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# Examining Effects of School and Teacher Inputs on Productive Efficiency of Ugandan Primary Schools: A Stochastic Frontier Analysis

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## Abstract

**This study evaluates the extent to which school and teacher quality inputs affect technical efficiency of primary schools in Uganda. Using stochastic frontier analysis, the study found textbook-pupil ratio, classroom-pupil ratio and teacher-pupil ratio exhibit increasing returns to scale on literacy and numeracy scores, and school mean efficiency varied widely across the four districts. Moreover, per pupil family expense on education, parent education and teacher salary demonstrate significant positive effect on pupil academic achievement while high rate of teacher absenteeism is detrimental to pupil performance. The study concludes that provision of basic requirements is not sufficient for pupil achievement and school productivity, but rather improving institutional organization to mobilize centres of power and capacity to use available scarce resources for productive gains should be promoted.**

**Keywords:** Primary Schools, Technical Efficiency, Uganda

## BACKGROUND

The importance of high quality education as an essential tool for accelerated economic growth and people's well-being is recognized in developing countries, especially since the Jomtein Declaration (on MDGs) in 1990 and Dakar Conference (on EFA goals) in 2000. In most of the sub-Saharan Africa countries, free public education has been provided at basic level for the past decade or so. These policy initiatives meant increased funding to education sector as a matter of priority amidst competing sectors of the economies over scarce resources. For instance in Uganda, free primary education policy was introduced in 1997 where government started paying tuition for pupils in public schools. Besides, contributions to Parent Teachers' Associations (PTAs) in public schools were stopped for every pupil of school going age. Government prioritization of primary education was also more explicitly stated in its Education Strategic Investment Plan (ESIP) (1997-2003) and the Education Sector Strategic Plan (ESSP) (2004-2015), that were developed on the premise that the social returns to education are higher for primary education than higher education. This in turn led to increased financing to primary education where the share of its budget to total education budget increased to over 50 percent for the past 13 years (MoFPED 2009). Specifically, education inputs such as additional teachers with in-service training, classrooms, text books, staff houses and toilet facilities increased.

These infrastructural developments led to increase in access indicators enormously. For instance, primary education gross enrolment increased from 16 percent in 1996 to 73 percent in 1997 before recording 113.1 percent with over 8 million in 2008, and with net enrolment ratio of about 90 percent for both sexes in 2008 (MoES 2008). It is argued that enhanced productivity and efficency of the schooling system and school performance in particular would

be one way to improve provision of high quality education necessary for economic transformation (Gonand et al. 2007; Sutherland et al. 2007). However, the actual situation is evidently different as reported on some efficiency and quality indicators. For instance, by 2010, there were 58 pupils per teacher which is below the sub-Saharan African (SSA) average of 50 pupils per teacher; survival rate to primary five and primary seven completion rate were recorded at 62 percent and 54 percent, all still below the SSA average of 70 percent and 64.5 percent, respectively. Besides, there has been declining performance in most schools as indicated by the matriculation results over time. This largely indicates that most schools are characterized by management and administrative defficiencies or the inability to operate at the optimal scale of production.

Several studies have attempted to measure efficiency of schools based on school data from developed education systems such as OECD and/or EU (e.g. Kirjavainen 2012; Gonand et al. 2007; Sutherland et al. 2007) using both parametric and non-parametric techniques. Some studies (e.g. Chubb & Moe 1990) obtained linear relationships between inputs and pupil academic achivements while others (e.g. Hedges & Greenwald 1994) focused more on pedagogical processes. In Uganda, similar studies (e.g. Byamugisha 2010; Nanyonjo 2007) were under-taken mainly by using least-squares estimations, found that inputs do matter but specific inputs such as parent involvement in schooling and teacher characteristics played great deal in pupil learning achievements. However, this study focuses on productivity improvements (i.e. technical efficiency) as a measure of service potential of primary education institutions. The study also intends to establish how school managerial cognitions and decisions on resource allocation and use affect environmental response, and what could be the underlying school and teacher factors responsible for any school efficiencies or defficiencies.

