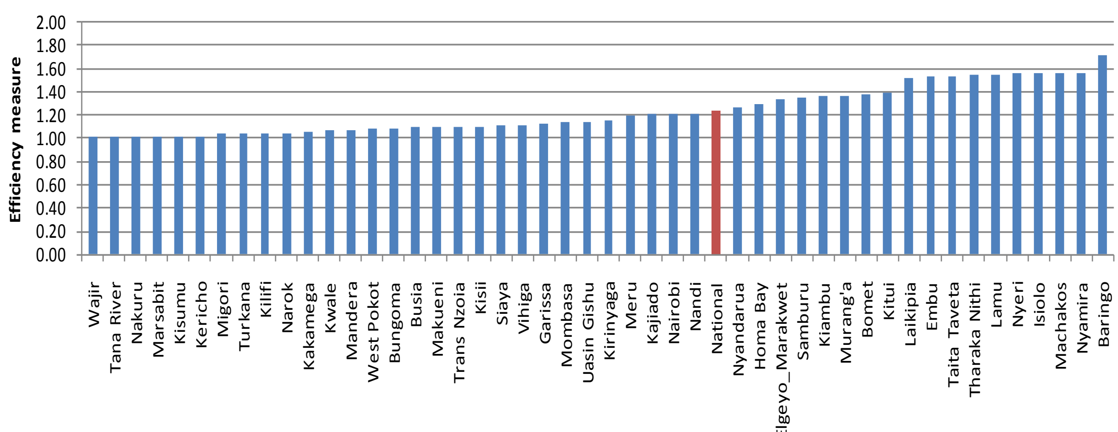
Figure 3-3: Primary education efficiency scores



Source: Author's computations

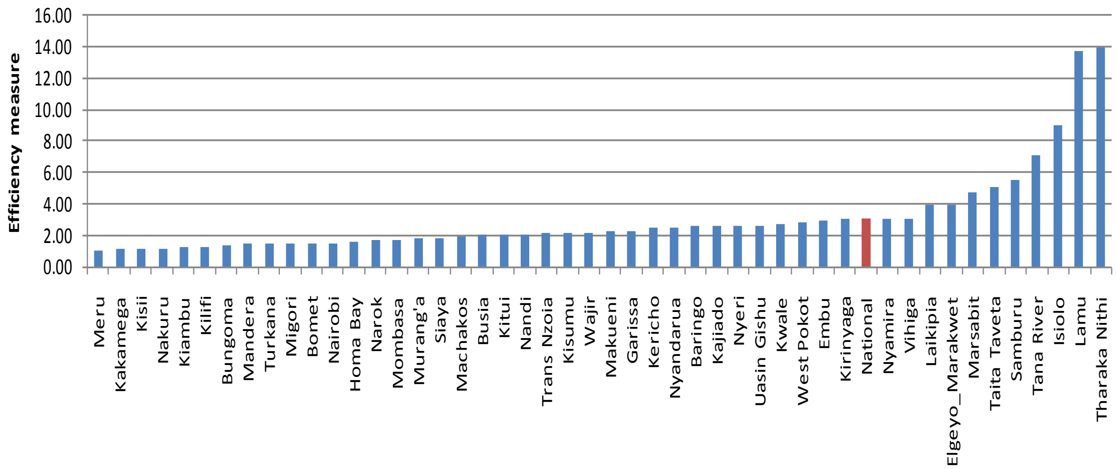
At secondary education level the bias corrected DEA efficiency measure ranged between 1.52 and 1.01 (see Figure 3-4 and Appendix Table 4). 18 counties recorded an efficiency measure greater than the national average of 1.12 while the remaining 29 counties recorded an efficiency measure of between 1.01 and 1.24. Tertiary education DEA bootstrapped efficiency estimates ranged 1.05 and 13.9 (see Figure 3-5).

Figure 3-4: Secondary education efficiency scores



Source: Author's computations

Figure 3-5: Tertiary education efficiency scores



Source: Author's computations

The most technically inefficient Counties using the DEA bootstrap estimates were Baringo (1.71) at primary; Isiolo (1.52) at secondary education level and Tharaka Nithi (13.9) at tertiary education level. The most efficient counties were Nakuru (1.02) at primary; Meru at secondary education (1.01) and tertiary education (1.05) levels.

For purposes of comparison, the standard DEA estimates show that Kenya has attained a high efficiency measure at primary and secondary education levels. On average, the national efficiency score for primary education is 0.82 with a minimum of 0.59 and a maximum of 1. The efficiency score at secondary education level was 0.92 (minimum of 0.79 and a maximum of 1). Tertiary education efficiency score was estimated at 0.52 (minimum of 0.15 and a maximum of 1). In the next section, the Malmquist total factor productivity change is estimates with a view to measuring the total factor productivity change during the study period.

3.6.2 Total factor productivity change using Malmquist indices

Table 6 in the Appendix shows county means of Malmquist total factor productivity indices estimated from 2005/6, 2007/8 and 2009/10 data. A score greater than 1 implies TFP growth (Coelli, 1996). The estimates of the Malmquist technical efficiency change show a clear trend of decreasing efficiency between 2005/6 and 2009/10. The average total factor productivity change was estimated at 0.95 for both primary and secondary education. This indicates declining total factor productivity between 2005/6 and 2009/10. Nine (9) counties reported increasing total factor productivity (greater than 1) at primary education level while 20 counties reported total factor productivity growth at secondary education level.

Technical efficiency change relative to constant returns to scale was positive for both primary and secondary education (see Appendix Table 6). Pure technical efficiency change relative to variable returns to scale technology was also positive. The cross county analysis on efficiency show that counties with higher per capita education expenditures do not necessarily have higher efficiency score. There are counties with low per-capita spending but higher efficiency scores suggesting that there are other factors that affect education outcomes rather than spending. The next section focuses on factors influencing efficiency using bootstrapped truncated regression model.

3.6.3 Determinants of technical efficiency

3.6.3.1 Descriptive statistics

Primary education DEA double bootstrap efficiency score was estimated at a minimum of 1.013 and a maximum of 1.717 while secondary score was between a minimum of 1.01 points and a maximum of 1.519 score. Tertiary education DEA bootstrap efficiency measure was estimated at 3.045 with a minimum of 1.048 and a maximum of 13.9. Individual counties receive an average of 2 percent, 2.5 percent and 2.1 percent of national primary, secondary and tertiary education financing.

Table 3-1: Summary statistics

Variable name (n=47)	Mean	Std Dev.	Minimum	Maximum
DEA bootstrap efficiency (Primary education)	1.24	0.21	1.01	1.72
DEA bootstrap efficiency (Secondary education)	1.12	0.11	1.01	1.52
DEA bootstrap efficiency score (Tertiary education)	3.05	2.78	1.05	13.94
Public spending at primary education (proportion)	0.40	0.50	0.10	0.70
Primary teachers' personnel emoluments (proportion)	0.85	0.04	0.77	0.91
Poverty headcount rate (%)	50.79	18.08	12.10	92.90
Primary education pupil teacher ratio	39.49	10.09	22.74	65.13
Female literacy rate (%)	64.65	23.12	6.07	93.95
Male literacy rate	78.53	18.73	29.31	96.58
Number of households with access to tarmac roads	332	225	0	993
Proportion of urban population	0.29	0.22	0.07	0.12
Public spending at secondary education (proportion)	0.30	0.20	0.10	0.60
Secondary education teachers' personnel (%)	0.59	0.06	0.43	0.75

Variable name (n=47)	Mean	Std Dev.	Minimum	Maximum
Secondary education pupil teacher ratio	23.94	6.56	12.07	44.83
Secondary school age population to school density	1,433	1,817	296	9,232
Public spending at tertiary education (proportion)	0.12	0.10	0.00	0.18
Percentage of pupils in private primary schools	9.53	9.09	0.91	42.86
Percentage of students in private secondary schools	13.78	13.63	0.00	56.65
Secondary education net enrolment rate	22.76	11.72	3.46	49.99

Source: Ministry of Education, Appropriation accounts-various, Open Data, and author's computations

However most of the education resources are allocated to teachers' personnel emoluments, estimated at 85 percent and 59 percent for primary and secondary education, respectively. Female literacy rate (64 percent) was lower than male literacy rate (78 percent). Teacher absenteeism was recorded at a maximum of 23 percent and a mean of 13 percent. The summary statistics further shows that the primary and secondary pupil teacher ratios were 39:1 and 23:1.

3.6.3.2 Estimation results on factors explaining technical efficiency

To determine the factors that affect technical efficiency, a truncated regression model (equation E3) using the DEA bootstrap efficiency estimates as dependent variable is estimated. The value of the dependent variable is truncated to have a lower limit of 1 and the explanatory variables include environmental factors. The empirical results of the truncated regression estimation on determinants of efficiency in schooling are presented in Table 3-2.

Because the inverse of the DEA score is the dependent variable, a positive sign in the coefficient indicates a negative influence on efficiency, while a negative sign denotes a positive effect on efficiency scores (Simar and Wilson, 2007). Government expenditure on primary education as a proportion of aggregate education spending has a negative and significant (at 10% level) coefficient. This means that variable has a positive and highly statistically significant effect on primary education efficiency. The coefficient of primary teacher salaries has a positive sign and highly statistically significant at 1 percent significance level. Thus while salaries as proportion of primary education expenditure has a negative and statistically significant effect on efficiency of primary education; spending on non-salary inputs would have a positive effect on efficiency of primary education.

Table 3-2: Bias-corrected bootstrapped truncated regression estimates of the determinants of technical efficiency

Variables	Primary	Secondary	Tertiary
Public spending at primary education	-3.941*		
	[2.248]		
Primary teachers personnel emoluments	2.637***		
	[0.973]		
Secondary school size	-0.00017		
	[0.000167]		
Household head's literacy rate (Female=1)	0.0031		-0.133***
	[0.00211]		[0.0462]
Poverty headcount rate	0.000146	0.000859	-0.0236
	[0.00195]	[0.000821]	[0.0475]
Proportion of urban population	0.0364	0.0295	0.958
	[0.265]	[0.110]	[3.821]
Percentage of pupils in private primary schools	-0.00051		
	[0.00597]		
Public spending at secondary education		-1.927***	
		[0.708]	
Secondary education teachers personnel		1.085***	
		[0.209]	
Secondary school size		-0.00021	
		[0.000178]	

Percentage of pupils in private secondary schools		0.00121	
		[0.00234]	
Public spending at tertiary education			20.78
			[64.47]
Access to tarmac roads			-0.00352
			[0.00222]
Access to secondary education			0.0248
			[0.0449]
Secondary schools population density			-0.00129*
			[0.000673]
Constant	-1.055	0.510***	14.60***
	[0.859]	[0.133]	[5.255]
Sigma	0.157***	0.0681***	2.259***
	[0.0150]	[0.0105]	[0.484]
Observations	47	47	47

Source: Author’s estimation; Number of bootstrap iterations 100. Standard errors in brackets.
*** p<0.01, ** p<0.05, * p<0.1

Estimation results in column 3 show that secondary education sub-sector public spending have a significant and negative coefficient and hence has positive influence on technical efficiency at this level. Secondary school teacher salaries as proportion of secondary education sub-sector public spending have a positive and significant sign and hence negative effect on technical efficiency at this level. The proportion of students enrolled in private (primary and secondary) schools has no significant effect on technical efficiency.

At tertiary education, female literacy and access to secondary schools have a positive effect on efficiency on tertiary education efficiency score. The finding confirms the link between secondary and tertiary education. That efficiency at tertiary education level can partly be achieved through improved access to secondary education across counties. The positive and significant effect of female literacy can be explained by the role played by female household heads on the education of their children including access to tertiary education, and the implied efficiency gains.

3.6.4 Estimates of savings from efficiency improvement

The amount of recurrent expenditure incurred by all 47 counties by level of education is presented in Appendix Table 7. The average public education spending (taking into account 2005/6, 2007/8 and 2009/10 annual spending) was Ksh 53 billion; Ksh 28 billion and Ksh 19 billion for primary, secondary and tertiary education levels, respectively. These resources were spent against the background of technical inefficiency.

We compute the expected spending (E) assuming counties were fully efficient by dividing the current level of spending by DEA bias-corrected efficiency score; multiplied with 100. Savings (S) are then obtained by deducting the expected level of spending, assuming counties were fully efficient from the actual spending (A) (see Appendix Table 7 and Table 3-3. In other words, S=A-E. The savings is then presented as a percentage of the actual spending during the study period. The savings that could have been realized if all counties were efficient in all education levels and with the possible minimum expenditures was 17 percent, 10 percent and 52 percent of primary, secondary and tertiary education spending, respectively. The average savings, however, should be seen in the context of the wide distribution of savings (Table 3-3).

Table 3-3: Expected savings assuming all counties were efficient (percent of education spending in 2009/10)

	Expected savings in 2009/10 (Ksh. millions)			Savings (%)		
County	Primary	Secondary	Tertiary	Primary	Secondary	Tertiary
1. Baringo	465	54	189	42	12	62
2. Bomet	340	66	90	28	10	33
3. Bungoma	159	80	105	8	7	25
4. Busia	86	57	64	9	15	50
5. Elgeyo_Marakwet	178	16	89	26	4	75
6. Embu	444	56	133	35	9	65
7. Garissa	19	13	41	11	14	57
8. Homa Bay	338	35	93	23	5	35
9. Isiolo	89	14	30	36	34	89
10. Kajiado	117	56	319	17	20	62
11. Kakamega	128	41	38	6	3	8
12. Kericho	20	20	170	2	4	59
13. Kiambu	507	141	294	27	8	21
14. Kilifi	44	11	38	4	3	22
15. Kirinyaga	108	32	112	13	5	67
16. Kisii	167	103	57	9	7	12
17. Kisumu	25	57	491	2	7	54
18. Kitui	748	49	137	28	7	51
19. Kwale	57	17	79	7	6	62
20. Laikipia	221	113	84	34	30	74
21. Lamu	58	4	15	35	8	93
22. Machakos	1,008	17	285	36	1	49
23. Makueni	241	53	185	9	5	56
24. Mandera	14	7	17	7	9	29
25. Marsabit	5	11	27	2	19	79
26. Meru	497	12	19	16	1	5
27. Migori	42	23	68	3	5	31
28. Mombasa	76	40	331	12	12	39
29. Murang'a	335	60	126	27	5	46
30. Nairobi	330	72	1,667	17	7	34
31. Nakuru	36	15	138	2	1	13
32. Nandi	216	15	161	18	3	52
33. Narok	35	5	54	4	2	39
34. Nyamira	408	86	156	36	12	67
35. Nyandarua	214	54	73	21	9	59
36. Nyeri	424	31	255	36	3	62
37. Samburu	58	15	18	26	22	82
38. Siaya	128	50	75	10	7	46

	Expected savings in 2009/10 (Ksh. millions)			Savings (%)		
County	Primary	Secondary	Tertiary	Primary	Secondary	Tertiary
39. Taita Taveta	174	28	82	35	10	80
40. Tana River	3	18	12	1	29	86
41. Tharaka Nithi	148	9	38	35	13	93
42. Trans Nzoia	100	35	135	9	7	52
43. Turkana	12	6	21	3	5	31
44. Uasin Gishu	146	120	739	12	20	62
45. Vihiga	108	25	134	10	4	68
46. Wajir	3	11	24	1	11	54
47. West Pokot	43	37	76	8	23	64
National	9,122	1,890	7,587	17	10	52

Source: Author's computations

3.7 CONCLUSIONS AND POLICY IMPLICATIONS

3.7.1 Conclusion

This essay set out to estimate levels of technical efficiency of public education spending at primary, secondary and tertiary education levels at county level in Kenya and to identify the associated factors. Since public education spending takes over 6.4 percent of GDP, high efficiency in resource use is critical to sustainable sector financing. The government has over time been spending substantial resources on the education sector but the outcomes remain low and large differences exist across counties. The standard Data Envelopment Analysis (DEA) and DEA double bootstrap procedure were used. The DEA double bootstrap enables one to estimate and explain the technical efficiency of public education spending, while addressing the limitations standard DEA procedure. The limitations include serial correlation and failure to take into account the underlying data-generating procedures, both of which constrain statistical inference. The study uses education indicator trend data including selected output indicators (NER and national examination performance) for three time period- 2005/6, 2007/8 and 2009/10.

