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**Evaluation of the impact of school canteen programs on  
internal efficiency of schools, cognitive acquisitions  
and learning capacities of students in  
rural primary schools in Senegal**

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# Evaluation of the impact of school canteen programs on internal efficiency of schools, cognitive acquisitions and learning capacities of students in rural primary schools in Senegal

## Abstract

This study evaluates the impact of school canteen programs on the performance of rural primary schools in Senegal using a "randomized experiment". 120 schools which had never had school canteens were selected in the four poorest regions of Senegal. They were randomly assigned to treatment and control groups. Students in the second (CP) and fourth (CE2) years of primary school were observed in each of the selected schools. Many tests (student, Kolmogorov-Smirnov, Mann-Whitney Levene, Chi<sup>2</sup>) were performed in order to verify the random nature of the treatment assignment. The results show that, at the school level, the two groups are relatively homogenous, but there are some differences at the individual level. Thus, the double difference methods used to estimate the impact of the meal program on academic performance. The results are as follows: the canteen has a positive and significant impact on the overall score of students in grade 2 (10.56 points). This result is confirmed in both mathematics (12.32 points) and French (8.72 points). However, the impact is not significant for older children (more than 10 years old) in CP. In terms of gender, the study shows a difference in the impact in favour of girls in the fourth grade. Looking at the cognitive impact, we find that, except for the level of knowledge, the canteen has a greater impact on the cognitive ability of the youngest (aged six and seven years). Competencies in memory (33.23 points) and reasoning (23.92 points) improved by more. These results are all significant at the 5% confidence level. However, school canteens do not improve the internal efficacy of public primary schools: dropouts and repeated grades have certainly decreased, but none of the results are statistically significant. By improving the nutritional intake of children who benefit from the meals supplied to the school, the canteens have positive externalities on the nutritional intake of children living with the beneficiary students. Moreover, there are interaction effects between the school canteen and two traditional schooling quality inputs: poverty and class size. Regarding these results, we can state that universalizing school canteens can be an effective method to accelerate progress towards quality education for all.

**Keywords:** School canteens, primary education, rural areas, school dropouts, repeated grades, nutritional intake, evaluations, double difference.

**JEL Code:** O1, I21, I28, I38

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## I. Introduction

Endogenous growth theory has led to a rediscovery of the importance of and the stakes involved in education. In effect, education plays an important role in development processes, both at the macro level (Krueger and Lindahl, 2001) and at the micro level (Duflo, 2001; Angrist and Krueger, 1991). Solid evidence shows that education makes it possible to attain a higher quality of life as well as strong and sustained growth (Diagne, 2008). Due to technological progress, the productivity of labour depends more than ever on academic qualifications (Bartel and Lichtenberg, 1987).

It is no doubt these advantages which have led the international community to make "quality education for all" the second priority among the Millennium Development Objectives (MDGs), after poverty reduction. Despite these considerations and this international commitment, progress in education for all has been slow and unequal. According to the new data from the UNESCO Institute for Statistics (2011), 67 million children did not receive education in 2009. In Sub-Saharan Africa, even though the number of children not in school went from 43 to 30 million between 1999 and 2009, 23% of all school aged children in the region remain excluded from the education system (UNESCO, 2011). Poor quality of education is another characteristic of education in developing countries. The rates of repeated grades and dropouts from school illustrate this phenomenon.

The present question is to know how to significantly raise the quality of education, especially in rural areas where it can be observed that education quality falls furthest behind. Many studies are interested in this question, but these are very often focused on education inputs such as classrooms, teacher recruitment, textbooks, school fees, etc. (Glewwe and Kremer, 2006; Duflo et al, 2007b and Piketty, 2004). A small number of studies have emphasized food and nutritional aspects as factors to improve the quality of and access to education.<sup>2</sup>

Studies on these questions are, however, highly varied in terms of the areas of impact, the quality of their implementation, and in terms of the method of evaluation. The most commonly studied areas of impact are diligence, nutritional status, school participation, repeated grades and dropping out (Adelman, Gilligan and Lehrer, 2008; Cueto and Chinen, 2007; Afridi, 2005; Vermeersch and Kremer, 2004; Akakpo, 2004; Ahmed and Ninno, 2002; Moore and Kunze, 1994; etc.). Other researchers are interested in the effects of school meal programs on gender disparity (Afridi, 2007). According to Jomaa, McDonnell and Probart (2010), the

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<sup>1</sup>A recent study showed, among other things, that no less than 200 million children in developing countries did not attain their potential level of cognitive development or physical capacity (Paxson and Schady, 2007).

<sup>2</sup>This is the reason that the World Food Program has been implementing school canteen programs in many developing countries for a long time. In 2008, 68 developing countries benefitted from these interventions. Most are located in Africa (WFP, 2008), where a large share of households are exposed to poverty and food insecurity.

effects of cognitive acquisitions are until now less well studied. Studies by Cueto and Chinen (2007) in Peru and by Adelman et Al. (2008) in Uganda are number among the exceptions.

Another way to differentiate among previous works is the approach adopted. Some use non experimental evaluation (Sanchez, 2009; Afridi, 2007; Ahmed, 2004) and thus run into difficulties eliminating selection bias. Others use experimental approaches to rigorously evaluate the impact of school canteen programs (for example, Vermeersch and Kremer (2004); Duflo et al. (2007b) for Kenya and Powell et al. (1998) for Jamaica).