The term “technical or productive efficiency” as used by various scholars (e.g. Banker et al. 1984; Chakraborty et al. 2001; Farrel 1957) mean institutions that can use limited resources available to achieve maximum outputs. A more efficient re-allocation of the existing scarce resources and the expectation of educational institutions to provide greater value for money represent the reality of the modern education systems whose outcomes are evaluated, aggregated and measured. In order for the government to realize value for money, the aspect of productivity needs to be studied and the underlying reasons for inefficiency be identified. To this end, the study is guided by the following research questions:

i. What is the level of productive efficiency in Ugandan primary schools?
ii. To what extent do pupil, family, quality of school and teacher factors influence pupil academic achievement?

Establishing the efficient and less efficient schools, and identifying the underlying factors responsible for (in)efficiencies may provide useful information for mitigation and also make schools acountable. Using stochastic frontier analysis techniques on locally generated data, the study brings some contributions to the understanding of efficiency and/or more explicitly how to improve school performance given the school inputs and financial resource scarcity in a developing economy like Uganda. Therefore, the results of this study may fill this gap.

## EMPIRICAL LITERATURE

Several studies using education production theory have pointed out the factors responsible for inefficiencies in primary schools and the varying degrees of efficiency levels. A framework of stochastic production frontier and the determinants of productive inefficiency indicate instructional and non-instructional expenditures as correlates of student performance. A study conducted in Texas State found that educational spending could be reduced by about 30

percent and achieve the same outcomes if its schools were operated efficiently (Grosskopf et al. 1997). This implies that failure to address the inefficiencies in the education system leads to wastage of resources. It had earlier been echoed that U.S. schools had large increases in resources with little if any improvement in outcomes. Besides, improving school system's efficiency is not straightforward effort, and that the failure to observe improved performance along with the increased resources demonstrates inefficiency (Hanushek 1996).

It is argued that the absence of improved school performance associated with increased resources is because of confounding factors that are not held constant (Hedges & Greenwald 1994), though the authors agree that schools and teachers matter. However, there is another view that such indicators as education and experience of the teachers are not reliable measures of quality in schools (Hanushek 1996). Rather the standardized test scores can be adopted as plausible measures of quality in schools because they have not attracted much criticism in literature. More to this understanding, Chubb and Moe (1990) in their work found student ability, school organization, and family factors as key determinants of students' achievements. They argue that school autonomy is a crucial element of effective school organization. They present evidence that schools where principals and teachers have more autonomy are more efficient. They found that correlation between academic achievement and school resources disappears when other variables presumably family factors are controlled. However, given these empirical facts, the relationship between school resources and academic achievement might still be hidden in management deficiency.

Methodologically, studies using data envelopment analysis (DEA) have evidently become more common than stochastic frontier (SFA) applications in the context of measuring the efficiency of schooling institutions. Most of these studies are using cross section data. Some studies compare the results of SFA and DEA (Sengupta & Sfeir 1986 & Mizala et al. 2002). Others concentrate on inefficiency differences and testing the relationship between test scores and spending on instruction (Deller & Rudnicki 1993) or teachers' merit pay (Cooper & Cohn 1997). Heshmati and Kumbhakar (1997) used a model introduced by Battese and Coelli (1995) which assumes that inefficiency has a truncated-normal distribution and is dependent on school environmental factors. However, the DEA neither allows statistical inference nor distinguishes inefficiency from statistical noise. As a consequence, inefficiency may be overstated implying both of these factors may cause problems and uncertainty.

On the other hand, in stochastic frontier analysis (SFA), the shortcomings cited under DEA are avoided and for this reason, it is a better alternative. In addition to inefficiency differences, information on the estimated parameters, i.e. the effects of quantitative inputs on outputs are also obtained. Barrow (1991) assessed the efficiency of local authorities using both cross-section and panel data with stochastic and deterministic methods. Johnes and Johnes (2009) analyzed the cost efficiency of British universities using SFA allowing for heterogeneity between universities with random parameters i.e. using true random effects model introduced by Greene (2005).

It can be deduced from the foregoing discussion that schools have different levels of inefficiencies that are attributed to various factors. Moreover, there are many school and teacher specific inputs that affect school performance. The results on school efficiencies and its determinants are mixed, and the conclusions about the effects of school resources and teacher quality depend upon the traditional estimate of education production functions. Recent econometric estimates of models that account for technical efficiency show a positive marginal

effect of resources on performance (Bates 1997; Deller & Rudnicki 1993; Ruggiero 1996). In this paper, we estimate a stochastic production frontier, which tests the hypothesis that, teacher and school resource inputs matter for productivity.