The estimated results with a DEA bootstrap procedure show that many counties in Kenya are inefficient with mean technical inefficiency measure of 1.24; 1.12 and 3.04 for primary, secondary and tertiary education levels, respectively. The results show that there is scope for improving efficiency in education resource utilization including increasing outputs without increasing inputs. Overall, an average county should perform as efficiently as the most efficient county by increasing outputs by 24 percent, 12 percent and 204 percent at primary, secondary and tertiary levels, respectively without changing the level of inputs.

From the estimation results, counties have substantial scope to enhance their efficiency by decreasing the waste of inputs by first, adopting similar practices to those of best performing counties; second, by using the available resources in a better way. Public spending on teachers' personnel emoluments has negative and statistically significant effect on technical efficiency. Thus high expenditure on pay does not necessarily translate to higher efficiency. In other words there is no direct correlation between technical efficiency and county socio-economic status and poverty status is a weak correlate of technical efficiency. Both efficient and inefficient counties are observed across the country regardless of the poverty status. The bootstrap truncated regression model corrects for the serial correlation problem in the second stage of the two-stage method. The serial correlation problem arises because variables used as inputs and outputs in the first-stage are likely to be correlated with variables in the second-stage, that is, the truncated regression.

There is also substantial potential in resource saving that can be realized with efficiency improvement in education service delivery. Some counties have higher technical efficiency score despite low per capita spending. This means that counties can improve education service delivery without necessarily increasing public spending.

The disparities in technical efficiency across counties and variations in expected savings suggest that different counties require different interventions to improve technical efficiency. Some counties may require more resources than others in order to achieve given level of education outcomes.

3.7.2 Policy implications

Ministry of Education, Science and Technology should put more effort to reducing inefficiency in provision of education services in the country. Concerted efforts should be directed towards ensuring consistent increase in education outcomes without necessarily increasing inputs. While the government continues to explore alternative sustainable education financing options for the ongoing and envisaged education reforms within the Vision 2030 and Constitution of Kenya (2010), efficiency improvements could be considered as one of the strategic options for mobilizing resources in the sector.

Counties can obtain better performance with better utilization of education inputs notably teachers. Spending a large share of total education on teachers is unfavourable in terms of technical efficiency. Improving aspects of education quality by improving levels of teacher utilization could improve efficiency of primary and secondary education schooling. Other interventions include attracting talented teaching labour force, improving ability of teachers to instruct and creating mechanisms that encourage greater parental education and greater interactions between teachers, parents and students. Given the negative effect of teacher wage bill on education efficiency, the government could adopt interventions towards efficient utilization of teachers including better supervision of teachers and stemming teacher absenteeism.

Further, efficiency level should be estimated on annual basis for purposes of monitoring the performance of education sector over time and to ensure sustainable education financing mechanisms. This requires regular and updated data collection on the critical education indicators such as per unit costs (both on budget and off budget), pupil teacher ratio, class size, school size, participation rate, learning achievement scores among others. While information on on-budget is readily available, information on off-budget expenditures by household and non-governmental organizations and direct programme support by some development partners, is not readily available both at national and county levels. The education ministries should maintain this data base through institutionalization of an appropriate education financial information system (EFIS) just as is the case in the health sector. The study findings would inform public policy on public expenditure management within decentralized systems, including addressing inefficiencies in education spending across counties; and improving efficiency in public resource management and utilization.

This study addresses the important policy issue of education sector technical efficiency in Kenya. It contributes to the literature on technical efficiency measurement through application of a recent methodological development - DEA double bootstrap approach. The approach enables estimating and explaining technical efficiency measures while simultaneously generating confidence intervals and standard errors for statistical inferences. From a policy perspective, the study suggests there is scope for improving education sector technical efficiency at county level. This is important given that counties are the new focus of public service delivery particularly education and health.

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CHAPTER 4

4 EXTERNAL EFFICIENCY OF EDUCATION AND TRAINING

4.1 INTRODUCTION

The proposition that knowledge accumulation through education is important to long-run economic growth is central to endogenous growth theory (Romer, 1986 and 1990; and Lucas, 1988) and the human capital augmented Solow growth model (Solow, 1956). Human capital theory posits that education constitutes a form of human capital that can raise productive capacity of individuals (Schultz, 1961 and Becker, 1964). Expanding the benefits to include effects of education on non-market social outcomes, also referred to as education externalities is critical in enhancing economic wellbeing. For measurement of external efficiency of education, one tries to establish the impact which education is making on individuals and a society.

The non-market outcomes or externalities on which impacts are traced include improved social well being, improved health and nutrition outcomes such as longer life expectancy, low child mortality and reduced fertility (Grossman, 2005; and Weir and Knight, 2000). Other non market benefits of human capital include democratization, respect of human rights and political stability; reduced inequalities in income distribution and poverty; environmental conservation and low crime rates (McMahon, 2001). An individual's education results into better earnings for themselves (Mince, 1974; Psacharopoulos, 1994 and 2004) but can also have positive effect on earnings of others (education externalities) (Rodriguez-Pose and Tselios, 2012). For instance, an individual’s earnings may be educational attainment of the other members of the household in which the target individual lives; education endowment of the region where the individual lives; or the educational attainment of the neighboring regions (Wier and Knight, 2000).

Households invest in the level of education that maximizes their utility (Weir and Knight, 2000). But if education externalities exist such a level of educational investment might not be optimal. Since long-run growth is driven by endogenous technological change from knowledge externalities, non socially optimal educational investments by current and past generations adversely affect future economic growth (Romer, 1986).

Incentive to invest in education and training comes partly from the labour market. Education attainment is associated with lower unemployment rate in some cases, but not in others (Kuepie, et al, 2006). Kingdon and Knight (2000, 2001) find that in South Africa, unemployment is highest among the relatively low skilled from a poor family background. Kuepie et al (2006) find that unemployment in West Africa is relatively high among the educated. Unemployment among educated workers may also be due to skills limitations and employers’ employment practices. For instance, employer preference for experienced workers as opposed to fresh graduates in South Korea led to high unemployment among new school graduates (Bae and Song, 2006).

The chapter focuses on employment sector participation, private returns to education and education externalities. In doing so, the analysis places human capital in a broader measurement framework on social returns to education generally desired for sustainable development. These effects have long-term implications on the overall socio-economic conditions of a country. The external efficiency of education and training in this study is captured through returns to education and effects of education and training on employment participation and economic well-being status across counties. Education externalities were measured through differences in individual earnings resulting from education endowment at household and county levels.

Several studies have estimated effects of education on employment sector participation and earnings (Wamuthenya, 2010; Nyaga, 2010 and Kabubo-Mariara, 2003). However the studies overlooked potential external effects of education. This essay extends this literature in various ways. The study uses recent data to update estimates of returns to all levels of education including vocational and technical training. Most previous research in Kenya concentrates on formal education. Previous estimates of returns to vocational and technical training are include Appleton et al,(1999) who analyse the 1977 and 1986 labour force surveys; Neizert (1996) using a small scale survey in Nairobi; Soderbom et al(2005); Holm-Nielsen and Thom (2004) and Rosholm et.al. (2007) for manufacturing sector.

Second, the study estimates externalities of education and training. The research question addressed in this study area is that: does the education of other household members or that of the county of residence affect individual earnings? While some studies have estimated externalities of schooling in some developing economies such as Ethiopia (Weir, 2000 and Weir and Knight, 2000) and developed economies (Rodriguez-Pose and Tselios, 2012), limited research work has been undertaken on the issue in Kenya. Kimenyi et al (2006) estimated the effect of education at district level on individual earnings but they did not estimate within household education externalities. Third, unlike previous studies, this study provides a more comprehensive view of the education income relationship in Kenya by focusing on all key employment sectors including agriculture. Unlike previous studies, analyses in this study are based on the most current micro level data (KIHBS, 2005/6) in Kenya.

Research on education externalities in Kenya is timely in various fronts. Although the country has high national education access levels at primary education; there are regional disparities and access levels at post primary level are low. As the country implements decentralization policies under the 2010 Constitution, it will be important to establish if education externalities exist in Kenya and the magnitude. Thus it is important to establish all benefits of schooling (private, internal and external) in order to inform policy on implications of the unsatisfactory levels of schooling.

4.1.1 Objectives of the study

The broad objective of this essay is to assess external efficiency of public spending on education in Kenya. The specific objectives are to:

(i) Estimate relationship between education and employment sector participation in Kenya;

(ii) Estimate private returns to education across employment sectors in Kenya;

(iii) Estimate internal and external effects of education on individual earnings in Kenya; and

(iv) Draw policy suggestions.

4.1.2 Organization of the study

The rest of the chapter is organised as follows. A survey on external efficiency literature is presented in section 4.2. Section 4.3 outlines the methodology. Section 4.4 presents the estimation results. Summary and conclusions are presented in Section 4.5.

4.2 LITERATURE REVIEW

Rate of return to education measures the benefits obtained from attainment of a given level of education, relative to the costs of education. There are various types of rates of return: fiscal rate of return, social rate of return and private rate of return (Badescus, 2006) to education. Fiscal rate of return refers to the discount rate that equalizes the costs of education, either direct or indirect public education expenditures and lost income tax revenue on students' forgone earnings to the benefits (such as increase in revenues and higher wages) of education for the public sector.

Social rate of return represents the discount rate that equalizes the social costs of education or opportunity cost of people not participating in the production of output and the full cost of provision of education, to the benefits of education. Examples of social benefits of education include greater socioeconomic wellbeing, social cohesion and active citizens' participation in issues of public interest such as voting.

Private rate of return is the discount rate that equalizes the costs of education during the study period such as tuition fees, forgone earnings net of taxes adjusted to the probability of being in employment, less the resources that are made available to students such as grants and loans; to the gains obtained from education (Badescus, 2006). In this study, private and social rates of return to education and training are estimated.

A substantial literature exists on returns to education or external efficiency of education (Psacharopoulos, 1994 and 2004). For measurement of external efficiency of education, one tries to establish the impact which education is making on the society including the relevance of education to the socio-economic conditions of a country, and the ability of graduates to enter and productively participate in the labour market while, improving their economic well-being. External efficiency includes community gains (external effects), personal gains (returns to an individual) and internal gains (returns to an individual's household). McMahon and Boediano (1992) estimated external efficiency in education in Indonesia and observed that external inefficiency in education can be explained by under-investment in secondary education, increased use of market signals for planning and annual budgeting decisions, insufficient resource allocation and inadequate educational financing methods.

Weir and Knight (2000) find sizeable and significant external benefits to schooling at household and site levels in form of higher farm production in Ethiopia. Kuepie et al (2006) found that education has positive impact on informal sector earnings in West Africa. The authors concluded that West Africa educational investments could be worthwhile (considering the unavailability of demanded jobs in the formal sector) particularly if the governments can support the growth of the informal sector through attractive policies. Kuepie et al (2006) also found that even though education does not prevent individuals from being unemployed, it does increase individual earnings by opening opportunities for the well educated to take advantage of profitable work openings especially in formal public and formal private sectors. In a related finding, the World Bank (2006) points out that, over time, as youth gain experience, higher education and skills development increase the employment incidence, enhances occupational mobility and increases individual earnings.

Psacharopoulos (1994 and 2004) survey estimates of returns to education. They found that overall private rates of return to education are higher than the social returns to education; returns to schooling are higher in private sector employment than in public sector employment; higher in developing countries than for developed countries and that primary education attracted the highest private and social returns on education worldwide. However, at higher education, private returns were much higher than social rates of return. These findings have remained the main justification for increased public spending on primary education and advocating for cost-sharing at higher education in most developing economies, especially in Africa, over time.

However, evidence has been mounting in recent studies using datasets from Africa that education earnings profile is convex (e.g. Appleton, Bigsten and Manda, 1999; Bigsten et al, 1998; Appleton and Balihuta, 1996; and Mwabu and Shultz, 2000; Soderbom et al, 2005; Wambugu, 2002a). However, such a pattern could exacerbate inequalities. As Holm-Nielsen and Thom (2004) argue, higher private returns on tertiary education are a major source of income and education inequalities in Latin America and the Caribbean when low income groups are not well represented at higher education level. Perhaps this is because in most cases majority of students enrolled at tertiary education are from the middle to high income groups (Deer, 2008). The inequalities in access to schooling translate into higher returns on education investment for the non-poor households.

Returns to education have been observed to vary across employment sectors. Wambugu (2002c) found that returns to university education were high in Kenya’s formal sector while returns to primary education were high in the informal sector. In contrast, Kuepie et al, (2006) found that higher education positively influences earnings in the informal sector in West Africa.

Some studies also focus on gender earning differentials. Some found that female workers earn less than their male counterparts in the public and private formal sectors. In addition education is a key factor in wage determination for both men and women in Kenya and the effect is stronger for men (Mathu, 2009; Kabubo-Mariara, 2003; Wamuthenya, 2010 and Macharia, 2009). In Uganda, education increases chances of women participation in paid employment (Nakiryowa, 2008).

However, in estimating returns to education, education may be endogenous in the sense that it might be correlated to the residual of the (structural) earnings function. Ashenfelter and Zimmerman (1997), Wooldridge (2002) and Wambugu (2002b) used parental education as an instrument to address potential endogeneity of individual's education. However, treating endogeneity of education with Instrumental Variables (IV) may lead to a downward estimation of the returns to education (Ashenfelter and Krueger, 1994). Wambugu (2002b) analyzed a sample of manufacturing sector workers in Kenya, and found this instrumental variable to be inappropriate. Distance to the nearest education facility was found to be a good instrumental variable for education.

In addition to influencing earnings, education plays an important role in individual's access to employment. Wamuthenya (2010) and Nyaga (2010) use the 1998/9 Labour Force Survey in Kenya to estimate multinomial logit employment sector model. The results show that schooling increases the probability of working in the formal sector. Attainment of primary education increase probability of working in the informal sector while secondary and university education reduces the probability of working in the informal sector. However the studies did not capture the effects of training. Kabubo-Mariara (2003) analyzed the 1994 WMS data. She found that education and demographic factors such as age play an important role in determining employment sector participation. Similarly, Wambugu (2002c) estimated a multinomial logit employment sector model that included the informal and agriculture sectors using the WMS 1994. He found that education is crucial to accessing wage employment in Kenya.