The literature review also highlights the rarity of experimental studies in Sub-Saharan Africa, with exceptions including Miguel and Kremer (2004) in Kenya, Vermeersch and Kremer (2005) in Kenya and Adelman et al., (2008) in Uganda. Miguel and Kremer (2004) are interested in the effects of deworming on education in the presence of externalities, while Vermeersch and Kremer (2005) test the effects of breakfast at school on the performance of preschool students. They do not find any effect on academic scores. As for Adelman et al. (2008), they show that meals at school do not raise the overall score of students in any age category considered. However, they underline the impact by age, and note a positive and significant result on the score of students aged between 11 and 14 who had experienced major delays in their studies.

The objective of this study is to fill in these gaps. It aims to evaluate the potential contribution of experimental school canteen programs on the access to primary education of boys and girls in rural areas, to keep students in school and to improve the quality of the education they receive.

This research makes a major contribution to the literature. It uses a randomised test to examine in detail the relationship between school canteen programs and both academic performance and cognitive acquisitions of students. The random assignment of the benefit eliminates the question of selection bias which many studies were unable to avoid. The experimentation that was carried out aimed to respect the principles of experimentation based on theory, such as a chain of causality linking the school meals to student's academic performance, comprehension of context, accounting for (anticipating) heterogeneity, use of multiple methods and a rigorous factual analysis.

The study deals with four regions of Senegal, a country in West Africa. Two are situated in the *centre* (Diourbel and Fatick) and the other two are in the *south* of the country (Sédhiou and Kolda). These two groups of regions have different characteristics. In terms of climate, those in the *south* receive more rain than those in the *centre*, which frequently face drought. In terms of accessibility, there are also differences in the density of the road network. The four regions also have common traits. They are among the poorest regions of the country and have school participation rates far under the national average, even though low school participation is more

marked in the *centre*, particularly in Diourbel. Finally, the pass rates at the primary final exam (CFEE) are far lower than the national average. These regions provide a promising context to verify the anticipated positive effect of a school feeding program. When considering improvements in nutritional status, increases in school participation and raising retention of students, the impact of school canteens should be as high as possible.

The study provides new results on how the academic performance of students in different grades and of different ages is affected by school feeding programs. It also shows how the impacts of this intervention are differentiated among four areas of cognitive ability (reasoning, memory, knowledge and understanding), which are very under-researched to date. In Sub-Saharan Africa, specifically in Uganda, just one experimental study has endeavoured to evaluate the impact of school feeding programs on learning capacities of students (Adelman et al., 2008). It provided information on the impacts of these programs on memorization, reasoning and ability to manipulate concepts. But, there was nothing on the impacts on the level of knowledge and comprehension which remain among the most targeted skills in basic education. According to the world report on monitoring Education For All (2005), many students at the end of primary are able to decipher a text, but do not always understand the meaning. The present study contributes to this question.

In selecting a francophone West African country, the study contributes significantly to the diversity of the literature. To date, research on school feeding programs are most concentrated on two countries: India (Afridi, 2011; Banerjee et al., 2004; Seshadri and Gopaldas, 1989; among others) and Kenya (Vermeersch and Kremer, 2005; Whaley et al., 2003; Duflo et al., 2007b; Glewwe et al., 2003; Neumann et al., 2007; Grillenberger et al., 2003; among others). The present study also updates research on the question, since the most recent was in 2004, with the exceptions of Adelman et al. (2008) and Adelman, Gilligan & Lehrer (2008) in Uganda. Thus, this is, to our knowledge, one of the first experimental evaluations in West Africa on the effects of providing hot lunches on cognitive acquisitions of students in rural primary schools.

The literature review on the contribution of inputs into education towards improved academic outcomes shows that, in developing countries, in addition to methodological weaknesses affecting the quality of many previous studies, school-level factors play an important role (Michaelowa, 2003). To our knowledge, the extent to which the school canteen programs strengthen or attenuate the effect of educational factors at the school level is relatively poorly studied. This is why the current research emphasizes the influence of schooling quality inputs on the efficacy of school feeding programs. Five factors are chosen to illustrate these facts: poverty, qualification of the teacher, availability of textbooks, and the school management committee and class size.

Finally, this study establishes the existence of complementarity and substitutability between the schools feeding programs and certain quality factors. Two categories of factors are used: factors linked to the school (class size, qualification of the teacher and availability of textbooks) and outside factors (whether or not coming from a poor family and degree of community commitment to the education of its children).

The results show that the school canteen programs make possible a significant improvement in the academic performance of schools. However, the impact is more pronounced among students in the second grade compared to those in the fourth grade. Moreover, the impact appears to vary with age within a grade, with younger students benefitting more, although this impact is only verified for the first grade. That the returns to school canteens decrease with age is also observed in terms of skill level. Referring to the BLOOM taxonomy (1957), school feeding programs have a greater beneficial impact on the cognitive on lower order learning processes such as knowledge and comprehension and have more limited impacts on higher order learning processes such as synthesis and evaluation, although their effects are more limited at higher levels of study. Then, various sources of heterogeneity are accounted for. We show that the impacts are higher for girls than for boys, and that the effect of canteens on the scores of students is greater when the educational establishment has a functional management committee or operates as a school cooperative. However, school canteens do not significantly improve the internal efficiency of public primary schools: dropouts and repeated grades have most certainly declined, but none of the results are statistically significant.