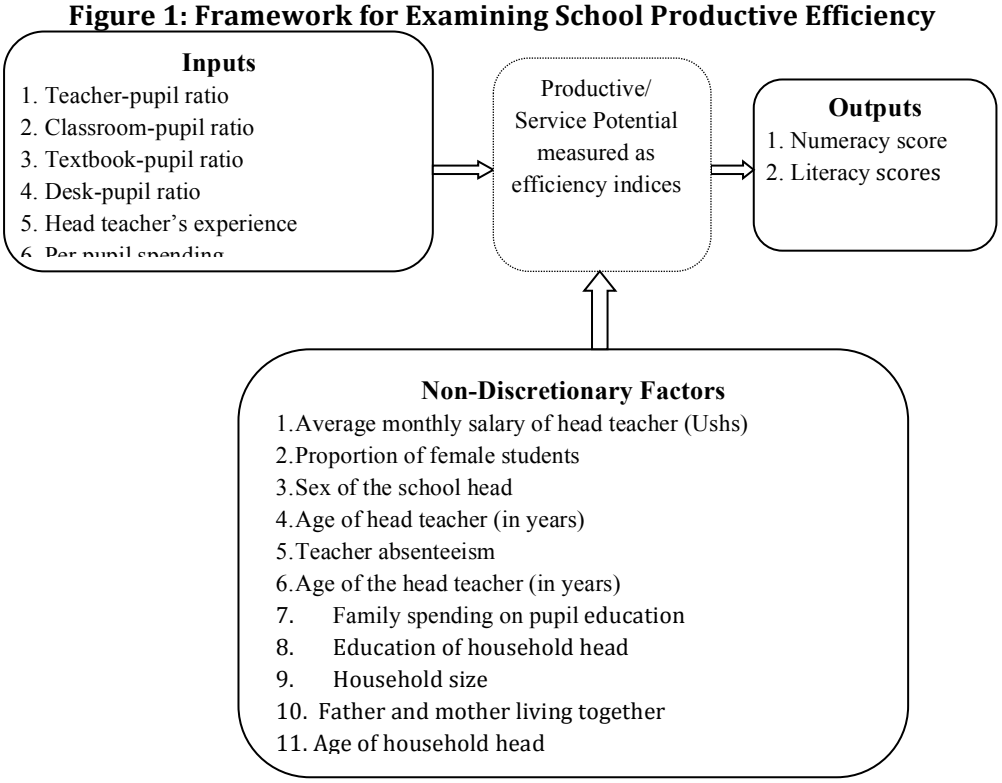
## METHODOLOGY

### Conceptual Framework

A conceptual framework (Figure 1) that explores productive efficiency considering a school as decision-making unit on discretionary inputs/outputs, and other factors external to the school's influence is developed and appropriate hypotheses formulated based on the works of Smith and Street (2006) and Mandl et al. (2008). A SFA model is employed that measure technical efficiency while distinguishing the statistical noise from inefficiency component. Besides, SFA has a priori assumptions about the functional form of the frontier regression. Most of recent 'efficiency' studies are rooted from the popular works (e.g. Debreu 1951; Farrell 1957) that provided basis and justification for measuring productive efficiency of service units. The service production process involves measuring the observable phenomenon such as inputs and outputs; specifying the relationship that exists between the phenomena; defining the efficient behavior; calculating the difference between each organization's observed data and the maximum achievable as defined by the specified relationship and judging how much of the difference is attributable to efficiency (Coelli et al. 1998).

The framework is also related or linked to the theory of public goods (Hammond 2002), where the efficient provision of public education is regarded as a two-stage production process. Stage one involves basic inputs (such as personnel, operating expenditures & infrastructure) used in the production of 'service or productive' potential, while stage two involves transformation of 'service' potential into desirable outputs (i.e. numeracy and literacy scores) depending on the demand and/or institutional environment (i.e. non-discretionary factors) where the service is being provided.