Most previous work focuses on returns to formal education in Kenya. A few studies include training in earnings equation. Neizert (1996) estimated returns to training in small scale enterprises (*Jua Kali* or literary interpreted as “hot sun”) in Nairobi using a small scale survey conducted in 1990. She found that informal training had positive earnings. The study did not estimate returns to formal technical training. Appleton, Bigsten and Manda (1999) used 1977 and 1986 labour force surveys and include job training in the earnings equation. Wambugu (2002c) includes post-secondary training in earnings function for informal sector, public sector and private sector using 1994 Welfare Monitoring Survey for Kenya. However, these studies overlooked internal and external effects of education on individual earnings.

Differences in education endowments at regional level can have strong effects on individual earnings. Muravyev (2008) used micro-level approach by augmenting the Mincerian wage equation with the average level of education of cities in Russia. A one (1) percent increase in proportion of urban population with a university degree contributes to a one percent increase in individual earnings for the city population.

Rodriguez-Pose and Vassilis (2012) found that regional level educational endowments generate positive and significant benefits for individual workers in Europe. The education externalities were captured through educational attainment of the other members of the household in which the target individual lives; education attainment at the regional level and educational attainment of the neighboring regions.

However, studies using Kenya data tend to overlook the potential implications of geographic factors and regional interactions on individual earnings. Kimenyi et al., 2006 measured educational externalities using district level education attainment but they did not capture within household social externalities.

Given that there is more current data now and returns to technical training were not captured in some of the previous studies this current study provides new estimates of private returns to education. It also estimates the factors influencing employment sector participation using the multinomial probit model to address the problem of independence of irrelevant alternatives in multinomial logit model employed by previous studies. This current study also extends the Mincerian wage equation to test for education externalities of household-level education attainment and county-level educational attainment in enhancing individual earnings.

4.3 METHODOLOGICAL APPROACH

4.3.1 Modeling employment sector choices

The working age population (15-64 years) consists of the unemployed, the employed and the inactive labour force. However it is assumed that earnings accrue to the employed persons in the labour force. Thus let S_j be the different employment sectors (j=1…4): S_1 = agriculture, S_2 = informal private sector, S_3 = formal public sector, S_4 = formal private sector. S_j can be viewed as a "response function" to a set of latent variables S_i which measures the propensities to enter sector S_j.

For each individual assume the propensity to enter sector S_j is linearly linked to the individual's characteristics (Kuepie *et al*, 2006). Hence:

$S_{ij} = \beta'_j X_i + \varepsilon_{ij}$ *E1*

On the other hand, the propensity to enter sector *k* is:

$S_{ik} = \beta'_k X_i + \varepsilon_{ik}$ ……………………………….*E2*

Where β_j is vector of parameters to be estimated; X_i is vector of explanatory variables mainly individual and household characteristics including education and training attainment. ε_{ij} and ε_{ik} are stochastic terms which are normally distributed with mean zero and positive variance. Thus the probability of individual *i* participating in sector S_j is equal to the probability that the propensity to enter sector S_j for the individual in question is greater than the propensity to enter other sectors, S_k and $j \neq k$. The probability model can be expressed as:

$Pr\ (S_{ij} > S_{ik})$ for $j \neq k$; k= 1,2,3,4 ………..E3

Sector participation model depends on the assumption adopted as regards the distribution of error terms. If we assume that the errors are independent from irrelevant alternatives (iia)[4] (Kuepie *et al*, 2006), then the difference between the errors follows a logistic distribution and the probability of individual *i* choosing sector S_j is expressed as follows:

[4] Independence of irrelevant alternatives (iia) property is a desirable condition imposed on axiomatic choice behavior (Arrow, 1951; and Dow and Endersby, 2004). The property holds that when comparing two alternatives in a preference relationship, the ordinal ranking of these alternatives should not be affected by addition or subtraction of other alternatives from the set of choices. Thus the odds ratio of choosing

$$Pr\ (S_{ij} = S_j) = \exp(\beta_j X_i) / \sum_{k=1}^{4} \exp(\beta_k X_i) \text{ for } j \neq k;\ k = 1,2,3,4 \qquad \text{………..E4}$$

We estimate the multinomial probit model (MNP) since the logit model may not address substitution patterns across the employment choices (Dow and Endersby, 2004) and imposes the independence of irrelevant alternatives (*iia*) property on the employment choice model. However, the main challenge associated with MNP is that the likelihoods may fail to converge due to under-identification in small samples. In this study, the model converged within a reasonable number of iterations. The likelihood ratio for the estimated error covariance was reported.

4.3.2 Earnings and returns to education

The earnings equation for each sector can be specified as:

$$Y_{ij} = \alpha Z_i + n_{ij} \qquad \text{………..E5}$$

Where Y_{ij} represents earnings for individual *i* working in sector j where j =1 for agriculture sector, j=2 for informal private sector, and j=3 for public sector and j=4 for formal private sector. α is vector of parameters to be estimated; Z_i is the vector of observed individual characteristics including education and training; and n_{ij} is the error term which is normally distributed with mean zero ($n_{ij} \sim (0, \sigma^2)$) and constant variance.

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between any two alternatives is independent of the addition or subtraction of other alternatives from the selection list and by extension the ratio of choice probabilities for any two alternatives does not depend on any of the other alternatives (Dow and Endersby, 2004).

Since the aim is to estimate the coefficients α for each sector, Y_{ij} is only observed if sector j is chosen. However, OLS estimators may suffer from selection bias (Wooldridge, 2002). Selection bias occurs if employees who do not participate in a given employment sector (such as public formal employment) are systematically different from those who do participate in the given employment sector. To correct for the selection bias, the two stage procedure model as proposed by Heckman (1979) was used.

Another potential problem in estimating returns to education using OLS is that education is potentially endogenous as it might be correlated to the error term of earnings function. Endogeneity is attributable to the unobserved individual heterogeneous characteristics. Such heterogeneity such as unobserved ability could be a positive correlate of both education and earnings leading to overstated returns to schooling. To address the problem, one can use Instrumental Variables (IV) (Wooldridge, 2002). The instrumental variable should be uncorrelated with the error term; that is, a variable that does not have direct influence on individuals' earnings; but is strongly correlated with the individual's education (endogeneous variable). For instance, Ashenfelter and Zimmerman (1997) used parental education as an instrument. However, treating endogeneity of education with Instrumental Variables (IV) may lead to downward estimations of the returns to education (Ashenfelter and Krueger, 1994). Omitted ability effects and attenuation biases play different roles and may result into having returns to education either overestimated or underestimated depending on the relative magnitude of the biases. For instance, the OLS estimates would be biased downwards if the selectivity bias is sufficiently strong (Soderbom *et al*, 2005) leading to large measurement errors. On the other hand, returns to education can be overestimated if bias in the OLS estimates from omitted heterogeneity effects is relatively small. Consequently, the two step control function approach (Garen, 1984 and Kuepie, 2006) was applied in testing and controlling for endogeneity and unobserved heterogeneity in the earning estimations.

First, the reduced form equation for the endogeneous variable is estimated and the residuals based on this estimation are computed. In the second step, residuals from the endogeneous variable equation enter the earnings equation as an additional regressor to control for unobserved heterogeneity. The significance of the residual term is used to determine the presence or absence of endogeneity in the estimation.

4.3.3 Measuring individual, internal and external effects of schooling

The internal and external effects of education on individual earnings (measure of economic well-being) in Kenya were estimated. Like Weir and Knight (2000, 2007), the study used individual and household-level data to estimate an equation with household-level and county-level aggregate education levels of the form:

$$\ln Y_i = \alpha_o + \sum \alpha_j X_i + \beta S_i + ED_v + \mu_i \qquad \text{..........E6}$$

Where Y_i is individual *i* earnings; X_i is individual characteristics including years of schooling, years of working experience, age and location; S_i is average years of schooling for household *i*; ED_v is average years of schooling for county v and μ_i is a stochastic error term. The coefficient for average years of schooling at county level is interpreted as the average increase in individual income for each additional year of average schooling in the county. Internal effects were captured through coefficient of average years of schooling at household level. The coefficient for average years of schooling at household level is interpreted as the increase in individual earnings for each additional year of average schooling in the household.

4.4 ESTIMATION RESULTS AND DISCUSSIONS

4.4.1 The data

Analysis in this essay is based on Kenya Integrated Household Budget Survey (KIHBS) 2005/6 dataset. During the survey, detailed data and information was collected on employment status, earnings, individual and household characteristics. This made it ideal for this type of analysis. Regional level variables were calculated as the sample means for the specific variables at county level. The sample consisted of adults aged 15-64 years who were working.

Table 4-1: Summary statistics

Variable name	Mean	Standard Deviation	Observations (Individuals)
Individual characteristics			
Primary Education dummy	0.525	0.499	15,456
Secondary Education dummy	0.207	0.405	15,456
University Education dummy	0.013	0.112	15,456
Technical Training dummy	0.251	0.434	15,448
Years of Education	8.557	3.229	15,345
Gender (Male=1)	0.55	0.50	18,464
Work Experience	9.90	3.31	18,423
Age (Years)	35.144	12.060	18,464

Variable name	Mean	Standard Deviation	Observations (Individuals)
Household characteristics			
Primary education years	6.292	1.930	8,111
Secondary education years	11.413	1.037	3,202
Technical education years	10.997	2.692	3,227
University education years	16.551	1.169	198
Household Size	5.904	2.986	18,464
Monthly Income (Individual)	10,748.20	35,587.93	10,423
Monthly Income (Household average)	9,865.44	30,524.89	12,190
Monthly Income (County average)	9,104.06	8,464.03	18,464
Location (Rural=1)	0.681	0.466	18,464
Employment sector participation			
Agriculture sector dummy	0.435	0.496	18,464
Informal sector dummy	0.183	0.387	18,464
Formal public sector dummy	0.073	0.260	18,464
Formal private sector dummy	0.066	0.248	18,464
Individual earnings by sector (Ksh.)			
Overall monthly income	10,748	35,588	10,423
Agriculture	3,032	8,517	1,517
Informal	6,293	24,591	5,580
Public	22,135	34,400	1,298
Private	24,993	60,140	1,172

Source: Author's computations based on KIHBS 2005/6

The average years of schooling in Kenya was 8.6 years which means that most Kenyan adults have an equivalent of primary education, and some limited post primary education years of schooling. The majority of Kenyans aged between 15 and 64 years had attained primary education (53 percent) followed with technical education (25 percent), secondary education (21 percent) and university education (1 percent).

There were however variations in average years of schooling across education levels. Adults with primary education had an average of 6.3 years of primary education; those with secondary education had attained an average of 11.4 years of schooling; while the average years of those with technical education and university education was 10.9 and 16.5 years, respectively. The average individual monthly income for sample adults was Ksh. 10,748; Average income at household and county level was Ksh. 9,865 and Ksh. 9,104 respectively.

4.4.2 Wages and education attainment in Kenya

Data presented in Table 4-2 shows the distribution of the active population to different economic activities grouped by gender, location, region and education attainment. More women than men are engaged in agriculture and informal sector activities; while more men are represented in the formal public and private sectors. About 56 percent and 52 percent of female workers are in the agriculture sector and informal sector respectively. On the other hand men constitute 67 percent and 73 percent of those working in the formal public and private sectors.

Table 4-2: Employment by gender, location and education attainment (%), 2005/6

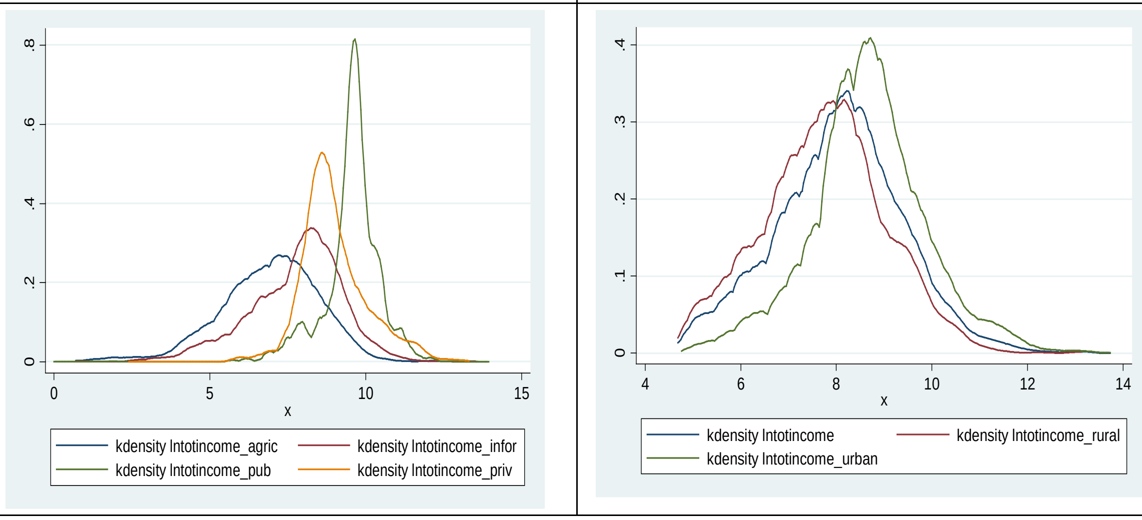
	Agriculture	Informal	Formal Public	Formal Private	Total
Gender					
Female	56.11	51.75	32.99	26.57	50.41
Male	43.89	48.25	67.01	73.43	49.59
Location					
Urban	1.76	36.54	41.22	55.18	17.64
Rural	98.24	63.46	58.78	44.82	82.36
Region					
Nairobi	0.01	14.54	9.07	35.03	7.36
Central	19.88	9.95	10.98	12.94	16.37
Coast	5.26	11.84	11.7	11.37	7.78
Eastern	21.11	13.69	12.15	5.87	17.29
North Eastern	0.77	1.46	1.4	0.09	0.89
Nyanza	16.47	15.65	16.47	6.08	15.24
Rift Valley	24.22	21.77	30.74	24.81	24.26
Western	12.29	11.11	7.51	3.8	10.81
Education					
No education	0.03	0.13	0.00	0.00	0.04
Primary education	65.86	52.42	11.71	29.00	54.13
Secondary education	22.64	27.89	13.85	25.94	23.38
Technical education	11.40	19.19	71.37	42.03	21.70
University education	0.08	0.36	3.07	3.03	0.73
Observations	6,222	2,269	910	1,212	10,613

Source: Author's computation using KIHBS 2005/6

A preliminary comparison of labour allocation across employment sector by education attainment, points towards a positive relationship between education attainment and wage employment. The likelihood of employment in the formal (public and private) sectors increases with the level of education attained. Majority of the workers in agriculture and informal sectors had some primary and complete primary education. Further, there are considerable differences in employment distribution between rural and urban areas.

Figure 4-1: Distribution of (log) monthly income by sector and location, 2005/6

Distribution of (log) monthly income by sector	Distribution of (log) monthly income by location



Data Source: KIHBS 2005/6; lntotincome represents total earnings/income; agric, infor, pub and priv represents agriculture, informal, formal public and formal private employment sectors.