The remainder of the document is structured as follows. The general nature of the intervention is described in section 1. The sampling and the data are covered in a second section. Section 3 deals with methods to estimate the impact. Section 4 deals with the estimation results of the impact of school canteens. Section 5 analyses interactions between school canteens and traditional schooling quality inputs.

## II. General description of the intervention

The intervention consisted of providing hot lunches through school canteens set up in some primary schools in rural Senegal. By accounting for the average daily needs for energy and protein intake of the school population as described in the School Feeding Manual (*Manuel d'Alimentation Scolaire*) (WFP, UNESCO and WHO, 1999), the food basket in the canteen is calculated on the basis of caloric compositions of products to provide: maize,<sup>3</sup> legumes, vegetable oil and iodized salt. The WFP provided the food supplies each term (annex 1). A monthly contribution of 200 FCFA per student is required from parents for acquisition of other products not included in the food basket provided by the WFP, but which are important for the functioning of the school canteens, such as fresh vegetables, fish and meat, as well as cereals other than maize, since the only cereal supplied by the WFP is maize.

This program is carried out in rural areas in public primary schools situated in four poor regions of Senegal: two regions which are *central* (Fatick and Diourbel) and two to the *south* (Kolda and Sédhiou). These areas are characterized by a low presence of school canteens relative to the rest of the country and by major delays in terms of students' schooling progress, along with a very high prevalence of poverty and vulnerability. The food insecurity prevailing in these zones following bad harvests not only impacts household income, but also impoverishes their food intake. Their children are, as a consequence, exposed to more acute risks of malnutrition. Moreover, the regions in the *centre* are essentially composed of farmers, and are nearer to the capital (Dakar), while those in the *south* primarily raise livestock and are still very isolated.

Various actors have participated in implementation of school canteen programs. They are, principally, the World Food Program (WFP), the Ministry of Education through its School Canteen Division (DCS, *Division des cantines scolaires*), National Institute of Study and Action for Development in Education (INEADE), Departmental Inspectorates of National Education (IDENs), school directors, teachers and communities.

The program went on for more than one school year. The school canteens were set up in the primary schools between February 2009 and March 2009 and both the surveys and the baseline test were performed in the same period. The final evaluations took place in June 2010. Thus, the duration of being exposed to the treatment is 13 months.

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<sup>3</sup>The cereals provided initially included rice, but since the food crisis the WFP has replaced it with maize to make up for price increases in order to maintain areas already covered.

### III. Sampling and data

#### Sampling

The first stage of targeting allowed us to select regions eligible on the basis of criteria relating to poverty and food insecurity. The second stage consisted of selecting eligible schools in each region. Each eligible school must not have a school canteen at the time of the beginning of the program. They must also have a total of at least 50 students, and no more than 600 students, for management reasons. Another eligibility criterion for the program is that the school should have an operational management committee. Finally, the school should have at least one class in each of the second and fourth grades (CP and CE2 in Senegal).

Based on these criteria, a sample of 120 schools was randomly selected. These schools are then distributed randomly into two groups of 60 schools: the treatment group (schools benefitting from meals supplied to the school) and the control group (non-beneficiary schools). Another group of 47 schools was selected among the population of remaining schools to serve as a replacement list. In each school, 40 students were randomly chosen in the CP (20 students) and CE2 (20 students) classes to take the standardized tests.

#### Data

Two types of data are used: primary and secondary. The primary data are collected within the framework of a two-phase survey performed by the CRES under the supervision of the Ministry of Education. The information collected from these surveys, used to provide a baseline and for monitoring, deal with the census of the school-aged population within a four kilometre radius of the school. Fact sheets are also used to collect data on the operations of school canteens. Moreover, data on the educational performance of students was collected at the beginning and end through standardized tests. The tests were designed by INEADE, which organized and graded the students' work. As for secondary data, they are taken from a database of the Ministry of Education, and also from the IDEN. They provide information on the total number of students, the number of dropouts and repeats, and the number of schools situated within a four kilometre radius of each school in the sample.

To verify the randomness when assigning the treatment group, a parametric student test (t-test for equality of averages) was performed on the pre-program individual-level characteristics (table 1). The results show significant differences between the two groups for many variables. Similar results are obtained when applying other tests (Kolmogorov-Smirnov, Mann-Whitney and Levene).<sup>4</sup>Thus, the groups are not homogenous at the individual level.

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<sup>4</sup>The results of other tests are not presented in the article, but are available from the authors. They show that we find significant differences between the two groups for quite a number of pre-program characteristics.