**Figure 1: Framework for Examining School Productive Efficiency**




**Source: Created by the author based on Smith and Street (2006), Mandl et al. (2008)**

In context, this investigation considers classrooms, teachers, desks and textbooks as public goods. Noteworthy that, though the distinction of two production phases allows evaluation of school productive efficiency where school management has full control of the inputs and outputs, there is a head teacher's factor (i.e. experience) which is somewhat an innate ability with a cumulative effect on not only students' achievement but also school performance, and it involves labor supply decisions.

**Models for Examining School Technical Efficiency**

Kumbhakar and Lovell (2000) proposed a good basis for stochastic frontier models with distinct parameterizations of the inefficiency term that can fit production functions. This approach is also emphasized in other various empirical works (e.g. Battesse 1992; Johnes & Johnes 2009; Mizala et al. 2002; Sengupta & Sfeir 1986) and with theoretical understanding from Greene (2005). Suppose the school as a producing entity exhibits a function $y_i = f(X_i, \beta)$ In the world of imperfection, the frontier analysis assumes that each school produces less than it can, due to a degree of inefficiency, thus yielding new specification as $y_i = f(X_i, \beta)TE_i$ where TEi is the level of efficiency for school 'i' in interval 0 and 1 inclusive. If TE =1 implies that the school is producing at optimal scale with the technology embodied in the production function and if TE<1 implies the school is not making the most of the inputs Xi in the production process. In context, output is also assumed to be subject to random shocks, implying that $y_i = f(X_i, \beta)TE_i \exp(v_i)$ and taking natural logarithms of both sides yields;

$$\ln(y_i) = \ln\{f(X_i, \beta)\} + \ln(TE_i) + v_i$$

If we consider various inputs, say k, that the school requires and then assuming that the production process is linear in natural logarithm, and defining $u_i = -\ln(TE_i)$ yields the following equation;

$$\ln(y_i) = \beta_0 + \sum_{j=1}^{k} \beta_j \ln(X_{ji}) + v_i - u_i$$

where ln *(.)* is the natural logarithm notation, subscripts *i* and *j* represent the inputs *j* used by school *i*. The coefficient *β0* is the level of technology and *βj*'s are the input elasticities. The outcomes *(yi)* are the test scores in reading and mathematics and the discretionary inputs are the textbook-pupil ratio, teacher-pupil ratio, classroom-pupil ratio, desk-pupil ratio, head teacher's teaching experience and per student spending, respectively. In the error term component, *vi* represents the random variable with null mean and unknown variance, and *ui* is the non-positive random representing the technical inefficiency for school *i*. However, *ui* is assumed to be independently and identically distributed between observations, and is obtained by truncation at point zero of the normal distribution with mean *μi*. Based on equation (2), the school technical efficiency (STE) of school 'i' can be computed as:

$$\mu_i = TE_i = \exp(-u_i)$$

The stochastic frontier estimation also specifies that the technical inefficiency component is heteroskedastic with the variance function depending on the linear combination of the non-discretionary factors as defined in the conceptual framework. The advantage of stochastic frontier estimation technique is it gives easily interpretable results, in the same way as the

standard OLS estimation approach. In effect, the frontier estimates have been contrasted with the OLS results to establish the robustness of frontier analysis against OLS. However, a drawback of the stochastic frontier analysis is the restrictive assumption about the functional form and its failure to consider multiple outputs (Ruggiero 1996). Nonetheless, the SFA approach is still regarded popular compared to other frontier methods for clear reasons highlighted above.

On the basis of reviewed literature and methodological framework, the following hypotheses are formulated and tested. First, it is hypothesized that school inputs exhibit increasing returns to scale, and that all schools are technically efficient, implying no additional outputs can be realized with increases in input mix. Second; school level hypotheses are that; average monthly salary of head teacher and high propotion of female students demostrate significant positive influence on test scores; low teacher absenteeism, increase in teacher age and male headteacher are all associated with improved academic performance. In addition, pupil and family related hypotheses state that; increase in expenditure on pupil education, schooled parents, small family size and increase in age of household head all demostrate positive effect on school academic achivement and viceversa. Moreover, male gender and decrease in pupil age have positive influence on achievement in literacy and numeracy scores.