Wage differentials are also observed with formal public sector workers receiving the highest income followed with private formal sector. Workers in the informal and agriculture sectors have the lowest levels of income with earnings skewed to the left (see Figure 4-1a). Individuals working in rural areas earn lower earnings relative to their counterparts in urban areas and the density is skewed to the left (see Figure 4-1b). However, the understanding of factors contributing to the nature of labour allocation across employment sectors and returns to schooling is an empirical issue, and is addressed in the next sections of this essay.

4.4.3 Labour allocation across employment sectors

A multinomial probit model was estimated to examine labour allocation across sectors and the associated factors (see equation E4). The dependent variable or outcome measure is a multiple variable consisting of employment sectors (S_j) where employment in: agriculture sector=1, informal sector =2, formal public sector =3 and formal private sector=4. The objective was to determine the effect of education and training on access to these employment sectors, while controlling for other factors that influence access to a given employment sector. The outcome variable, employment sector, was treated as an unordered categorical variable. It is assumed that the variable does not have a natural ordering[5]. The base or reference employment sector was the agriculture sector. Table 4-3 presents the multinomial probit model estimation results.

Table 4-3: Multinomial probit model estimates by sector of employment

Variable name	Informal	Formal Public	Formal Private
Secondary education dummy	0.0975*	0.750***	0.477***
	[0.0519]	[0.0794]	[0.0676]
University education dummy	0.647*	3.294***	2.484***
	[0.352]	[0.332]	[0.333]
Technical training dummy	0.240***	1.963***	1.054***
	[0.0535]	[0.0689]	[0.0649]
Gender (male=1)	-0.0833*	0.291***	0.454***
	[0.0473]	[0.0678]	[0.0628]
Experience	-0.203***	0.260***	-0.0746*
	[0.0338]	[0.0530]	[0.0435]
Experience squared	0.0147***	-0.0165***	0.004
	[0.00224]	[0.00333]	[0.00289]
Household head	0.558***	0.511***	0.715***
	[0.0522]	[0.0725]	[0.0680]
Rural urban dummy (rural=1)	-1.996***	-1.986***	-1.849***
	[0.0502]	[0.0625]	[0.0615]

[5] The assumption of non natural ordering of employment sectors is critical since employment status is not ordinal and does not have any natural ordering (that is does not follow either ascending or descending order) and the distance between the employment sectors responses is unknown (Wooldridge, 2002).

Variable name	Informal	Formal Public	Formal Private
Age	0.0611***	0.319***	0.0848***
	[0.0118]	[0.0209]	[0.0168]
Age squared	-0.00101***	-0.00380***	-0.00141***
	[0.000153]	[0.000259]	[0.000218]
Central	-2.436***	-1.865***	-3.009***
	[0.459]	[0.466]	[0.461]
Coast	-1.414***	-0.882*	-2.165***
	[0.463]	[0.471]	[0.465]
Eastern	-2.192***	-1.686***	-3.354***
	[0.459]	[0.466]	[0.462]
North Eastern	-0.916	0.71	-2.758***
	[0.604]	[0.612]	[0.690]
Nyanza	-1.975***	-1.554***	-3.426***
	[0.458]	[0.465]	[0.461]
Rift Valley	-2.146***	-1.241***	-2.919***
	[0.458]	[0.464]	[0.460]
Western	-2.209***	-1.962***	-3.551***
	[0.459]	[0.468]	[0.463]
Constant	2.249***	-6.691***	1.232**
	[0.506]	[0.626]	[0.549]
Observations	11,504	11,504	11,504
Log likelihood	-9494.65		
Wald χ^2 (51)	4594.06***		

Robust standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1; Base: Agriculture sector

Persons with secondary and university education are more likely than persons with primary education to be engaged in the formal public and private sectors relative to agriculture. Technical training increases probability of employment in the informal, public and formal private sectors relative to agriculture sector. Males have higher probability of being employed in the formal public and private sectors than their female counterparts. The results corroborate those of Nyaga (2010) who found that education is a key determinant of participation in formal sector employment; and that higher education increases the likelihood of working in the formal public and private sectors.

Being a male reduces the probability of being engaged in the informal sector. Residing in rural areas is associated with lower probability of employment in informal and formal (public and private) sectors. The finding is consistent with the regional dummies, where residing in all the other provinces reduces the probability of engaging in informal sector and formal employment; relative to Nairobi. The finding was expected given that agriculture is the predominant economic activity in rural Kenya. Work experience increases the probability of participating in the formal public sector but at a decreasing rate. However work experience is negatively associated with probability of working in the informal sector. Age is positively associated with employment in the informal and formal sectors but at a decreasing rate.

4.4.4 Returns to education and training

The returns to education were estimated using a Mincerian semi-log wage equation (Equation E5) for agriculture, informal, formal public and formal private employment sectors. First, four separate earnings regressions for the respective employment sectors and the total earnings equation were estimated by OLS. Then the two-step Heckman model was used to examine potential selection bias. Statistical issues including endogeneity and heterogeneity were controlled for.

4.4.4.1 Testing and correcting for endogeneity

The control function approach was utilised in testing and controlling for endogeneity of education in the earnings equation. In this method, household head's level of schooling and primary school proximity at the time when an individual was attending school are potential instruments (Lemke and Rischall, 2003). It is also important to note that whereas various studies have used parental education and schooling proximity as instruments, school proximity is more preferred to parental education (Lemke and Rischall, 2003). This is mainly because parental education might be correlated with child's wage level.

First, female household head's education attainment, male household head's level of education attainment, primary school proximity and secondary school density (proxy for school proximity) were included as regressors in the reduced form equations of individual's level of schooling (potential endogeneous variable). In this case separate reduced form equations were estimated for primary, secondary, technical and university education under the various employment sectors. The residuals, λ_i based on the estimations were computed. In the second step, the individual earning function for the various employment sectors was estimated with the respective residuals included among the regressors to control for unobserved heterogeneity.

For all sectors, the coefficients for residuals of years of education attainment by levels were individually insignificant. The F test was also used to test for joint significance of the residual terms. The null hypothesis that years of schooling for the various levels of education are exogenous was tested against the alternative hypothesis that years of schooling for the various levels of education are endogeneous. The F-test statistic was $F(4,9911)=24.43$ with $prob>F=0.000$ for the overall income equation; $F(4,1226)=24.43$

with prob>F=0.000 for the agricultural sector equation; F(4,4847)=7.12 with prob>F=0.000 for the informal sector equation; F(4,1201)=11.14 with prob>F=0.000 for the public sector equation and F(4,1086)=6.26 with prob>F=0.000 for the private sector equation. Thus the null hypothesis that years of education for the various education levels are exogenous may not be rejected. Therefore, endogeneity of education does not seem to be a major problem in the earnings models.

4.4.4.2 OLS estimation results

The earnings determinants of workers in various sectors are examined based on Equation E5. First, an OLS model was estimated; followed by the Heckman's two step model to correct for the selection bias. A common statistical issue in OLS estimates using cross sectional data is heteroscedasticity. Under OLS, estimates are consistent in the presence of heteroscedasticity but the conventional computed standard errors are not valid. Consequently, White's test (see Wooldridge, 2002) was used to check for the problem in all earnings equations. The White's test statistics and p-values are as follows: Total income (χ^2_{131} = 443, p-value = 0.00); agriculture sector (χ^2_{99} = 160, p-value = 0.00; informal sector (χ^2_{128} = 371, p-value = 0.00); public sector (χ^2_{131} = 241, p-value = 0.00) and formal private sector (χ^2_{122} = 182; p-value = 0.00). Since the p-value is less than level of significance (α =0.01, 0.05, 0.10) in each sector, the null hypothesis of homoskedasticity is rejected. To solve the problem of heteroscedasticity, an OLS model with robust standard errors was estimated for each sector (see Table 4-4).

Table 4-4: Earnings Equation Estimates (OLS) by employment sector

Variable	Log total income	Log income agriculture sector	Log income informal sector	Log income formal public sector	Log income formal private sector
Primary education (years)	0.0481***	0.0424***	0.0266***	0.0924***	0.0671***
	[0.0057]	[0.0156]	[0.0068]	[0.0185]	[0.0156]
Secondary education (years)	0.0664***	0.0362***	0.0431***	0.0914***	0.0756***
	[0.0039]	[0.0114]	[0.0050]	[0.0106]	[0.0098]
Technical training (years)	0.123***	0.0674***	0.0628***	0.118***	0.125***
	[0.0037]	[0.0141]	[0.0055]	[0.0096]	[0.0095]
University education (years)	0.149***	0.0899***	0.0784***	0.132***	0.153***
	[0.0059]	[0.0097]	[0.0300]	[0.0097]	[0.0096]
Age (years)	0.0417***	-0.00167	0.0241***	0.107***	0.0495***
	[0.0067]	[0.0180]	[0.0086]	[0.0193]	[0.0170]
Age squared	-0.00038***	0.00004	-0.00026**	-0.0011***	-0.00027
	[0.00009]	[0.0002]	[0.00012]	[0.0002]	[0.00023]
Gender (male=1)	0.391***	0.196***	0.367***	0.145***	0.131**
	[0.0226]	[0.0697]	[0.0301]	[0.0370]	[0.0553]
Rural urban dummy (rural=1)	-0.466***	-0.360***	-0.360***	-0.154***	-0.268***
	[0.0238]	[0.113]	[0.0314]	[0.0368]	[0.0589]
Experience	0.0630***	0.0029	0.0372*	0.128***	0.0707
	[0.0164]	[0.0574]	[0.0204]	[0.0431]	[0.0432]
Experience squared	-0.00221**	-0.00005	-0.0003	-0.0067***	-0.0024
	[0.0011]	[0.0037]	[0.0014]	[0.0025]	[0.0029]
Central	-0.432***	-2.492***	-0.288***	-0.461***	-0.497***
	[0.0495]	[0.2200]	[0.0677]	[0.111]	[0.0848]
Coast	-0.253***	-2.474***	-0.0554	-0.362***	-0.509***
	[0.0509]	[0.2660]	[0.0703]	[0.111]	[0.0885]
Eastern	-0.707***	-3.133***	-0.511***	-0.453***	-0.582***
	[0.0500]	[0.2220]	[0.0689]	[0.107]	[0.0973]
North Eastern	-0.139	0.0001	-0.333	-0.427***	-0.121
	[0.1320]	[0.0030]	[0.279]	[0.142]	[0.0910]
Nyanza	-0.718***	-2.876***	-0.551***	-0.567***	-0.806***
	[0.0493]	[0.2160]	[0.0704]	[0.101]	[0.107]
Rift Valley	-0.564***	-2.612***	-0.546***	-0.534***	-0.594***
	[0.0466]	[0.2140]	[0.0653]	[0.102]	[0.0887]
Western	-1.039***	-3.391***	-0.879***	-0.693***	-0.665***
	[0.0542]	[0.2290]	[0.0733]	[0.107]	[0.118]
Constant	6.798***	9.940***	7.276***	5.785***	6.733***
	[0.1280]	[0.3660]	[0.162]	[0.387]	[0.328]
Observations	9,925	1,240	4,861	1,215	1,100
R-squared	0.385	0.103	0.2	0.414	0.562

Robust standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1

Source: Author's computations using KIHBS 2005/6 data set

However, if those who enter formal employment for instance are systematically different from those who participate in the informal sector, there is potential sample selection bias. Conversely, if those who enter agricultural employment are systematically different from those who do participate in the formal sector for instance, there is potential sample selection bias.

We use Heckman's two-step procedure (Heckman, 1979) to collect for the potential selection bias. Results are presented in Table 4-5. First, the results based on the first step selection equation are reported for each employment sector; followed with the outcome (earnings) results in the second column. Sector's outcome variable equals 1 for the selected sector, otherwise 0.

There is weak evidence of selection bias into the agriculture sector (as opposed to informal, public, and formal private sectors). The estimated coefficient of inverse Mills ratio in the agricultural sector earnings equation is statistically significant at 10 percent. This indicates that earnings of workers with average characteristics in the agriculture sector are statistically different from earnings for workers randomly selected into the sector. The selection bias may occur if those engaged in the agricultural sector have some unobserved characteristics that attract them to work in the sector.

Thus estimating a log earnings equation for employment in agriculture sector would yield biased estimates. The coefficient of inverse Mills ratio in the log earnings equation for informal, public and formal private employment equations is not statistically different from zero suggesting absence of selection bias. The selection bias corrected estimates provided more robust results of the earnings function for the agriculture sector. The coefficients for various education levels estimated from equation E5 represent the rates of return to an additional year of education for the given level of education. Results on the returns to education are presented in Table 4-5 and Figure 4-2.

Table 4-5: Estimated rates of returns to education and training by sector using Heckman two step procedure