**Table1: Student test applied on student, household and school (individual level)**

Variables	Control (schools with no canteen)		Treatment (schools with canteen)		H <sub>0</sub> : equality of averages
	Observation	Average (std error)	Observation	Average (stderror)	Difference (p-value)
<b>Characteristics of student</b>					
Age of student	954	10.356 (0.0623)	1117	10.015 (0.0601)	0.341 (0.000)***
Sex of student (girl=1)	1302	0.456 (0.013)	1586	0.528 (0.012)	-0.072 (0.000)***
Attended Koranic school (yes=1)	1302	0.236 (0.011)	1586	0.266 (0.011)	-0.029 (0.069)*
Health situation(sick=1)	1302	0.22 (0.011)	1586	0.258 (0.01)	-0.038 (0.017)**
Attended preschool (yes=1)	1302	0.043 (0.005)	1586	0.04 (0.004)	0.003 (0.647)
Received dewormer (yes=1)	1302	0.163 (0.01)	1586	0.178 (0.009)	-0.014 (0.292)
<b>Characteristics of student's household</b>					
Age of household head (HH)	954	51.421 (0.4304)	1117	52.307 (0.395)	-0.886 (0.129)
Sex of household head (female=1)	1206	0.907 -0.008	1508	0.911 (0.007)	-0.003 (0.774)
Marital status of HH (married=1)	1200	0.947 -0.006	1505	0.952 (0.005)	-0.005 (0.526)
Religion of HH (Muslim=1)	1202	0.94 (0.01)	1507	0.960 (0.000)	-0.02 (0.01)**
HH is literate (yes=1)	218	0.527 (0.033)	254	0.492 -0.031	0.035 -0.444
Monthly food expenditures	941	67235.8 1304.95	1091	76005.14 1480.14	-8769.27 (0.000)***
Time to walk to school (minutes)	954	14.95 0.432	1117	16.760 0.432	-1.804 (0.003)
Household size of student	954	13.09 0.233	1117	13.742 0.171	-0.644 (0.023)
Number of rooms in student's household	922	5.434 0.103	1435	5.454 0.098	-0.0194 (0.895)
Annual education expenditures	927	31171.2 1072.62	1443	31949.2 1021.8	-777.96 (0.613)
Annual health expenditures	927	46918.21 2023.37	1443	44263.6 1511.50	2654.66 (0.285)
<b>Characteristics of student's teacher and school director</b>					
Experience of student's teacher	954	5.43 (0.123)	1117	5.17 (0.123)	0.255 0.145
Age of student's teacher	954	31.7 0.1821	1117	31.58 0.1692	0.112 0.649
Qualification of teacher (BFEM=1)	1302	0.53 0.013	1586	0.59 0.012	-0.06 (0.001)***
Age of school director	921	38.83 0.26	1083	38.42 0.207	0.402 0.228
Experience of school director	725	14.314 0.314	943	11.303 0.18	3.011 (0.000)***
Qualification of director (CEAP=1)	1059	0.322 0.014 0.035	1284	0.159 0.233 0.012	0.162 (0.000)*** (0.000)***

### **Academic results of students and schooling performance of schools**

Aggregate score	954	30.43 0.363	1117	29.92 0.342	0.514 (0.3043)
Score in mathematics	954	30.86 0.436	1117	29.92 0.434	0.94 (0.129)
Score in French	954	30.007 0.474	1117	29.96 0.435	0.041 (0.948)
Repeat rate	948	6.409 0.208	1117	7.947 0.255	1.538 (0.000)***
Dropout rate	948	3.919 0.254	1117	5.013 0.199	-1.093 (0.000)***

**Notes:** Significant at 1% (\*\*\*), 5% (\*\*) and 10% levels.

**Source:** Authors, using the survey on school canteens in Senegal (CRES, 2009-2010).

Program treatment was assigned at the school level and the same tests were given. The results show a degree of homogeneity. We deduce that the significant differences at the individual level can be attributed to the degrees of freedom rather than the randomization process

## IV. Impact estimation methods

The equality of averages tests does not rigorously confirm the hypothesis of homogeneity. Thus, the unbiased estimator of the treatment effect is calculated using the double difference method. We are looking to eliminate the temporal changes by postulating the hypothesis that the control group experiences the same temporal changes as the treatment group. We thus have:

$$E(Y_1^c - Y_0^c | T=1) = E(Y_1^c - Y_0^c | T=0).$$

The average treatment effect obtained by double differences is given by  $\Delta^{DID}$  :

$$\Delta^{DID} = [(E(Y_1^T | T) - E(Y_0^T | T)) - (E(Y_1^C | C) - E(Y_0^C | C))].$$

$Y_0^T$  represents the average of the treatment group before program implementation ( $t=0$ ), and  $Y_1^T$  represents the average of this group afterwards ( $t=1$ ). Similarly,  $Y_0^C$  represents the average of the control group before implementing the program ( $t=0$ ), and  $Y_1^C$  afterwards ( $t=1$ ).

We can use the ordinary least squares (OLS) method to estimate the preceding equation. The advantage is to provide information on the significance of parameters and to control for certain pre-program characteristics. The model to estimate is the following:

$$Y_i = \alpha + \beta T_i + \gamma t_i + \delta(T_i \cdot t_i) + \varepsilon_i \quad (1)$$

With  $i = 1, \dots, N$  and  $t = 0, 1$ .

$Y_i$  is the score of student  $i$ ,  $T_i$  is an indicator of treatment (=1 if  $i$  receives the treatment),  $t_i$  is a time index (=1 in the post-treatment period),  $\alpha$  represents the constant in the regression,  $\beta$  is the specific effect on the treatment group,  $\gamma$  measures the shared time trend of both groups,  $\delta$  is the estimator of the average effect of treatment and  $\varepsilon_i$  is the error term.

This equation can be controlled by the pre-program characteristics which may influence the academic results of students. The model to estimate becomes:

$$Y_i = \alpha + \beta T_i + \gamma t_i + \delta(T_i \cdot t_i) + \sum_{j=1}^n \lambda X_{ij} + v_i \quad (2)$$

$X_{ij}$  is the vector of preprogram characteristics and  $v_i$  is the new error term.