**Data**

The study uses standardized tests administered by Uganda National Examinations Board (UNEB). About 2,000 primary six (P6) pupils sat for the tests in literacy and numeracy in 2008 in the districts of Apac, Iganga, Hoima and Kiboga. These districts represent regional and national framework in terms of performance in the Primary Leaving Examinations (PLE) conducted annually for primary seven (P7) pupils. Twenty five schools were sampled per district within which about 20 pupils from P6 sat the National Assessment for Progression in Education (NAPE) assessment tests. Data on budgets, schools and teachers was obtained from the baseline survey questionnaires administered by the Uganda Bureau of Statistics (UBOS) enumerators. The descriptive results for the variables are presented in Table 1 and appendices I – II, respectively. It is evident that about three quarters of the schools are headed by male teachers and teacher absenteeism is a rampant phenomenon with about 84 percent of teachers absenting from school for atleast a day per month. There is about equal gender representation in schools implying all children are given learning opportunities as a measure of improving literacy rates for all, and achieve MDGs targets.

It is also observed that parents are in a supportive way of children's schooling by allocating some family budgets to learning, as a response to government concerns on UPE policy arrangement. Though may not be sufficient but about averagely Ushs 1200 is spent on a pupil per family per month. Some features from appendix II indicate that average school enrolments are large in Iganga and least in Kiboga district (i.e. about one half the national average). The schools have on average 9-11 teachers and this varies depending on school size. In addition, across the four districts, the numeracy score are higher than literacy scores, and Iganga district tails in both subjects with scores below the pooled average.

**Table 1: Descriptive statistics of the variables used in analysis**

| Variable | N | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Age of household head | 1978 | 40.97 | 11.11 | 3.0 | 82.0 |
| Father and Mother living together | 1978 | 0.83 | 0.38 | 0.0 | 1.0 |
| Household size | 1978 | 6.37 | 3.44 | 0.0 | 33.0 |
| Education of household head | 1978 | 2.33 | 0.99 | 1.0 | 6.0 |
| Pupil age (in years) | 1978 | 13.57 | 1.19 | 10.0 | 20.0 |
| Pupil gender (Male=1) | 1978 | 0.50 | 0.50 | 0.0 | 1.0 |
| Proportion of female students | 1978 | 48.93 | 6.57 | 0.0 | 55.8 |
| Age of head teacher (<=40) | 1978 | 0.34 | 0.47 | 0.0 | 1.0 |
| Age of head teacher (>40-50) | 1978 | 0.39 | 0.49 | 0.0 | 1.0 |
| Age of head teacher (>50-60) | 1978 | 0.27 | 0.44 | 0.0 | 1.0 |
| Teacher absenteeism (0 days) | 1978 | 0.14 | 0.35 | 0.0 | 1.0 |
| Teacher absentiesm (1-5 days) | 1978 | 0.59 | 0.49 | 0.0 | 1.0 |
| Teacher absentiesm (>5 days) | 1978 | 0.27 | 0.44 | 0.0 | 1.0 |
| Gender of head teacher (Male =1) | 1978 | 0.76 | 0.43 | 0.0 | 1.0 |
| Family per pupil expenditure on education | 1978 | 1220.43 | 992.18 | 356.3 | 9795.5 |
| Average monthly salary of head teacher | 1978 | 329,660.1 | 92,645.9 | 0.0 | 519,800.0 |

**Source: Created by the author (2012)**

## RESULTS AND DISCUSSION

### Partial Elasticties and Returns to Scale

The partial elasticities of the school outputs (for numeracy and literacy subjects) are estimated and they permit the evaluation of the effect of changes in the amount of the quality inputs on the school outputs (Table 2).

**Table 2: Partial Elasticities and Technical Efficiency Indices**

| Partial Elasticities | Literacy | Numeracy |
|---|---|---|
| Text book –pupil ratio | 0.20*** | 0.08*** |
| Desk-pupil ratio | -0.10*** | 0.01*** |
| Teacher-pupil ratio | 0.38*** | 0.55*** |
| Class room-pupil ratio | 0.15*** | 0.30*** |
| Head teacher's experience | 0.02*** | -0.01*** |
| Per student expenditure | 0.07*** | -0.08*** |
| **Returns to Scale** | **0.11*** ** | **-0.10*** ** |
| **Level of technology** | 2.56 | 3.90 |
| **Technical Efficiency Indices** | | |
| Iganga | 0.37 | 0.44 |
| Apac | 0.46 | 0.58 |
| Hoima | 0.52 | 0.56 |
| Kiboga | 0.68 | 0.60 |
| **All** | **0.46** | **0.53** |