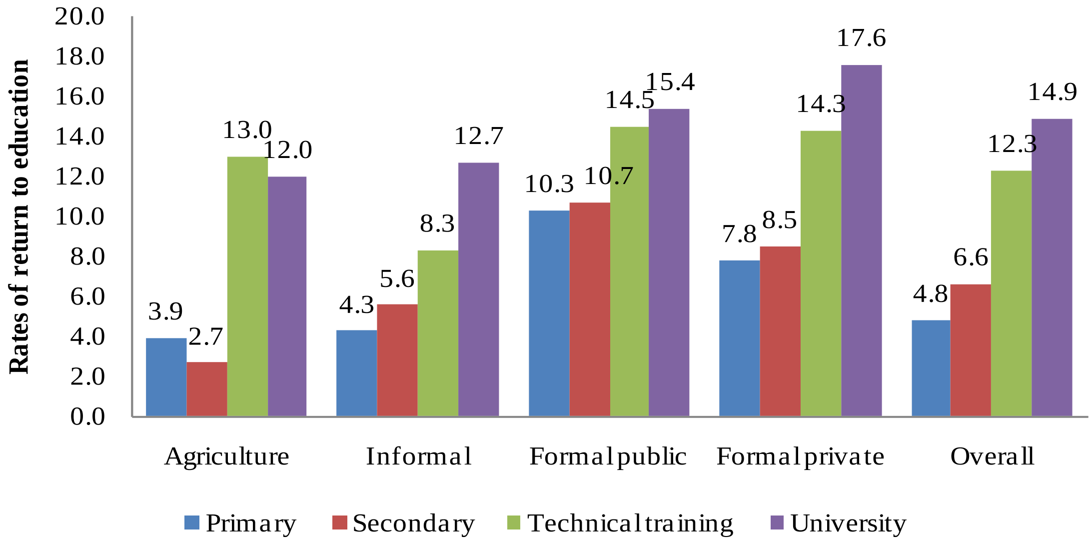
	Selection Agriculture	Earnings Agriculture	Selection Informal	Earnings Informal	Selection public	Earnings public	Selection private	Earnings private
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Primary education (years)	0.00707	0.0393*	-0.0181***	0.0426*	0.0349***	0.103***	0.0169*	0.0776***
	[0.00833]	[0.0220]	[0.00669]	[0.0247]	[0.0126]	[0.0159]	[0.00950]	[0.0156]
Secondary education (years)	0.00902	0.0267*	-0.0113**	0.0556***	0.0708***	0.107***	0.0371***	0.0854***
	[0.00567]	[0.0265]	[0.00446]	[0.0158]	[0.00756]	[0.0182]	[0.00598]	[0.0108]
Technical training (years)	-0.0320***	0.130***	-0.0446***	0.0832*	0.140***	0.145***	0.0582***	0.143***
	[0.00630]	[0.0342]	[0.00470]	[0.0494]	[0.00692]	[0.0334]	[0.00570]	[0.0118]
University education (years)	-0.0496**	0.182**	-0.0649***	0.127*	0.106***	0.154***	0.0661***	0.176***
	[0.0211]	[0.0878]	[0.00990]	[0.0761]	[0.00748]	[0.0258]	[0.00690]	[0.0126]
Age (years)	-0.0288***	0.0335	0.0687***	-0.0117	0.210***	0.143**	0.0655***	0.0609***
	[0.00929]	[0.0312]	[0.00817]	[0.0735]	[0.0151]	[0.0603]	[0.0110]	[0.0196]
Age squared	0.000490***	-0.00057	-0.000868***	0.000211	-0.00233***	-0.00153**	-0.000915***	-0.00041
	[0.000122]	[0.000482]	[0.000108]	[0.000933]	[0.000186]	[0.000683]	[0.000146]	[0.000262]
Gender (male=1)	-0.220***	0.509**	-0.0762***	0.362***	0.224***	0.174***	0.351***	0.156**
	[0.0339]	[0.213]	[0.0273]	[0.0973]	[0.0380]	[0.0651]	[0.0350]	[0.0781]
Rural Urban (rural=1)	1.022***	-1.980**	-0.667***	0.137	-0.301***	-0.241***	-0.337***	-0.506***
	[0.0442]	[0.958]	[0.0290]	[0.741]	[0.0385]	[0.0736]	[0.0352]	[0.0805]
Experience	0.0159	-0.00999	-0.0895***	0.152	0.238***	0.162**	-0.0430*	0.0485
	[0.0254]	[0.0700]	[0.0222]	[0.114]	[0.0368]	[0.0772]	[0.0260]	[0.0442]
Experience squared	0.000513	-0.00103	0.00880***	-0.00752	-0.0136***	-0.00817*	0.00359**	-0.00069
	[0.00169]	[0.00456]	[0.00148]	[0.0104]	[0.00227]	[0.00443]	[0.00174]	[0.00300]
Number of children aged 0 to 5 years							-0.0902***	
							[0.0210]	
Number of children aged 6 to 13 years	0.0389***		-0.0225*		0.0508***		-0.0959***	
	[0.0134]		[0.0116]		[0.0150]		[0.0161]	

	Selection Agriculture	Earnings Agriculture	Selection Informal	Earnings Informal	Selection public	Earnings public	Selection private	Earnings private
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Number of children aged 14 to 17 years							-0.160***	
							[0.0256]	
Inverse Mills ratio	-1.881*		-0.784		0.234		0.174	
	[1.095]		[1.352]		[0.317]		[0.168]	
Constant	-1.753***	11.09***	-1.870***	7.952***	-7.663***	3.745	-2.718***	5.709***
	[0.181]	[2.449]	[0.157]	[3.000]	[0.321]	[2.281]	[0.208]	[0.589]
Observations	12,184	12,184	16,257	16,257	17,130	17,130	17,125	17,125

Robust Standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1
Source: Author’s computations using KIHBS 2005/6 data set

The OLS estimates underestimate returns for schooling in agricultural sector when compared with the bias corrected estimates perhaps due to the omitted effects and attenuation biases. Thus the OLS estimates would be biased downwards meaning selectivity bias is sufficiently strong leading to the observed measurement errors. We interpret estimates from the selection bias corrected models.

Figure 4-2: Mincerian rate of return to education and training in Kenya, by sector



Source: Estimates from 2005/6 KIHBS data

Results in Figure 4-2 indicate that the rate of return to education increase with level of education. The returns for technical education are higher than for university education in the agriculture sector. Technical education rates of return are highest in the formal public sector followed with the formal private sector. University education rates of return are highest in the formal private sector followed with the formal public sector. Level of returns to technical training and university education can be associated with the role higher education and training play in skills development. The findings corroborate those of Wamuthenya (2010) and Nyaga (2010) who also found that education increases earnings for workers in the formal public and private sectors.

Results on the control variables, notably location and gender indicate that men, and more particularly those working in the formal public and private sectors earn significantly more than women working in the respective sectors. This is perhaps because men are able to dedicate more time to work and hence positive impact on their earnings. However, earnings for men working in the informal and agriculture sector private sectors are less than their female counterparts, and the effects are statistically significant. However, the estimated coefficients of education and training variables are small in agriculture and informal sector employment than in formal public and private sectors of employment. Individual's labour income increases with age and experience but at a decreasing rate. Workers in urban areas earn more than their counterparts in rural areas for all sectors.

4.4.5 Comparing individual, internal and external effects of education

Returns estimated in the previous sections do not capture internal (within household benefits) and external benefits of schooling; or what has been referred to as social benefits of schooling in the literature (Psacharopoulos, 2004). These benefits are also referred to as spillover effects or externalities. They accrue to other members of society, either within the household or within the community.

4.4.5.1 Descriptive statistics

The summary statistics of variables used in this section are presented (see Table 4-6). The average monthly earning was Ksh. 10,221 with a standard deviation of Ksh. 36,057. Average years of schooling at county and household level; and individual years of schooling were estimated at 8.481 years, 8.331 years and 8.105 years; respectively. Average level of technical education attainment was estimated at 1.587 years with a standard deviation of 3.98 years. Mean age and experience for the study sample was 34 years and 15 years, respectively.

Table 4-6: Summary statistics

	Observations	Mean	Standard Deviation	Minimum	Maximum
Total monthly earnings (Ksh.)	12460	10,221	36,057	108	91,667
Log of total earnings	12460	8.105	1.404	4.685	13.729
Individual years of education	21479	8.469	3.188	0.000	18.000
Average education years at household level	24745	8.331	2.748	0.000	18.000
Average education years at county level	28017	8.381	0.932	6.524	11.069
Years of technical training	28017	1.587	3.985	0.000	18.000
Rural urban dummy	28017	0.666	0.472	0.000	1.000
Age (Years)	28017	33.689	12.424	15.000	64.000
Age squared	28017	1289	941	225	4096
Gender	28017	0.473	0.499	0.000	1.000
Experience (Years)	20537	15.332	11.493	0.000	69.000
Experience squared	20537	367	486	0	4761

Source: Estimates from 2005/6 KIHBS data

An individual-level earnings equation is estimated with log of individual earnings as dependent variable. In addition to individual's years of schooling, locality, gender, age and experience, the equation includes average years of schooling at county level and average years of schooling at household level.

4.4.5.2 Endogeneity, relevance and validity of instrumental variable

The average years of education at county level is potentially endogenous in the individual earnings function. This is because it may correlate with other unobserved county level variables (Weir and Knight, 2000) and the coefficient might include the effects of both average level of schooling in the county and other county level fixed effects on economic wellbeing not caused by schooling. Another source of endogeneity is that although education attainment is a predetermined variable, investment in education made a number of years ago may be correlated with unobserved variables which affect current level of socio-economic wellbeing.

To address the endogeneity problem, three options exist. We could control for several county level variables by including them in the regression. Second, we could include a measure of education at neighbourhood level, that is, group of households within each county and control for other county level fixed effects by including the county dummy variables in the regression. Third, county level education variable can be instrumented with availability of schools on the responsiveness of household investment in schooling (Lemke and Rischall, 2003). The third option is explored, whereby we instrument county level education variable with primary school density at county level which is a proxy for previous government investment across counties.

For an IV to be valid, it must fulfill three conditions. First, its effect on a potentially endogeneous variable should be statistically significant. Second, the instrumental variable's size of its effect should be large (F>10) and finally, the instrumental variable should be exogeneous, that is uncorrelated with the error term of the structural equation (Bound et al., 1995). The validity of instrument can be tested by regressing the instrumental variable on average county level education years. The partial R^2 tests the strength of the instrument while F statistic tests the statistical significance of the Shear R^2 (Shea, 1997).

An instrumental variable 2SLS model was estimated using school density as an instrument. Durbin-Wu-Hausman test was carried out to establish exogeneity of county level education variables. The test statistic was 0.963 with *p*-value=0.326. Thus the null hypothesis that average county level years of education are exogenous may not be rejected. As a result, it can be concluded that county level education was not endogenous. Therefore, OLS estimates of the earning function are reported.

4.4.5.3 Externalities of education

OLS estimates are presented in column 2 in Table 4-7. Coefficients of average level of education at household and county levels are used to measure level of education externalities. Coefficient of years of schooling at individual level captures private benefits or individual returns of schooling. Coefficient of average education years at household level and county level capture the internal and external effects of schooling.

Table 4-7: Internal and external effects of education on individual earnings

Variables	Log of individual earnings
	OLS
Education years at individual level	0.0673***
	[0.00765]
Average education years at household level	0.0822***
	[0.00825]
Average education years at county level	0.127***
	[0.0127]
Technical Training	0.0466***
	[0.00263]
Rural urban dummy (1=rural)	-0.452***
	[0.0248]
Age	0.0279***
	[0.0105]
Age squared	-0.00022
	[0.000138]
Gender	0.405***
	[0.0235]
Experience	0.0233***
	[0.00590]
Experience squared	-0.000419***
	[0.000127]
Constant	4.765***
	[0.182]
Observations	10,138
R-squared	0.338

Standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1

The results show that living in a county where people are more educated has positive economic benefits for an individual. This is because external effects of schooling are higher than internal and individual effects of schooling. A one year increase in schooling among household members is associated with 8.2 percent increase in individual income compared to a 12.7 percent external effect, captured through an additional schooling year at county level. Individual effects of schooling are estimated at 6.7 percent.

These findings corroborate those of Weir (2000) who found that external effects of schooling in Ethiopia on agricultural productivity were more than the internal benefits captured through average level of primary and secondary education at the household and site levels. However, residing in rural areas reduces individual earnings by 57.1 percent[6] and the effect is statistically significant. Being male significantly increases individual earnings by 49.9 percent. A one year increase in technical training among individuals is associated with a 4.7 percent increase in individual income.

4.5 CONCLUSION AND POLICY IMPLICATIONS

4.5.1 Conclusion

External efficiency of education relates to the relevance of education to the socio-economic conditions of a country. External efficiency can be captured through the effects of schooling on household wellbeing (internal effects), external effects (accruals to the region such as community or district or county level) and the probability of graduates entering and productively participating in the labour market while improving their earnings. This essay utilized data from the most recent nationally representative household survey (KIHBS 2005/6) for Kenya to estimate the correlates of labour

[6] Since the dummy variables enter the semi-logarithmic equation in a dichotomous form, the effect measures the discontinuous effect of the variable on individual earnings (Harvorsen and Palmquist, 1980). The appropriate interpretation of the dummy variable coefficient is thus obtained through a direct transformation of the coefficient using the formulae, ($e^{\beta i} - 1$) where $e^{\beta i}$ is the exponential of the dummy variable coefficient.

allocation across employment sectors, associated rates of return and externalities of education. First, labour market participation by sector was estimated, followed with private returns to education. Internal and external effects of schooling were captured through the estimation of a coefficient of average years of schooling at household and county level, respectively, on individual earnings.

The estimation results indicate positive relationship between log total earnings and level of education attained. Earnings increase with level of education but vary across employment sectors. Education plays an important role in employment sector participation. Individuals with higher levels of education attainment tend to participate in non-agriculture (informal, public and private) employment sectors. Rate of returns for persons with secondary education, technical training, and university education are highest in the formal sectors. Social rate of return (that is internal and external effects of schooling) to education are higher than private (individual) rates of return to schooling.

4.5.2 Policy Implications

In terms of policy, it is important to increase access to schooling at all levels of education and across all counties for eligible individuals to benefit from the positive and substantial external effects of schooling. Counties with more educated persons and with higher education attainment stand to benefit in terms of improved economic well-being; macro and micro policy decisions and any future reforms in the education sector with regard to increasing access. Improving financing mechanisms for quality education should promote equitable investment and improved efficiency in education at all education levels and across counties; in order to ensure that counties with low schooling levels also benefit from public spending on education and training in the country. Investment in training is also critical given the associated private returns. The essay contributes to the literature in three ways. First, it extends the Mincerian earnings equation to provide empirical evidence on externalities of household-level and county-level education attainment. Second, it provides comparison of private, internal and external effects of education. Third, it provides a comprehensive update of returns to education and technical training using most current data.

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CHAPTER 5

5 CONCLUSIONS AND POLICY IMPLICATIONS

5.1 SUMMARY OF FINDINGS

This thesis had three main objectives. The first objective was to evaluate the distribution of public spending on education in Kenya using benefit incidence analysis while simultaneously analyzing the factors that influence demand for schooling. The study utilized the Kenya Integrated Household Survey (2005/6) data set, which is the most current micro data for Kenya. The second objective was to examine measures and sources of technical efficiency of public education spending at county level in Kenya using the DEA double bootstrap. This method overcomes the limitations of the standard DEA approach. Education indicators data and public expenditure data for the period 2005/6-2009/10 was utilized. The final objective of the thesis was to examine the external efficiency of public education spending in Kenya. The elements of external efficiency examined include private returns to education and training and education externalities within the household and within counties.

With respect to the first objective, the results indicate that children from high income groups are more likely than children from low income group to enroll at all levels of education. Enrollment rates among the low income group are particularly low at secondary, technical and university education levels. Factors that constrain enrolments include poverty, overage students who opt to drop out of schools, residing in rural areas, being a female child and low levels of household head's level of schooling. Therefore, the benefit from public education spending at the margin is skewed towards middle and high income groups. The results also revealed large disparities across the 47 Kenya counties.

The DEA bootstrap estimates of technical efficiency are 1.24, 1.12 and 3.04, for primary, secondary and tertiary (technical and university) education levels, respectively. The estimates indicate that there is scope for improvement in technical efficiency in education resource utilization at the county level. Education outputs can be increased by 24 percent, 12 percent and 204 percent for primary, secondary and tertiary education, respectively, without increasing inputs. The potential resource saving is estimated at 17 percent, 10 percent and 52 percent for primary, secondary and tertiary education, respectively. Factors associated with low technical inefficiency include high spending in personnel emoluments.

The analysis of external benefits of education finds that private rates of returns to schooling increase by level of education and vary across employment sectors. Increase in average years of education at the household level and at the county level increase individual earnings. These external effects of schooling are higher than private or individual rates of return to schooling.

5.2 CONCLUSIONS

Education is an important sector for sustainable growth and development. The sector receives one of the highest allocation for public expenditures in the fiscal budget. However performance indicators are either unsatisfactory and regional disparities are apparent. The study provides an assessment of benefit incidence and efficiency of education expenditures and associated factors at primary, secondary, technical and university levels of education.

Despite the expansion in schooling and high rates of participation in primary education, there is an urgent need to address issues affecting the benefit incidence of schooling, key among them inequalities, quality of education and access to post primary education for low income groups. This will enable attainment of requisite skills that attract higher returns in the labour market. Although improving the resource base for Kenya schools is imperative, additional resources is by no means a panacea for low student achievement and the overall low education outcomes. Increase in resources is not a necessary condition for improving education outcomes, but rather the impact of resources is conditional upon how they are managed and utilized. The study would inform policy on targeting education expenditures, improving equity and efficiency in education provision and financing.