While randomization<sup>5</sup> was performed at the school level, while there are no significant differences in group characteristics at the school level between the control and treatment groups, the same cannot be said at the level of students. Positive correlation may exist between students in the same class, or even in the same school. We must therefore account for this cluster phenomenon in the estimation of equation 2.<sup>6</sup>

The estimation in panel form makes it possible to account for specific individual unobserved effects, considered by OLS as being the same for each individual, and for individual observable effects which vary over time. Equation 3 gives the model to estimate:

$$Y_{it} = \alpha + u_i + \beta T_{i1} + \gamma t + \delta(T_{i1} \cdot t) + \sum_{i=1}^n \lambda X_{it} + \epsilon_{it} \quad (3)$$

$X_{it}$  is the vector of individual observable characteristics which vary over time (age, income, etc.),  $u_i$  is the specific unobserved individual effect which varies over time and is non-random, while  $\epsilon_{it}$  is the new error term of the equation and represents the unobserved characteristics in time  $t$  of individual  $i$ .

The results obtained in the preceding give the overall effect of the program on the population (ATE: average treatment effect). Equation 4 gives us the average treatment effect on the treated (ATT) by accounting for partial adherence.<sup>7</sup> The regression is performed in two steps:

The equation to estimate in the first step is:

$$T_{fi} = \alpha + \beta T_i + u_i \quad (3)$$

The equation to estimate in the second step is:

$$Y_i = \alpha + \beta \hat{T}_{fi} + \gamma t_i + \delta(\hat{T}_{fi} \cdot t_i) + \lambda X_i + v_i \quad (4)$$

Estimation of equation 4 must account for cluster effects as in equation 2. We must point out that the two estimators (ATE and ATT) are pertinent depending on whether we aim to measure the effect across the entire program or only on those who benefitted (Parienté, 2010).

<sup>5</sup> See Duflo et al. (2007a) for more details about these methods of impact evaluation.

<sup>6</sup> Using STATA to account for the cluster phenomenon, the cluster option was added to all of the estimates.

<sup>7</sup> The concept of partial adherence is very important in the context of an experimental program. When this is not accounted for in the estimates, the results measure the intention to treat rather than the actual effect of the treatment on the treated. The debate has not been settled regarding the two types of impact, but it turns out that the intention to treat is more important for policy makers because it more closely reflects reality. When a public policy is implemented, there is a strong chance that the entire target population benefits or that non-targeted persons do not benefit at all (cf. Gertler et al., 2010). For more details on these issues see Angrist and Lavy (2004) or Gertler et al. (2010).

An important aspect of the study concerns interactions between the canteen and factors underlying education quality. Equation 5 introduces the model which accounts for these interactions.

$$Y_i = \alpha + \beta T_i + \gamma t_i + \delta(T_i * t_i) + \varphi_1(T_i * \square) + \varphi_2(t_i * \square) + \varphi_3(T * t_i * \square) + \lambda F' + \varphi_4 \square + \omega_i(5)$$

$\square$  is the interaction variable,  $F'$  is the vector of control variables and  $\omega_i$  is the new error term. The estimator is the interaction effect between the variable of interest and the education quality factor is given by  $\varphi_3$ . If the last of these is positive (negative), we can say that there is complementarity (substitutability). In this case, the impact of school canteens is strengthened (weakened) by the quality factor.

## V. Estimation of the impact of school canteens on:

- cognitive acquisitions
- learning capacity of students
- internal efficacy of schools
- quality of nutrition of children

### 5.1 Impact of canteens on global cognitive acquisitions

The table in annex 3 presents the estimation results of the impact of school canteens on the cognitive acquisitions of students. The estimates are performed using two techniques: ordinary least squares and fixed effects. In both cases, we find that the school canteen improves the cognitive acquisitions of students by 6.03 percentage points. This result is significant at the 5% level. If we control for pre-program characteristics in the equation, the effect becomes slightly smaller (5.59 points), but remains significant.

Using the information from the Ministry of Education and telephone calls to directors of certain educational establishments which were surveyed, it was found ex-post that eight schools in the treatment group did not ultimately benefit from the program, while 12 schools in the control group ultimately benefitted from a school feeding program. Several explanations can be offered. Concerning the 12 control schools which received the treatment, they benefitted from programs of other partners. The WFP is not the only organization in Senegal supporting schools by offering them a school canteen. Others, including CARITAS, Counterpart International and JICA, support this type of program. For ethical reasons, the research program was not able to stop the school canteens from being set up in schools targeted by these organizations. As for schools in the treatment group which did not benefit from the program, these were late in

establishing a parent student association to receive the food from the WFP, while others did not ultimately have the number of students required, or it was not possible to make contact with the school director when the time came to proceed with steps to program implementation.

Thus, the program does not have complete adherence. Accounting for this fact gives the average effect among treated students. It is greater than the effect obtained in the overall sample (9.1 compared to 6.3 percentage points) (annex 9). It is also significant at the 1% level. Overall, the canteens significantly improve the students' standardized test scores, i.e., overall they improve the cognitive acquisitions of students, although differences were observed by level of study.

In effect, the canteen only has a positive and significant effect on the average score of students in the second grade (CP). The score increases by 11.9 points (annex 4). It is somewhat smaller (10.6 points) when controlling for characteristics, but both results are significant at the 1% level. However, for students in the fourth grade, we observe a 3.8-point increase in their average score, although the impact is not significant at the 10% level. Thus, canteens do not improve the score of the youngest students.