**Source: Created by the author (2012)**

Partial elasticities indicate the degree of responsiveness of the outputs for one percent change in the input requirements. The textbook-pupil ratio, classroom-pupil ratio and teacher-pupil ratio have positive elasticities on the two subjects while the rest have varying effect signs, respectively. Specifically, head teacher experience and per pupil family expense have positive elasticity on literacy and negative on numeracy, with returns to scale of 0.11 and -0.10 of school inputs on the former and latter, respectively. The negative scale implies that the increase of all the school factor inputs leads to less than the proportional increase in the school achievements in literacy and numeracy. The government's effort on improving school resource inputs such as textbooks, hiring teachers and constructing classrooms in primary schools may somewhat be linked to improved school outcomes. This result is contrary to previous research (e.g. Hanushek 1996) that indicated that school and teacher resources lead to little if any

improvement in school outcomes and that, it may not be clearly known on how to improve school systems' efficiency.

## Estimating Technical Effeciency Indices

The technical efficiency indices are estimated and grouped as per the district and subject, respectively. The indices vary from one district to another and in between subjects. Across the districts, the technical efficiency indices range from 0.37 to 0.68 with national averages of 0.46 and 0.53 for the two subjects (Table 2). It is worth noting that, 30 percent of the schools perform below optimal scale probably due to management defficiences attributed to school administration. Evidently, Iganga and Kiboga districts record the lowest (0.37 & 0.44) and highest (0.68 & 0.60) productive efficiences in literacy and numeracy, respectively. On the other hand, Iganga schools' service potential is below the national average, implying government's effort to revamp the education standards of the district could be wanting. The discriptive statistics also confirm this result, the district has low quality inputs probably justiying low outputs as compared to other districts. Besides, the average enrolments is high with low average scores compared to Hoima and Kiboga districts (Appendix II).

Examining the district specific indices, most schools in Apac district are moderately efficient (between 0.46 to 0.58) as compared to Kiboga district with most schools (about 68 percent) demostrating substantial (0.68 to 0.60) productive potential. Within schools in each district, most schools in Iganga score low efficiency levels (less than 0.40), while most schools in Hoima and Kiboga record relatively high scores, and yet these schools receive equal funding from similar sources. These results are in consonance with previous research works (e.g. Bates 1997; Ruggiero 1996) that, providing school inputs may account for some positive marginal effect on school achievement. Besides, schools' better organization, students' intellectual capabilities and their family background are some of the key determinants of their academic achievement and school success. It is also argued that school autonomy plays great deal, as it is crucial element of effective school organization and good practices (e.g. Hanushek 1996).

## Factors affecting Academic Achievements of Schools

The previous section discusses the degree or level of efficiencies of the schools across the four districts. However, we cannot significantly make strong case of the efficiencies between schools unless; the underlying causes of school academic achievements are identified and examined. Table 3 presents the stochastic frontier and OLS estimations of determinants of numeracy and literacy scores. A further reflection on both kinds of results indicates the frontier model results are superior as indicated by Vignoles et al. (2000). For instance; the frontier models look more robust than OLS as indicated by the clear differences in explanatory power of the literacy and numeracy regression estimates; there is consistency in effects across the two subjects, and of more significance are the slopes for the frontier models that are somewhat more steeper than OLS estimates. These features suggest frontier estimates weigh more robustly that OLS and thus the preceding discussion is based mainly on the stochastic frontier results with little reference, if any made on the OLS estimates.