5.3 IMPLICATIONS FOR POLICY

It is important to deal with pre-labour market inequalities including disparities in access and benefit incidence of schooling across regions, gender and income groups. There is need to improve efficiency in allocation and utilization of education expenditures. National and county governments will need to allocate resources more equitably while taking into account other socio-economic factors that constrain demand of schooling, notably poverty and over-age enrolment. Policies should be designed towards improving internal, technical and external efficiency of schooling across all counties in the country.

Effectiveness of education outcomes as captured by the labour market outcomes will continue to be limited by the inefficiencies in an education process that leaves those from poor households with skill deficits. There is need to improve efficiency in allocation and utilization of education expenditures. Interventions to ensure education expenditures are allocated more efficiently could include linking the expansion of schools to population density and recurrent resource availability. Counties will need to plan the allocation and deployment of human resources in order to address the problem of uneven distribution of resources while taking into account other socio-economic factors that affect demand of schooling.

Inequalities in education spending and access to education services need to be reduced. Education transfers between the central and sub-national government should be based on more equity-oriented system targeting areas with low education outcomes. Concerted efforts should be made to improve efficiency and eliminate wastage in education spending.

An equitable resource allocation framework should be developed under which counties with lower education outcomes receive higher portion of shared revenue than the better performing and non-poor counties. The increase in allocation to poorer counties can help improve efficiency and equity in education service delivery. Sub-national government education mandate that require additional spending should be explicitly accounted for in the budget estimates and where possible, the spending tracked up to facility level.

The education sector needs to strengthen the education information system and design an education financial information system to enable updated and quality data availability for regular analysis of benefit incidence and monitoring the quality of education across all levels of schooling. Policies should be designed towards improving internal, technical and external efficiency of schooling across all counties in the country.

Given the skills deficit among most youth who exit the education system, in most cases before the completion of basic education schooling, there is scope for targeted training opportunities including technical and vocational training; adult education and other informal post school opportunities. Moreover, technical training has positive rates of return on individual earnings.

It is important to address factors that constrain access to and delivery of quality education across all education levels and counties; and especially in disadvantaged areas and among the poor.

Another aspect that can improve education returns is to improve the school environment and the ability of the population especially youth to engage in the labour market. The government may consider linking education inputs and financing to outcomes such as learning achievements and skills development and a qualifications framework that provides a signal to all levels of schooling right from basic education to higher education. There should also be feedback mechanism between students and teachers while encouraging parents' direct involvement in their children's education. This could include home schooling and regular discussion with teachers of their children's progress in learning.

Finally, it is imperative to address internal, technical and external inefficiencies in the education system. Spending more does not necessarily mean better outcomes but rather how the resources are efficiently utilized and managed. It will be important to provide opportunities to skills-deficit youth who are no longer in the system. The study findings would inform decentralization and financing reforms in the education sector.

5.4 CONTRIBUTIONS OF THE THESIS

This thesis has six contributions that relate to application of most current techniques in linking education inputs to learning processes, outputs, outcomes and education externalities. First, the study is one of the few studies to estimate technical efficiency of education spending in Kenya. In doing so the study uses DEA double bootstrap procedure which is a superior technique to the standard DEA to estimate technical efficiency measures across all education levels and to determine correlates of technical efficiency of education. Confidence intervals for technical efficiency measures obtained from the DEA double bootstrap procedure enable statistical inference to be conducted.

Second, the study applies the marginal benefit incidence technique using cross sectional data to determine potential beneficiaries of expansion of public education spending in Kenya. The study provides analysis on disparities in education sector performance, technical efficiency and average benefit incidence at county level; and factors affecting benefit incidence of education.

Third, the study estimates comprehensive returns to education and training. It also estimates private returns for all levels of education and for technical education across employment sectors. In addition it estimates external benefits of schooling (education externalities within households and within regions (counties). These are rarely estimated yet they hold great policy relevance.

Fourth, the study addresses important policy issues including inequalities, efficiency and benefit incidence of education. Addressing these policy issues is important for the country in terms of meeting the aspirations of Kenya Vision 2030 and the need to enhance decentralization in education management as stipulated in the 2010 Constitution.

Fifth, the study has micro-macro policy relevance. Analysis on marginal benefit incidence, technical and external efficiency of public education spending and associated factors would inform policy on decentralization and financing reforms in the education sector; and improving equity and efficiency in education provision and financing.

Sixth, the research contribute to existing academic work on efficiency in public expenditure management, externalities of education and benefit incidence analysis by providing additional empirical evidence at sub-national level. Finally, findings from the three essays would inform policy on improving efficiency in public expenditure management and effective resource utilization within decentralized education system; and targeting of education spending.

5.5 AREAS FOR FUTURE RESEARCH

Due to data limitations, it was not possible to estimate benefit incidence, efficiency and returns to early childhood education in Kenya. Thus it would be important to estimate returns to this level of education in Kenya and its long term effects of labour market outcomes especially earnings. Further, there is a research gap on the link between the macro and micro research evidence on returns to education and technological accumulation in Kenya. Whereas this study has used micro level data to measure returns to education, more empirical work is required using macro level approach.

APPENDIX

Table 1: School gross enrolment rate by county (%), 2005/6

Tercile	1				2				3			
County	**Primary**	**Secondary**	**Technical**	**university**	**primary**	**Secondary**	**Technical**	**University**	**Primary**	**Secondary**	**Technical**	**university**
Baringo	82	26	1	1	83	25	1	1	63	42	2	5
Bomet	133	16	1	1	103	31	1	1	76	58	3	2
Bungoma	64	1	1	1	113	57	1	1	76	73	1	4
Busia	150	16	1	1	125	41	1	1	109	72	1	4
Elgeyo_Marakwet	120	16	1	1	119	52	1	1	99	67	1	1
Embu	126	17	1	1	95	70	1	1	88	74	1	7
Garissa	120	5	1	1	91	33	1	1	79	36	1	1
Homa Bay	112	16	2	1	128	28	1	1	82	82	7	1
Isiolo	117	10	1	1	121	31	2	1	101	38	4	1
Kajiado	67	0	1	1	94	2	1	1	66	30	6	1
Kakamega	131	19	1	1	135	23	1	1	121	30	1	5
Kericho	75	2	1	1	81	9	1	1	108	18	1	1
Kiambu	143	17	2	1	128	35	1	1	94	87	2	4
Kilifi	85	2	1	1	100	5	1	1	84	38	4	3
Kirinyaga	132	16	1	1	107	50	4	1	99	76	1	1
Kisii	139	26	1	1	137	45	3	2	113	74	3	5
Kisumu	140	10	1	2	122	23	3	1	95	73	6	1
Kitui	62	7	1	1	87	30	1	4	85	43	2	1
Kwale	129	9	1	1	116	29	1	1	104	36	3	2
Laikipia	118	7	1	1	129	40	6	1	155	12	1	1
Lamu	76	13	1	1	64	18	1	1	63	25	1	1
Machakos	60	8	1	1	68	3	1	1	87	10	1	1
Makueni	70	17	1	1	107	6	1	1	69	28	1	1
Mandera	127	14	1	1	120	50	1	1	95	48	4	8
Marsabit	107	47	1	1	104	94	1	1	68	76	3	2
Meru	134	13	1	1	119	30	4	1	106	58	16	14
Migori	131	5	1	1	104	16	1	1	92	52	2	2

Tercile	1				2				3			
County	**Primary**	**Secondary**	**Technical**	**university**	**primary**	**Secondary**	**Technical**	**University**	**Primary**	**Secondary**	**Technical**	**university**
Mombasa	108	51	1	2	84	82	2	1	74	79	7	4
Murang'a	126	28	1	1	123	21	1	1	115	26	3	1
Nairobi	132	14	1	1	153	50	8	5	155	55	2	12
Nakuru	119	38	1	1	125	61	1	1	88	54	2	6
Nandi	81	1	1	1	71	13	1	1	63	23	1	1
Narok	116	12	1	1	101	55	1	1	69	71	4	6
Nyamira	114	14	1	1	111	39	1	1	61	69	1	1
Nyandarua	104	11	1	1	116	40	1	1	95	27	3	3
Nyeri	111	32	1	1	113	20	1	1	106	37	4	9
Samburu	97	8	1	1	86	34	1	1	58	29	6	1
Siaya	82	12	1	1	79	11	1	1	93	0	1	1
Taita Taveta	135	14	1	1	120	35	6	2	99	63	1	6
Tana River	68	3	1	1	86	0	1	1	125	37	1	1
Tharaka Nithi	132	12	4	1	116	38	1	1	95	57	15	3
Trans Nzoia	102	2	3	1	84	33	1	2	67	72	6	9
Turkana	108	14	1	1	105	49	2	2	87	73	1	1
Uasin Gishu	123	26	4	1	111	42	5	1	125	55	3	5
Vihiga	112	6	1	1	109	31	1	1	128	69	1	1
Wajir	120	15	1	1	118	29	2	1	105	47	5	4
West Pokot	127	13	1	1	131	24	1	2	79	54	3	3
Total	110	14	1	1	107	34	1	1	93	50	3	3

Source: Author's computations based on KIHBS 2005/6 ; enrolment rate of less than 1% was rounded upwards to 1%.

Table 2: Average unit subsidy (spending per child) by district, 2005/6 (Ksh.)

District	Primary	Secondary
Nairobi	4,550.62	7,829.74
Kiambu	4,412.81	18,512.26
Kirinyaga	7,803.18	21,377.52
Muranga	7,685.75	24,076.53
Nyandarua	6,069.58	17,095.23
Nyeri	7,155.52	15,995.42
Thika	6,513.37	23,807.71
Maragua	6,419.20	18,129.44
Kilifi	4,622.28	16,599.69
Kwale	4,023.69	8,810.20
Lamu	7,131.44	10,489.43
Mombasa	3,665.19	10,958.17
Taita Taveta	5,493.41	19,665.06
Tana River	3,629.39	29,956.91
Malindi	3,705.29	11,144.99
Embu	6,458.93	15,414.02
Isiolo	5,974.79	7,269.93
Kitui	6,631.50	15,693.56
Makueni	6,148.39	12,144.11
Machakos	6,093.34	21,498.08
Marsabit	6,044.81	28,744.37
Mbeere	8,350.09	27,128.85
Meru Central	7,583.57	20,327.26
Moyale	3,873.67	6,845.72
Mwingi	6,563.84	18,073.15
Nyambene	4,862.85	12,183.98
Tharaka	8,000.70	17,132.79
Meru South	7,791.24	27,736.68
Garissa	1,392.19	7,079.17
Mandera	2,633.83	16,680.70
Wajir	1,462.59	10,640.52
Gucha	7,200.67	11,805.81
Homa Bay	7,896.51	19,628.87
Kisii	8,192.31	14,279.99
Kisumu	11,628.27	10,628.54
Kuria	5,237.72	50,616.19
Migori	6,564.50	21,157.47
Nyamira	9,875.36	10,969.37
Rachuonyo	5,191.46	10,982.17
Siaya	5,409.22	19,410.36
Suba	7,342.23	17,961.90
Bondo	6,594.34	18,180.88
Nyando	6,140.41	17,396.48
Baringo	6,559.05	12,712.33
Bomet	4,967.07	8,394.85
Keiyo	7,967.83	16,592.26
Kajiado	6,795.57	21,056.72
Kericho	9,810.22	27,519.48

District	Primary	Secondary
Koibatek	7,703.56	11,658.12
Laikipia	6,272.03	16,355.38
Marakwet	8,006.36	18,906.71
Nakuru	6,939.62	16,899.84
Nandi	5,524.55	12,952.71
Narok	5,725.50	8,003.35
Samburu	3,676.33	18,136.08
Trans Mara	5,988.41	19,329.73
Trans Nzoia	4,556.14	8,278.28
Turkana	3,190.83	31,071.12
Uasin Gishu	5,225.68	10,829.03
West Pokot	5,875.13	11,809.99
Buret	5,078.17	12,880.56
Bungoma	4,480.02	10,272.11
Busia	4,139.99	12,942.98
Mt. Elgon	4,454.97	13,258.82
Kakamega	6,420.70	26,566.35
Lugari	5,944.36	16,400.89
Teso	4,361.93	11,728.21
Vihiga	6,004.27	22,705.30
Butere/Mumias	4,994.60	9,250.43
Total	5,951.93	16,645.95

Source: Author's computations based on KIHBS, 2005/6 dataset

Table 3: Average benefit incidence by income tercile and county (%), 2005/6

	Primary Education			Secondary Education			Tertiary Education		
County	Tercile 1	Tercile 2	Tercile 3	Tercile 1	Tercile 2	Tercile 3	Tercile 1	Tercile 2	Tercile 3
Baringo	6	21	72	1	9	90	2	2	97
Bomet	30	39	31	9	26	65	2	2	97
Bungoma	14	57	29	3	50	47	1	1	98
Busia	24	49	27	9	41	50	1	14	85
Elgeyo_Marakwet	46	41	13	15	49	35	1	1	98
Embu	42	32	26	9	37	54	1	1	98
Garissa	67	25	8	19	62	19	6	6	88
Homa Bay	63	29	8	43	25	32	7	41	52
Isiolo	23	38	39	8	46	46	2	27	71
Kajiado	4	32	64	2	4	94	2	2	97
Kakamega	36	48	16	29	46	25	3	3	94
Kericho	58	29	12	19	49	32	2	5	93
Kiambu	39	37	24	14	31	54	20	13	68
Kilifi	51	25	24	10	16	74	5	5	90
Kirinyaga	59	27	14	33	48	19	2	47	52
Kisii	49	35	16	16	27	58	25	25	50
Kisumu	68	20	12	42	26	32	3	60	37
Kitui	31	38	31	10	40	50	7	10	83
Kwale	53	32	15	39	42	19	2	48	50
Laikipia	47	31	21	29	37	33	5	5	90

Lamu	81	13	6	90	5	6	28	22	50
Machakos	77	20	3	90	8	2	10	40	50
Makueni	36	47	17	14	62	24	1	13	86
Mandera	58	29	13	33	45	22	27	23	50
Marsabit	29	37	34	9	30	62	1	12	87
Meru	45	36	18	13	34	53	1	1	98
Migori	38	35	28	29	39	31	19	18	63
Mombasa	32	39	29	39	34	27	2	2	97
Murang'a	50	34	16	24	48	28	1	62	37
Nairobi	33	55	12	23	60	17	1	27	73
Nakuru	10	31	60	2	21	77	26	23	51
Nandi	39	39	22	14	43	43	1	1	98
Narok	44	31	25	17	24	59	24	30	46
Nyamira	28	52	20	9	59	32	2	6	92
Nyandarua	39	40	21	38	29	33	2	10	88
Nyeri	22	45	33	7	55	37	1	1	98
Samburu	71	24	5	75	24	1	1	2	97
Siaya	46	37	18	17	42	40	2	55	44
Taita Taveta	84	9	7	61	3	36	5	5	90
Tana River	28	51	21	7	51	42	1	50	50
Tharaka Nithi	58	31	11	6	55	40	22	15	63
Trans Nzoia	55	42	3	21	62	18	4	52	54
Turkana	47	34	19	34	32	35	25	35	40
Uasin Gishu	58	32	10	17	41	42	8	8	85
Vihiga	46	38	16	26	44	30	4	31	65
Wajir	36	48	16	16	40	44	1	32	67
Total	42	37	22	19	38	42	6	16	78