When considering the impact on cognitive acquisitions by gender, we find interesting results. Overall, the canteen only improves the score of girls, whose results improve by 6.4 points. This result is significant at the 5% level. Aside from physiological considerations as described by Alton (2005) and Tupe et al. (2008),<sup>8</sup>this result can be explained in two ways. First, we point to the existence of discrimination within households in terms of access to food and redistribution of income (Adelman et al., 2008). Second, the canteens implicitly retain girls at school, which frees them from heavy household chores which they usually perform in the afternoon. Thus, they are less distracted and study better.

**Table2: Overall impact of canteens on cognitive acquisitions by level of study**

Aggregate scores				
	CP		CE2	
Treatment*time	<b>11.86</b>	<b>10.56</b>	<b>3.81</b>	<b>2.80</b>
	(3.586)***	(3.854)***	(2.453)	(2.712)
Treatment	-2.58	-3.65	.744	-0.628
	(1.499)*	(1.867)*	(1.559)	(1.635)
Time	6.57	7.13	29.35	29.24
	(2.483)**	(2.855)**	(1.699)***	(1.939)***
Characteristics of student				
Sex (female=1)		1.58		-2.17
		(1.206)		(1.023)**
Age		1.18		0.48
		(0.399)***		(0.210)**
Eats until full (yes=1)		3.72		2.88
		(1.804)**		(1.479)*

<sup>8</sup>For Alton (2005) and Tupe et al. (2008), physiological differences mean that girls have greater nutritional needs than boys. For example, they need more iron than boys, due to their particular characteristics. This is particularly the case for girls of child-bearing age (Tupe et al. 2008). This may result in differences in responses to school food programs.

In state of good health (yes=1)	-2.61 (1.099)**	1.27 (.802)		
Interruption of studies (yes=1)	1.16 (2.466)	-0.64 (1.253)		
Nutritional conditions	0.51 (1.897)	0.74 (1.257)		
Attended preschool (yes=1)	-3.63 (2.499)	0.36 (1.364)		
<b>Characteristics of school of student</b>				
Household size	0.07 (.040)*	0.03 (.0713)		
Household head is literate (yes=1)	-3.49 (1.519)**	-1.05 (0.914)		
Age of household head	0.07 (0.040)*	0.01 (.021)		
Religion of household head (Muslim=1)	2.25 (1.486)	1.69 (0.992)*		
Marital status of household head (married =1)	3.30 (2.343)	1.77 (1.814)		
Sex of household head (female=1)	4.37 (1.797)**	-2.88 (1.133)**		
<b>Characteristics of school</b>				
Existence of management committee at school (yes =1)	-1.85 (2.465)	-.656 (1.732)		
Time to walk to school (minutes)	-0.06 (0.055)	-0.03 (0.031)		
Existence of separated latrines (yes=1)	-1.36 (2.319)	-1.32 (1.802)		
<b>Characteristics of teacher and director</b>				
Experience of teacher	-0.01 (.251)	-0.13 (.201)		
Qualification of director with BAC <sup>9</sup> (CAP=1)	-20.64 (4.356)***	-2.03 (6.566)		
Qualification of director without BAC (CEAP=1)	-22.26 (4.074)***	-2.18 (6.514)		
<b>Location</b>				
Location of school (centre=1)	4.82 (2.687)*	5.74 (1.80)***		
<b>Number of observations</b>	<b>1698</b>	<b>1352</b>	<b>2444</b>	<b>1978</b>
<b>R2</b>	<b>0.1493</b>	<b>0.2105</b>	<b>0.5507</b>	<b>0.5851</b>

**Notes:** (.) Standard error; significant at 1% (\*\*\*), 5% (\*\*) and 10% (\*) levels; **HH:** household head; the cluster option is added to the estimations.

**Source:** Authors, using the survey on school canteens in Senegal (CRES, 2009-2010).

## 5.2 Global scores in mathematics and French

This study evaluated the impact of canteens on the fundamental disciplines of primary education,<sup>10</sup> mathematics and French. Annex 10 presents the estimation results. In French, we find that the program increases the average score of students by 5.6 percentage points. The effect disappears when we add the control variables. These results corroborate the conclusions

<sup>9</sup>In Senegal, the qualifications required of primary school teachers are: one year of vocational training to obtain an Elementary Certificate of Pedagogical Aptitude (CEAP, *Certificat Élémentaire d'Aptitude Pédagogique*) for those with a BFEM and a Certificate of Pedagogical Aptitude (CAP, *Certificat d'Aptitude Pédagogique*) for those with a bachelor's.

<sup>10</sup>CONFEMEN (Conference of Education Ministers of Countries Using French as a Common Language) considers French and mathematics as the two main disciplines in primary education. They are used to evaluate the performance of students in member countries of this organization.

of Powell et al. (1998) which show that school meals do not substantially improve abilities in French. As opposed to French, the canteen significantly improves the average score of students in mathematics (6.35 points without control and 6.32 points with control). Thus, canteens are only confirmed as improving cognitive acquisitions in this discipline. This result confirms findings in previous studies by Ahmed (2004) and Whaley and Neumann (2003).

### 5.3 Scores in French and mathematics by level of study

The analysis of the effect of school canteens by discipline (French and mathematics) and level of study (CP and CE2) reveal other interesting results. Previous trends are confirmed by discipline. In both mathematics and French, the program only improved the cognitive acquisitions of the youngest (grade 2). In the literary discipline (French), the estimates show that school canteens increase the average score of students in CP by 11.0 percentage points. After introducing the control, the effect is slightly smaller (8.7 points), but is still significant at the 5% level. As for the more technical discipline (mathematics), the results are similar. The canteens only significantly raise the scores of students in CP (12.6 points without control variable and 12.3 with control variable). It is worth noting that the gain is four points higher in mathematics than in French for students in CP.