**Table 3: Results of the Determinants of School Academic Achievement**

| | Frontier Stochastic model | | OLS model | |
|---|---|---|---|---|
| | Literacy | Numeracy | Literacy | Numeracy |
| Variable | Coef. | Coef. | Coef. | Coef. |
| | 0.05** | 0.63** | 0.10*** | 0.10** |
| Family per pupil expenditure on education | [0.03] | [0.30] | [0.03] | [0.05] |
| | 0.13** | 0.14*** | 0.01* | 0.07** |
| Education of household head | [0.06] | [0.06] | [0.01] | [0.03] |
| | 0.36** | 0.14 | 0.07 | 0.13 |
| Father and Mother living together | [1.51] | [0.15] | [0.07] | [1.01] |
| | -0.23*** | -0.72* | -0.09 | -0.03 |
| Household size | [0.08] | [0.38] | [0.06] | [0.07] |
| | 0.89** | 0.67* | 0.01** | 0.02* |
| Age of household head | [0.45] | [0.36] | [0.01] | [0.01] |
| Average monthly salary of head teacher | 0.27*** | 0.84*** | 0.14* | 0.35* |
| | [0.52] | [0.33] | [0.07] | [0.18] |
| Age of the head teacher | 0.80 | 0.68 | 0.05 | 0.11 |
| | [1.44] | [1.51] | [0.04] | [0.23] |
| Age squared of the head teacher | -0.56* | -0.09 | -0.02 | -0.03 |
| | [0.30] | [0.27] | [0.01] | [0.01] |
| Gender of head teacher (Male =1) | 0.22 | 0.64 | 0.01 | 0.03 |
| | [0.60] | [0.58] | [0.13] | [0.10] |
| Proportion of female students | 0.01 | 0.92 | 0.03 | 0.03 |
| | [0.01] | [0.62] | [0.04] | [0.03] |
| Teacher absenteeism (0 days) | | | | |
| Teacher absentiesm (1-5 days) | -0.25** | -0.06* | -0.40*** | -0.08** |
| | [0.12] | [0.03] | [0.16] | [0.04] |
| Teacher absentiesm (>5 days) | -0.52*** | -0.26** | 0.21* | -0.03** |
| | [0.03] | [0.13] | [0.11] | [0.01] |
| Pupil age (in years) | -0.35 | -0.27 | -0.05* | -0.05 |
| | [0.23] | [0.24] | [0.02] | [0.04] |
| Pupil gender (Male=1) | 0.75** | 0.53 | 0.01 | 0.01 |
| | [0.31] | [0.42] | [0.11] | [0.10] |
| Constant | 55.07*** | 7.23** | 2.67** | 5.01* |
| | [18.01] | [3.26] | [1.28] | [2.66] |
| Adjusted R-Squared | | | 18.1% | 19.9% |
| Wald $Chi^2$ / F-Statistic (P-value) | 33.27 | 30.56 | 2.72 | 1.72 |
| | (0.002 | (0.006) | (0.064) | (0.098) |
| N | 1978 | 1978 | 1978 | 1978 |

**Source: Created by the author (2012)**

Notes: Standard errors in the parenthesis, ***p<0.01, **p<0.05, *<p=0.1; The base category is "other" methods.

The results generally indicate that the effect of family per pupil education expenditure on the school productive potential is positive and significant (at 5%) across the two subjects, with high effect for numeracy model than for literacy. This implies other factors equal, increasing family expenditure on education by say, 1 percent raises performance by 5 percent and 63 percent in literacy and numeracy, respectively. It is also evident that the effect of household head education level on matriculation results is positively significant for the two subjects.

Several studies (e.g. Hanushek 1996; Chubb & Moe 1990) elsewhere have quite demonstrated and concluded that family socio-economic background plays great deal in pupil achievement and overall school productivity because of their cumulative effect on children cognitive

learning skills and innate abilities. This argument is further strengthened by the positive effect sizes of 'father and mother living together' and 'age of household head' variables on pupil achievement. Moreover, considering the pupil factors, there is no clear cut as most effects are insignificant. With exception of pupil gender effect on literacy scores, all other effects are insignificant though with correct effect signs. For instance, male gender demonstrates significant (5%) positive effect performance in literacy and positively insignificant on numeracy model, respectively.

The average monthly earning of the head teacher significantly (1%) improves school academic performance both in literacy and numeracy subjects, again with greater effect size on numeracy model. This implies other factors equal, increasing teachers' salary say by 1 percent raises achievement by 27 percent and 84 percent and viceversa. In this instance, the salary acts as motivational tool, and teachers are compelled to devote the required time to teaching and mentoring pupils. This may also imply, high salaries reflect the teacher quality. In other words, higher pay tends to be competitive and attracts better-qualified applicants and besides, the pay slows down the attrition of teachers with higher opportunity cost, presumably among dedicated teachers. Just like in South Carolina where they found that higher salaries were an incentive pay system to teachers and for better school results (Cooper & Cohn 1997). Age of the head teacher can usually be associated with teaching experience especially in primary education and thus improves school performance. The age factor exhibit diminishing marginal returns because there is maximum age beyond which the effect becomes negative. The older teachers tend to have a wealth of experience. Besides, the labor turnover among such category of teachers is relatively low as most of them probably tend to stay in one place as they wait for retirement. This practice gives them an opportunity to organize a school to produce better results.