Source: Author’s computations based on KIHBS, 2005/6 dataset

Table 4: Estimates for DEA bootstrap Efficiency Scores and Confidence Intervals (100 bootstrap replications)

		Primary						Secondary						Tertiary					
	County	**Efficiency score (VRS)**	**Efficiency score Bias Corrected**	BIAS	Variance	Lower Bound	Upper Bound	**Efficiency score (VRS)**	**Efficiency score Bias Corrected**	BIAS	Variance	Lower Bound	Upper Bound	**Efficiency score (VRS)**	**Efficiency score Bias Corrected**	BIAS	Variance	Lower Bound	Upper Bound
1	Baringo	1.621	1.7165	-0.0954	0.0025	1.636	1.827	1.1151	1.1420	-0.0269	0.0002	1.119	1.178	2.438	2.6137	-0.1755	0.0127	2.453	2.885
2	Bomet	1.316	1.3851	-0.0688	0.0013	1.325	1.471	1.0889	1.1138	-0.0249	0.0002	1.092	1.145	1.434	1.4989	-0.0648	0.0025	1.436	1.621
3	Bungoma	1.000	1.0886	-0.0886	0.0014	1.012	1.148	1.0483	1.0753	-0.0270	0.0002	1.052	1.099	1.279	1.3328	-0.0541	0.0019	1.280	1.436
4	Busia	1.000	1.0929	-0.0929	0.0030	1.003	1.196	1.1416	1.1707	-0.0291	0.0004	1.143	1.215	1.907	1.9827	-0.0753	0.0040	1.909	2.143
5	Elgeyo_Marakwet	1.273	1.3435	-0.0704	0.0014	1.276	1.429	1.0131	1.0455	-0.0324	0.0005	1.016	1.089	3.768	3.9727	-0.2044	0.0206	3.778	4.327
6	Embu	1.500	1.5389	-0.0389	0.0006	1.505	1.590	1.0620	1.1023	-0.0403	0.0009	1.066	1.188	2.706	2.8866	-0.1811	0.0144	2.715	3.183
7	Garissa	1.090	1.1274	-0.0372	0.0004	1.093	1.181	1.1440	1.1573	-0.0133	0.0001	1.146	1.174	2.226	2.3079	-0.0819	0.0055	2.228	2.501
8	Homa Bay	1.238	1.3009	-0.0629	0.0012	1.248	1.382	1.0000	1.0491	-0.0491	0.0008	1.007	1.126	1.4728	1.5364	-0.0636	0.0025	1.474	1.655
9	Isiolo	1.500	1.5643	-0.0643	0.0012	1.510	1.636	1.4706	1.5187	-0.0481	0.0013	1.475	1.601	8.7052	9.0506	-0.3454	0.0835	8.715	9.779
10	Kajiado	1.146	1.2070	-0.0612	0.0013	1.150	1.290	1.2220	1.2512	-0.0292	0.0003	1.225	1.286	2.287	2.6282	-0.3416	0.0386	2.316	3.126
11	Kakamega	1.000	1.0628	-0.0628	0.0026	1.003	1.173	1.0000	1.0350	-0.0350	0.0004	1.002	1.084	1.041	1.0887	-0.0474	0.0013	1.042	1.177
12	Kericho	1.000	1.0202	-0.0202	0.0002	1.002	1.058	1.0000	1.0380	-0.0380	0.0005	1.003	1.092	2.289	2.4603	-0.1709	0.0117	2.304	2.717
13	Kiambu	1.294	1.3647	-0.0706	0.0022	1.298	1.455	1.0000	1.0835	-0.0835	0.0059	1.004	1.259	1.000	1.2671	-0.2671	0.0216	1.013	1.567
14	Kilifi	1.000	1.0389	-0.0389	0.0006	1.002	1.095	1.0000	1.0285	-0.0285	0.0004	1.002	1.080	1.230	1.2777	-0.0482	0.0017	1.231	1.381
15	Kirinyaga	1.000	1.1543	-0.1543	0.0115	1.009	1.344	1.0131	1.0518	-0.0387	0.0010	1.016	1.141	2.879	3.0226	-0.1441	0.0111	2.882	3.274
16	Kisii	1.045	1.1035	-0.0583	0.0018	1.050	1.236	1.0000	1.0804	-0.0804	0.0045	1.002	1.225	1.084	1.1411	-0.0574	0.0017	1.086	1.241
17	Kisumu	1.000	1.0177	-0.0177	0.0002	1.001	1.049	1.0000	1.0768	-0.0768	0.0063	1.003	1.301	1.9382	2.1638	-0.2256	0.0185	1.958	2.488
18	Kitui	1.339	1.3974	-0.0584	0.0011	1.347	1.477	1.0436	1.0750	-0.0314	0.0004	1.045	1.126	1.9275	2.0211	-0.0936	0.0048	1.930	2.183
19	Kwale	1.000	1.0714	-0.0714	0.0015	1.004	1.139	1.0000	1.0617	-0.0617	0.0022	1.003	1.159	2.553	2.6486	-0.0958	0.0071	2.556	2.868
20	Laikipia	1.500	1.5176	-0.0176	0.0002	1.502	1.548	1.3954	1.4345	-0.0391	0.0006	1.397	1.493	3.693	3.8965	-0.2038	0.0202	3.703	4.248
21	Lamu	1.500	1.5469	-0.0468	0.0009	1.502	1.618	1.0611	1.0826	-0.0215	0.0001	1.065	1.101	13.298	13.7883	-0.4902	0.1954	13.309	14.939
22	Machakos	1.488	1.5670	-0.0789	0.0017	1.493	1.647	1.0000	1.0134	-0.0134	0.0001	1.001	1.038	1.806	1.9578	-0.1516	0.0086	1.818	2.191

		Primary						Secondary						Tertiary					
	County	**Efficiency score (VRS)**	**Efficiency score Bias Corrected**	BIAS	Variance	Lower Bound	Upper Bound	**Efficiency score (VRS)**	**Efficiency score Bias Corrected**	BIAS	Variance	Lower Bound	Upper Bound	**Efficiency score (VRS)**	**Efficiency score Bias Corrected**	BIAS	Variance	Lower Bound	Upper Bound
23	Makueni	1.020	1.0998	-0.0795	0.0035	1.023	1.243	1.0000	1.0515	-0.0515	0.0011	1.002	1.114	2.155	2.2619	-0.1068	0.0061	2.157	2.447
24	Mandera	1.000	1.0737	-0.0737	0.0009	1.008	1.123	1.0573	1.0947	-0.0374	0.0005	1.060	1.146	1.363	1.4128	-0.0498	0.0021	1.364	1.531
25	Marsabit	1.000	1.0176	-0.0176	0.0001	1.002	1.052	1.2100	1.2304	-0.0204	0.0001	1.212	1.253	4.512	4.6785	-0.1664	0.0225	4.516	5.069
26	Meru	1.139	1.1912	-0.0520	0.0010	1.149	1.284	1.0000	1.0097	-0.0097	0.0001	1.000	1.027	1.0023	1.0483	-0.0460	0.0012	1.003	1.133
27	Migori	1.000	1.0357	-0.0357	0.0007	1.002	1.115	1.0000	1.0487	-0.0487	0.0009	1.001	1.121	1.3972	1.4559	-0.0587	0.0022	1.399	1.569
28	Mombasa	1.000	1.1358	-0.1358	0.0132	1.004	1.360	1.0951	1.1348	-0.0397	0.0009	1.096	1.212	1.440	1.6518	-0.2122	0.0152	1.458	1.964
29	Murang'a	1.317	1.3716	-0.0549	0.0013	1.328	1.451	1.0000	1.0549	-0.0549	0.0015	1.003	1.145	1.744	1.8417	-0.0979	0.0046	1.749	2.010
30	Nairobi	1.142	1.2082	-0.0664	0.0020	1.148	1.324	1.0000	1.0735	-0.0735	0.0053	1.002	1.268	1.000	1.5186	-0.5186	0.0537	1.040	1.925
31	Nakuru	1.000	1.0171	-0.0171	0.0001	1.002	1.043	1.0000	1.0116	-0.0116	0.0001	1.001	1.040	1.011	1.1476	-0.1362	0.0067	1.024	1.353
32	Nandi	1.166	1.2128	-0.0464	0.0007	1.172	1.280	1.0017	1.0273	-0.0256	0.0002	1.005	1.067	1.957	2.0796	-0.1228	0.0068	1.963	2.288
33	Narok	1.000	1.0393	-0.0393	0.0009	1.003	1.106	1.0010	1.0201	-0.0191	0.0001	1.003	1.042	1.586	1.6458	-0.0594	0.0027	1.588	1.782
34	Nyamira	1.477	1.5672	-0.0900	0.0038	1.491	1.712	1.1127	1.1305	-0.0178	0.0001	1.116	1.151	2.934	3.0760	-0.1419	0.0111	2.937	3.321
35	Nyandarua	1.222	1.2638	-0.0423	0.0007	1.228	1.326	1.0767	1.0950	-0.0183	0.0001	1.080	1.120	2.3636	2.4691	-0.1055	0.0067	2.366	2.669
36	Nyeri	1.474	1.5584	-0.0845	0.0016	1.484	1.640	1.0000	1.0276	-0.0276	0.0004	1.000	1.088	2.3302	2.6344	-0.3042	0.0339	2.355	3.093
37	Samburu	1.292	1.3461	-0.0539	0.0007	1.297	1.396	1.2659	1.2827	-0.0168	0.0001	1.267	1.305	5.275	5.4694	-0.1945	0.0307	5.279	5.926
38	Siaya	1.000	1.1092	-0.1092	0.0056	1.008	1.252	1.0000	1.0755	-0.0755	0.0049	1.002	1.272	1.775	1.8467	-0.0716	0.0035	1.777	1.994
39	Taita Taveta	1.474	1.5406	-0.0671	0.0014	1.478	1.619	1.0833	1.1086	-0.0253	0.0003	1.085	1.150	4.748	5.0386	-0.2907	0.0388	4.764	5.533
40	Tana River	1.000	1.2146	-0.0146	0.0001	1.001	1.046	1.3659	1.4055	-0.0396	0.0009	1.368	1.465	6.852	7.1023	-0.2508	0.0522	6.857	7.697
41	Tharaka Nithi	1.466	1.5432	-0.0772	0.0014	1.471	1.616	1.1058	1.1487	-0.0429	0.0009	1.110	1.239	13.317	13.9385	-0.6214	0.2188	13.332	15.062
42	Trans Nzoia	1.000	1.1016	-0.1016	0.0034	1.005	1.210	1.0453	1.0773	-0.0320	0.0006	1.048	1.131	2.011	2.0956	-0.0847	0.0046	2.013	2.259
43	Turkana	1.000	1.0360	-0.0360	0.0005	1.003	1.091	1.0000	1.0553	-0.0553	0.0012	1.002	1.126	1.398	1.4492	-0.0511	0.0022	1.399	1.571
44	Uasin Gishu	1.057	1.1368	-0.0796	0.0021	1.066	1.240	1.2208	1.2495	-0.0287	0.0002	1.225	1.286	1.9529	2.6373	-0.6844	0.1380	2.048	3.502
45	Vihiga	1.000	1.1111	-0.1111	0.0071	1.003	1.271	1.0000	1.0367	-0.0367	0.0004	1.003	1.081	2.9498	3.0942	-0.1444	0.0113	2.953	3.344

		Primary						Secondary						Tertiary					
	County	**Efficiency score (VRS)**	**Efficiency score Bias Corrected**	BIAS	Variance	Lower Bound	Upper Bound	**Efficiency score (VRS)**	**Efficiency score Bias Corrected**	BIAS	Variance	Lower Bound	Upper Bound	**Efficiency score (VRS)**	**Efficiency score Bias Corrected**	BIAS	Variance	Lower Bound	Upper Bound
46	Wajir	1.000	1.2131	-0.0131	0.0001	1.001	1.034	1.0992	1.1264	-0.0272	0.0003	1.100	1.169	2.097	2.1734	-0.0768	0.0049	2.098	2.355
47	West Pokot	1.000	1.0860	-0.0860	0.0022	1.014	1.195	1.2742	1.2908	-0.0166	0.0001	1.276	1.312	2.687	2.7877	-0.1003	0.0079	2.690	3.019
	Average	*1.1723*	*1.2353*	*(0.0630)*	*0.0020*	*1.1779*	*1.3195*	*1.0816*	*1.1182*	*(0.0366)*	*0.0010*	*1.0841*	*1.1815*	*2.8685*	*3.0447*	*(0.1762)*	*0.0251*	*2.8780*	*3.3477*
	Max	*1.6211*	*1.7165*	*(0.0131)*	*0.0132*	*1.6359*	*1.8267*	*1.4706*	*1.5187*	*(0.0097)*	*0.0063*	*1.4755*	*1.6009*	*13.317*	*13.9385*	*(0.0460)*	*0.2188*	*13.3316*	*15.0620*
	Min	*1.0000*	*1.0131*	*(0.1543)*	*0.0001*	*1.0010*	*1.0343*	*1.0000*	*1.0097*	*(0.0835)*	*0.0001*	*1.0003*	*1.0269*	*1.0000*	*1.0483*	*(0.6844)*	*0.0012*	*1.0033*	*1.1332*

Source: Author’s computations

Table 5: DEA and DEA bootstrap efficiency scores by level and county

		Bootstrap efficiency scores			Standard DEA efficiency scores						
	County	Primary education	Secondary education	Tertiary education	Primary education	Secondary education	Tertiary education	Primary education per capita spending	Secondary education per capita spending	Tertiary education per capita spending	Poverty Rate
1	Baringo	1.7165	1.1420	2.6137	0.52	0.91	0.41	9,633	10,858	89,278	59
2	Bomet	1.3851	1.1138	1.4989	0.79	0.92	0.70	6,740	10,705	52,512	51
3	Bungoma	1.0886	1.0753	1.3328	1.00	0.95	0.78	7,265	14,705	46,823	52
4	Busia	1.0929	1.1707	1.9827	1.00	0.87	0.52	6,390	7,951	69,842	66
5	Elgeyo_Marakwet	1.3435	1.0455	3.9727	0.72	0.98	0.27	10,210	16,853	137,979	55
6	Embu	1.5389	1.1023	2.8866	0.58	0.95	0.37	10,651	22,419	99,065	41
7	Garissa	1.1274	1.1573	2.3079	1.00	0.80	0.45	1,296	2,336	81,506	55
8	Homa Bay	1.3009	1.0491	1.5364	0.76	0.98	0.68	7,866	12,629	53,929	43
9	Isiolo	1.5643	1.5187	9.0506	0.69	0.66	0.12	6,446	5,449	318,743	63
10	Kajiado	1.2070	1.2512	2.6282	0.75	0.79	0.44	5,007	7,392	83,725	12
11	Kakamega	1.0628	1.0350	1.0887	0.91	0.93	0.96	7,065	12,610	38,131	52
12	Kericho	1.0202	1.0380	2.4603	0.96	1.00	0.44	7,924	16,149	83,827	39
13	Kiambu	1.3647	1.0835	1.2671	0.74	1.00	1.00	7,004	22,745	36,615	25
14	Kilifi	1.0389	1.0285	1.2777	1.00	1.00	0.81	5,307	5,830	45,019	67
15	Kirinyaga	1.1543	1.0518	3.0226	1.00	1.00	0.35	8,333	24,222	105,398	26
16	Kisii	1.1035	1.0804	1.1411	0.96	1.00	0.92	7,722	17,924	39,680	60