The results are very interesting for education policy. By increasing the average score of second grade students in French, the canteen improves the skills of students in reading and writing, the most targeted skills in French tests in grade 2. The capacity to read is crucial because it helps students understand, which allows them to learn well. If the student does not know how to read, and thus does not understand what he/she is supposed to be learning, the risk of dropping out is real (Gove and Cvelich, 2010). As such, the canteen combats the risk of dropping out and thus fights against poverty in the long run.<sup>11</sup>

The experimental research showed that, of all learning in school, mastering French, and in particular learning to read, should be first priority. It is the most crucial skill to develop at school. It is one of the best predictors of academic achievement; the best opportunity to teach children to read and write is between grades 1 and 3. If at this stage students do not have a good level of reading and do not understand what they read, the probability that their level will decline over time is very high (Gove and Cvelich, 2010). Gauthier et al. (2003) remind us of an important result shown in previous studies, namely that a student with difficulties in reading at the end of first grade of primary school (C1) has a nine in ten chance of having bad grades by the end of fourth grade (CE2).

Of even greater concern is the fact that the probability that this same student is having difficulties in secondary school is about 90%. This result should not be surprising. For all materials

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<sup>11</sup>Students who leave school before obtaining the minimum skills required are very likely to be poor. These results have been demonstrated by many recent studies (Hanuschek and Woessmann, 2007; Glewwe, 2002).

which require reading, the student who is behind in reading at the end of CP has a high probability of dropping out. The need to intervene as quickly as possible in the development of students' reading skills is clear. This recommendation is crucial for students from disadvantaged families.

#### **5.4 Scores in French and mathematics by age and level of study**

In Senegal, the normal age for CP is between 6 and 7 years of age. Students who are above this age are considered as experienced some delay in their studies. In this study, the impact of school canteens on cognitive acquisitions in French and mathematics was estimated by level of study and age of student. The second of these is broken into three categories: 6-7 years, 8-9 year and more than 10 years. The results of these estimates are presented in annexes 6 and 7. The second grade results show, at the 5% level, that school canteens only improve the results of students aged 8 and 9 year in both mathematics and French. For those who are delayed in their schooling progress, whether because they repeated a grade or because they entered school at a later age than other students, the results are not significant. None of the results for fourth grade students were statistically significant.

#### **5.5 Impact of school canteens on cognitive skills of students**

The standardized tests are organized on the basis of items which aim to evaluate a certain number of skills as described in the BLOOM taxonomy.<sup>12</sup>In the present study, the impact of the canteens is determined in terms of four cognitive skills: comprehension, reasoning, memorization and knowledge. These are not affected by hunger or nutritional deficiency in the same way.

Concerning comprehension skills, the canteen has a beneficial impact on second grade students; in particular those aged 8 and 9 (7.6 points). Moreover, no significant impact is observed in comprehension skills in the fourth grade. The few results which exist for CE2 students aged 8 and 9 disappear when we add the control variables to the equation. These trends are almost the same for other skills such as reasoning and memorization. In effect, in these two areas, the impact of the canteen is only significant for age categories 6-7 years and 8-9 years in the second grade. The impacts on reasoning and memorization are respectively 23.9 and 33.2 points for the first age category and 15.6 and 17.2 for the second. For the level of knowledge, the canteen has a greater impact among those who are behind in second grade, a group whose score improves by more. This impact is not statistically significant among the youngest (6-7 years).

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<sup>12</sup>The BLOOM taxonomy accounts for 6 areas: knowledge, comprehension, application, analysis, synthesis and evaluation, which constitute successive steps in the development and perfection of the human spirit.

Finally, we find that canteens have a much stronger impact in smaller classes and in reasoning and memorization skills. In effect, the cognitive functions most affected by hunger are directly related to reasoning and memorization skills. Three cognitive functions are involved in reasoning: attention, memory and mental imaging. The function which is most affected by hunger is, to a certain extent, attention. A student suffering from hunger cannot sufficiently concentrate in class and retains less of what he/she learns, and girls are more vulnerable than boys (Alton, 2005; Tupe et al., 2008).

## **5.6 Impact of school canteens on the internal efficacy of schools**

Internal efficacy allows us to follow cohorts during their time in the system. This measure of internal efficacy is captured using flow indicators, namely the repeat and dropout rate flow indicators. The impact of canteens is studied for both of these indicators of the internal efficacy of the education system.

### ***Repeating grades***

The repeat rate is the proportion of students who passed a grade and who repeated the grade. The results show that the canteens substantially improve the internal efficacy of beneficiary schools by reducing the repeat rate by 0.17 percentage points, although the coefficient is not significant at the 10% level. The results are similar in terms of their significance when accounting for partial adherence: we have a greater impact (0.27 points), which is also non-significant.

We should underline that the significance of the results may be linked to the ability of the experimental approach to detect very small impacts on the dropout rate. The threshold for the minimum detectable effect is 1.16 points (annex 11), but the impact is about 0.17 points.

### ***School dropout***

The dropout rate is the proportion of students registered in a given grade who leave the school system in the following academic year. It provides information on the retention capacity of the education system. The regression results using the difference-in-difference method show that school canteens positively impact school retention, although the impact is not statistically significant. They decrease the dropout rate of the schools by an average of 1.17 percentage points (annex 17). In the treated schools, canteens decrease the dropout rate by 1.74 percentage points, but the result is not always statistically significant (annex 19).