The effect of teacher absenteeism on pupil achievement is shown to be negative and significant. Moreover, the effect sizes become larger as days of absenteeism also increase. For instance, effect of teacher absenteeism (> 5days) is about double (for literacy model) and four times (for numeracy model) than 1-5 days of absenteeism, respectively. Teacher absenteeism is partly an impediment to pupil academic progress and overall school productivity. It is rather straightforward to think that absenteeism implies no work done for the paid labor. This vice from work is a bad practice in every working aspect. In Uganda, absenteeism is rampant among teachers and this could largely reflect low efficiency in some or most schools.

## CONCLUSION

In conclusion, the better way to model efficiency of schools depends on the available information and the prevailing circumstances in that particular school. Otherwise, factors that influence school productivity and the indicators that measure technical efficiency are rather mixed. This study suggests that though money matters, it entirely depends on its efficient use and available resources to educate the pupils.

Better salary package may attract quality teachers who in turn improve school performance despite their higher costs. The study suggests that for efficient provision of education as public good, institutions should mobilize centers of power and capacity to use the available meager resources for productive gains. This can go along way with organizational culture and set-up of the institutions through supervision to mitigate absenteeism practices.

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# APPENDICES

## Appendix I

## Variable Definitions and Descriptions

| Variable category | Variable | Description |
|---|---|---|
| **School budget** | School expenditure per pupil per term | Measured in Uganda Shillings |
| **Quality of teacher inputs** | Experience of the head teacher | The number of the years the head teacher has served in the school being investigated |
| | Graduate head teacher | Yes =1; '0' otherwise |
| | Diploma head teacher | Yes =1; '0' otherwise |
| | Other qualifications of head teacher | Yes =1; '0' otherwise |
| | | |
| | Age group of the graduate teacher (>=26-40 years) | Yes =1; '0' otherwise |
| | Age group of the graduate teacher (>40-50 years) | Yes =1; '0' otherwise |
| | Age group of the graduate teacher (>50 years) | Yes =1; '0' otherwise |
| | Absentiesm of the head teacher (0 days) | Yes =1; '0' otherwise |
| | Absentiesm of the head teacher (1-5 days) | Yes =1; '0' otherwise |
| | Absentiesm of the head teacher (>5 days) | Yes =1; '0' otherwise |
| | Gender | Male=1; '0' otherwise |
| **Quality of school inputs** | Text book-pupil ratio | Number of text books per pupil |
| | Pupil-teacher ratio | Number of pupils per teacher |
| | Pupil-desk ratio | Number of pupils per desk |
| | Pupil-class ratio | Number of pupils per class |

**Source: Created by the author (2012)**

## Appendix II

## Summary of Selected School Quality Inputs and Outputs

| | Textbook-Pupil ratio | Pupil-desk ratio | Pupil-teacher ratio | Pupil-class ratio | Head teacher experience | Per pupil expense by school | literacy score | Average numeracy score | school size | Salary (000's) | N0. Of teachers |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Apac** | 3.0 | 15 | 74 | 135 | 2.8 | 894.9 | 16.6 | 25.3 | 789 | 328.8 | 11 |
| **Hoima** | 2.0 | 5 | 56 | 69 | 4.2 | 1478.2 | 24.3 | 28.8 | 508 | 332.6 | 10 |
| **Iganga** | 2.0 | 6 | 68 | 143 | 2.8 | 1611.7 | 13.9 | 18.5 | 611 | 356.5 | 10 |
| **Kiboga** | 3.0 | 4 | 37 | 49 | 3.2 | 2862.8 | 23.4 | 31.4 | 290 | 267.8 | 9 |
| **All** | 2.0 | 8 | 59 | 102 | 96 | 1513.6 | 19.3 | 25.7 | 552 | | 96 |

**Source: Created by the author (2012)**