	County	Bootstrap efficiency scores			Standard DEA efficiency scores						
	County	Primary education	Secondary education	Tertiary education	Primary education	Secondary education	Tertiary education	Primary education per capita spending	Secondary education per capita spending	Tertiary education per capita spending	Poverty Rate
17	Kisumu	1.0177	1.0768	2.1638	0.73	0.94	0.52	7,093	14,755	70,969	45
18	Kitui	1.3974	1.0750	2.0211	0.71	0.95	0.52	8,968	10,892	70,578	63
19	Kwale	1.0714	1.0617	2.6486	1.00	1.00	0.39	5,751	7,203	93,473	73
20	Laikipia	1.5176	1.4345	3.8965	0.64	0.71	0.27	7,360	14,137	135,211	48
21	Lamu	1.5469	1.0826	13.7883	0.66	0.87	0.08	8,934	9,170	486,916	31
22	Machakos	1.5670	1.0134	1.9578	0.69	1.00	0.55	9,285	16,786	66,137	57
23	Makueni	1.0998	1.0515	2.2619	0.90	1.00	0.46	9,762	17,584	78,909	64
24	Mandera	1.0737	1.0947	1.4128	1.00	0.97	0.73	734	1,166	49,910	86
25	Marsabit	1.0176	1.2304	4.6785	0.91	0.83	0.22	3,751	3,060	165,214	79
26	Meru	1.1912	1.0097	1.0483	0.79	0.90	1.00	8,442	15,933	36,701	28
27	Migori	1.0357	1.0487	1.4559	0.89	1.00	0.72	6,252	8,164	51,162	46
28	Mombasa	1.1358	1.1348	1.6518	1.00	0.88	0.70	3,256	6,116	52,713	38
29	Murang'a	1.3716	1.0549	1.8417	0.64	1.00	0.57	8,024	23,269	63,853	31
30	Nairobi	1.2082	1.0735	1.5186	0.95	1.00	1.00	3,414	6,491	41,572	22
31	Nakuru	1.0171	1.0116	1.1476	0.78	0.90	0.99	6,428	12,593	37,036	42
32	Nandi	1.2128	1.0273	2.0796	0.87	1.00	0.51	8,182	13,057	71,651	47
33	Narok	1.0393	1.0201	1.6458	0.83	1.00	0.63	5,128	5,619	58,089	34
34	Nyamira	1.5672	1.1305	3.0760	0.63	0.90	0.34	10,719	20,839	107,435	46
35	Nyandarua	1.2638	1.0950	2.4691	0.68	0.93	0.42	7,138	15,108	86,544	50
36	Nyeri	1.5584	1.0276	2.6344	0.65	1.00	0.43	9,318	30,879	85,322	32
37	Samburu	1.3461	1.2827	5.4694	0.74	0.79	0.19	4,529	4,700	193,142	78
38	Siaya	1.1092	1.0755	1.8467	0.91	1.00	0.56	8,342	14,121	64,998	36
39	Taita Taveta	1.5406	1.1086	5.0386	0.69	0.90	0.21	9,431	16,211	173,845	55
40	Tana River	1.0146	1.4055	7.1023	0.77	0.73	0.15	4,504	3,972	250,869	75
41	Tharaka Nithi	1.5432	1.1487	13.9385	0.59	0.82	0.08	11,393	7,550	487,609	37
42	Trans Nzoia	1.1016	1.0773	2.0956	0.94	0.96	0.50	6,384	10,188	73,632	50
43	Turkana	1.0360	1.0553	1.4492	1.00	1.00	0.72	1,587	1,396	51,193	93
44	Uasin Gishu	1.1368	1.2495	2.6373	1.00	0.82	0.51	6,597	10,803	75,181	45
45	Vihiga	1.1111	1.0367	3.0942	1.00	1.00	0.34	8,643	19,010	108,008	41

		Bootstrap efficiency scores			Standard DEA efficiency scores						
	County	Primary education	Secondary education	Tertiary education	Primary education	Secondary education	Tertiary education	Primary education per capita spending	Secondary education per capita spending	Tertiary education per capita spending	Poverty Rate
46	Wajir	1.0131	1.1264	2.1734	0.86	0.80	0.48	1,071	1,804	76,770	84
47	West Pokot	1.0860	1.2908	2.7877	0.76	1.00	0.37	4,182	4,730	98,403	69
	National	1.2353	1.1182	3.0447	0.82	0.92	0.52	6,797	11,874	105,215	47

Source: Author’s computations

Table 6: Malmquist Productivity Indices (County means)

	County	Primary education: Technical efficiency change	Technological change	Pure technical efficiency change	Scale efficiency change	Total factor productivity change	Secondary education: Technical efficiency change	Technological change	Pure technical efficiency change	Scale efficiency change	Total factor productivity change
1	Baringo	1.02	0.94	0.75	1.36	0.96	0.92	1.07	0.93	0.98	0.98
2	Bomet	1.12	0.89	1.12	1.00	1.00	0.79	1.04	0.80	0.99	0.82
3	Bungoma	1.00	0.97	1.00	1.00	0.97	1.07	1.11	1.06	1.01	1.18
4	Busia	1.00	0.92	1.00	1.00	0.92	0.78	1.04	0.79	0.98	0.81
5	Elgeyo_Marakwet	1.09	0.86	1.11	0.98	0.94	0.87	1.06	0.87	1.00	0.92
6	Embu	1.09	0.91	1.23	0.89	0.99	0.96	1.06	0.97	0.99	1.02
7	Garissa	0.94	0.95	1.00	0.94	0.89	0.95	1.05	0.98	0.96	0.99
8	Homa Bay	1.04	0.95	1.04	1.00	0.99	1.01	1.09	1.01	1.00	1.10
9	Isiolo	0.97	0.95	0.96	1.00	0.92	0.94	1.11	0.98	0.96	1.04
10	Kajiado	0.98	0.97	0.97	1.01	0.95	0.87	1.02	0.86	1.01	0.89
11	Kakamega	1.02	0.92	0.97	1.05	0.94	1.01	1.10	1.03	0.98	1.11
12	Kericho	1.07	0.98	1.07	1.01	1.04	1.07	1.08	1.03	1.04	1.16
13	Kiambu	0.98	0.89	1.07	0.92	0.88	1.00	1.16	1.00	1.00	1.16
14	Kilifi	1.00	0.96	1.00	1.00	0.96	0.86	0.90	0.95	0.91	0.78
15	Kirinyaga	1.01	0.93	1.00	1.01	0.93	0.93	1.16	0.94	0.99	1.08
16	Kisii	1.00	0.91	0.90	1.11	0.90	1.00	1.13	1.00	1.00	1.13
17	Kisumu	1.06	1.02	1.06	1.00	1.09	0.93	0.74	0.93	1.00	0.69
18	Kitui	1.05	0.92	1.05	1.00	0.97	0.91	1.11	0.91	1.00	1.01
19	Kwale	0.99	0.93	1.00	0.99	0.92	0.96	1.10	0.97	0.99	1.05
20	Laikipia	1.04	0.90	1.03	1.01	0.94	0.77	0.93	0.74	1.04	0.72
21	Lamu	1.06	0.91	1.04	1.02	0.97	0.79	1.02	0.84	0.93	0.80
22	Machakos	1.11	0.91	1.20	0.93	1.01	0.92	0.68	0.97	0.95	0.62
23	Makueni	1.06	0.91	1.09	0.97	0.96	1.00	1.14	1.00	1.00	1.14
24	Mandera	1.00	0.97	1.00	1.00	0.97	0.82	1.06	0.90	0.91	0.87

25	Marsabit	0.94	0.92	0.91	1.03	0.87	0.84	0.97	0.86	0.98	0.82
26	Meru	0.97	0.90	0.95	1.01	0.87	1.08	1.02	1.08	1.00	1.10
27	Migori	0.98	0.91	0.92	1.07	0.90	0.82	1.05	0.83	0.99	0.86
28	Mombasa	0.87	0.97	0.93	0.94	0.85	0.96	1.05	0.99	0.97	1.01
29	Murang'a	1.11	0.86	1.24	0.89	0.95	0.98	1.13	0.98	1.00	1.10
30	Nairobi	0.88	0.97	0.89	0.99	0.85	0.86	1.17	1.00	0.86	1.01
31	Nakuru	1.13	0.93	1.13	1.01	1.06	1.00	0.93	0.98	1.02	0.93
32	Nandi	0.95	0.88	0.95	1.01	0.84	0.86	1.10	0.90	0.96	0.95
33	Narok	1.10	0.93	1.10	1.00	1.02	0.83	1.06	0.88	0.94	0.88
34	Nyamira	1.01	0.86	1.11	0.92	0.87	1.11	1.09	1.01	1.10	1.21
35	Nyandarua	1.08	0.89	1.16	0.93	0.96	1.07	1.10	1.05	1.02	1.17
36	Nyeri	1.08	0.97	1.25	0.87	1.05	1.00	0.93	1.00	1.00	0.93
37	Samburu	1.04	0.97	1.02	1.02	1.01	0.87	0.98	0.89	0.98	0.85
38	Siaya	1.02	0.95	0.97	1.06	0.97	1.00	1.14	1.00	1.00	1.14
39	Taita Taveta	1.14	0.89	1.11	1.02	1.02	0.90	1.09	0.88	1.02	0.98
40	Tana River	1.02	0.89	1.06	0.96	0.90	0.84	0.98	0.83	1.02	0.82
41	Tharaka Nithi	1.06	0.91	1.09	0.98	0.96	0.91	1.01	0.86	1.07	0.92
42	Trans Nzoia	1.00	0.98	0.98	1.02	0.98	0.90	1.12	0.91	0.99	1.00
43	Turkana	1.00	0.96	1.00	1.00	0.96	0.89	1.05	0.91	0.97	0.93
44	Uasin Gishu	1.05	0.93	1.00	1.05	0.97	0.89	1.06	0.89	0.99	0.94
45	Vihiga	1.06	0.90	1.05	1.01	0.95	0.93	1.10	0.93	1.00	1.02
46	Wajir	0.96	0.97	0.94	1.02	0.94	0.81	1.02	0.86	0.94	0.82
47	West Pokot	1.09	0.93	1.11	0.99	1.01	0.82	0.97	1.08	0.77	0.80
	National	1.03	0.93	1.03	1.00	0.95	0.92	1.04	0.93	0.98	0.95

Source: Author’s computations. Note: All Malmquist index averages are geometric means

Table 7: Actual education spending, expected spending assuming 100% efficiency and expected savings, 2009/10

		2009/10 actual spending (Ksh.Million)			Expected spending assuming 100% efficiency (Ksh.)			Expected saving (%)		
County	County_name	Primary	Secondary	Tertiary	Primary	Secondary	Tertiary	Primary	Secondary	Tertiary
1	Baringo	1,114	436	307	649	382	117	42	12	62
2	Bomet	1,222	650	272	882	584	181	28	10	33
3	Bungoma	1,960	1,136	420	1,800	1,057	315	8	7	25
4	Busia	1,012	393	128	926	336	65	9	15	50
5	Elgeyo_Marakwet	695	369	119	517	353	30	26	4	75
6	Embu	1,268	605	203	824	549	70	35	9	65
7	Garissa	168	93	72	149	81	31	11	14	57
8	Homa Bay	1,462	748	267	1,124	713	174	23	5	35
9	Isiolo	246	42	34	157	28	4	36	34	89
10	Kajiado	684	279	516	566	223	196	17	20	62
11	Kakamega	2,159	1,208	465	2,032	1,167	428	6	3	8
12	Kericho	1,021	547	287	1,001	527	117	2	4	59
13	Kiambu	1,897	1,828	1,394	1,390	1,687	1,100	27	8	21
14	Kilifi	1,168	381	175	1,124	370	137	4	3	22
15	Kirinyaga	809	652	168	701	620	56	13	5	67
16	Kisii	1,780	1,389	457	1,613	1,286	401	9	7	12
17	Kisumu	1,426	794	913	1,401	738	422	2	7	54
18	Kitui	2,629	703	272	1,882	654	134	28	7	51
19	Kwale	854	287	126	797	270	48	7	6	62
20	Laikipia	648	374	113	427	261	29	34	30	74
21	Lamu	163	53	17	106	49	1	35	8	93
22	Machakos	2,787	1,257	582	1,778	1,240	297	36	1	49
23	Makueni	2,660	1,090	331	2,418	1,037	147	9	5	56
24	Mandera	206	87	57	192	79	40	7	9	29
25	Marsabit	298	58	34	293	47	7	2	19	79
	Meru		1,272			1,260			1	

County	County_name	2009/10 actual spending (Ksh.Million)			Expected spending assuming 100% efficiency (Ksh.)			Expected saving (%)		
		Primary	Secondary	Tertiary	Primary	Secondary	Tertiary	Primary	Secondary	Tertiary
26		3,096		423	2,599		404	16		5
27	Migori	1,218	489	216	1,176	466	148	3	5	31
28	Mombasa	633	336	839	557	296	508	12	12	39
29	Murang'a	1,237	1,154	277	902	1,094	150	27	5	46
30	Nairobi	1,915	1,046	4,883	1,585	974	3,216	17	7	34
31	Nakuru	2,149	1,276	1,070	2,113	1,261	932	2	1	13
32	Nandi	1,230	572	310	1,014	557	149	18	3	52
33	Narok	914	260	139	879	254	84	4	2	39
34	Nyamira	1,128	744	232	720	658	75	36	12	67
35	Nyandarua	1,027	623	123	813	569	50	21	9	59
36	Nyeri	1,183	1,170	411	759	1,138	156	36	3	62
37	Samburu	226	68	22	168	53	4	26	22	82
38	Siaya	1,300	707	163	1,172	657	88	10	7	46
39	Taita Taveta	496	283	102	322	255	20	35	10	80
40	Tana River	242	62	14	238	44	2	1	29	86
41	Tharaka Nithi	422	70	41	273	61	3	35	13	93
42	Trans Nzoia	1,087	488	259	987	453	124	9	7	52
43	Turkana	341	112	67	329	106	46	3	5	31
44	Uasin Gishu	1,217	601	1,191	1,071	481	452	12	20	62
45	Vihiga	1,077	719	197	969	694	64	10	4	68
46	Wajir	195	94	45	193	84	21	1	11	54
47	West Pokot	538	163	119	495	126	43	8	23	64
	Total	53,208	27,769	18,872	44,086	25,880	11,285	17	10	52

Source: Appropriation Accounts and author’s computations