## 5.7 Impact of school canteens on students' quality of nutrition

The analysis of the nutritional state of students in the sample shows that they have fairly imbalanced food intake. When comparing daily recommended intakes for children in this category to the intakes of students in the sample, we observe a wide gap. While the average energy needs are evaluated at 2000 kcal/day, students only obtain 1123kcal from their food, barely half of what they need. However, in terms of protein, children are above minimum needs (47 g/day compared to the 40g they need). While proteins are indispensable for proper functioning of the body, we should point out that it is energy intake which provides the body with energy and facilitates motor activities. If children are in caloric deficit, this may affect every type of cognitive acquisition. Tables 3 and 4, which follow, respectively present the nutritional situation of children in the sample and recommended daily needs.

**Table 3: Daily nutritional values of students before intervention**

Variable	Number of students	Average	St. dev.	Median	Maximum
Total quantity of energy	2496	1123.55	796.71	999.77	7649.40
Total quantity of protein	2496	47.95	33.45	42.67	299.56
Total quantity of lipids	2496	31.97	22.32	27.44	234.43
Total quantity of carbohydrates	2496	206.50	159.69	176.80	1650.17

**Source:** Authors, using Survey on School Canteens in Senegal (CRES, 2009-2010).

**Table 4: Average daily needs for energy and protein of children in preschool and primary**

	Primary school: children aged 6 to 12 years	Preschools: children aged 3 to 5 years
Energy (kcal)	2000	1600
Protein (g)	40	32

**Source:** Guide to implement and manage school canteens (*Guide de mise en place et de gestion des cantines scolaires*), School Canteens Division, 2011.

### Did the canteens improve the nutritional state of beneficiary children?

Before the program, children consumed an average of 1179.8 kcals, 32.4 g of lipids, 49.8g of protein and 219.6g of carbohydrates per day. After treatment, the intake values respectively rise to daily intakes of 1557.0 kcals, 62.2 g of protein, 42.0 g of lipids and 250.3g of carbohydrates. The table below, using the double difference method, shows that school canteens improve the nutritional state of beneficiary children. Table 5 show that intake rises for energy (323.0 kcal), lipids (2.7 g), protein (7.8 g) and carbohydrates (25.7g).

**Table 5: Impact of school canteens on nutritional state of beneficiary children**

Variable	Energy	Lipids	Protein	Carbohydrates
<b>Impact</b> (standard error)	<b>329.35</b> (20.98)***	<b>2.67</b> (0.97)***	<b>7.79</b> (0.57)***	<b>25.73</b> (1.94)***
<b>Number of observations</b>	5160	5060	5060	5060
<b>R2</b>	0.072	0.008	0.019	0.017

**Notes:** Significant at the 1% (\*\*\*), 5% (\*\*) and 10% (\*) levels; the cluster option is added to account for variation within schools.

**Source:** Authors, using Survey on School Canteens in Senegal (CRES, 2009-2010).

### Do canteens make it possible to improve the nutritional situation of children living with beneficiary children?

When applying the double difference method on the nutritional status of children living with beneficiary students, we observe positive external effects of the canteen. The results in the table below show that the school canteen program has a positive impact on the nutritional values of children living with students benefitting from a meal provided at the canteen. Energy intake of children benefitting from meals provided by school canteens improves by 142.4 kcals, as do intake of lipids (8.6g), protein (6.7 g) and carbohydrates (18.3g).

**Table 6: Impact of school canteens on nutritional situation of children living with beneficiary students**

Variable	Energy	Lipids	Protein	Carbohydrates
<b>Impact</b> (Standard error)	<b>142.486</b> (62.246)***	<b>8.65</b> (2.463)***	<b>6.617</b> (2.706)***	<b>18.306</b> (11.919)***
Number of observations	4894	4894	4894	4894
R2	0.0421	0.0769	0.0355	0.0271

**Notes:** \*\*\* Significant at 1% threshold; the cluster option is added to account for variability within schools.

**Source:** Authors, from survey on school canteens in Senegal (CRES, 2009-2010)

## VI. Extensions

The role of schooling inputs in the quality of education has been the object of many studies. Some are old (Jamison et al, 1981; Levinger, 1986; Angrist et al., 1999, etc.), and others are more recent (Duflo et al., 2007b; Glewwe and Kremer, 2005; Piketty, 2004; Glewwe et al., 2004; Vermeersch and Kremer, 2004; etc.). The interactions of these inputs have generated significant controversy. Some affirm that the effects of school canteen programs on academic performance depend on a combination of factors including design and administration of the

program, student characteristics and organization of the school (Korugyendo and Benson, 2012), whereas others estimate that the school canteen programs cannot compensate for mediocre infrastructure, a shortage of well-trained teachers or shortcomings in the curriculum for the labour market (Vermeersch and Kremer, 2004; Grantham-McGregor, 2005). Research on complementarity and substitutability between school canteens and traditional factors behind quality are better understood when the data comes from experimentation. This is the context of the analysis provided below on interactions between the school canteen program and these inputs into primary education quality.

Five traditional factors play an important role in the quality of education in developing countries. They can be grouped into two main categories: factors linked to schools (class size,<sup>13</sup>qualification of the teacher and textbooks) and factors outside of the school (whether the student belongs to a poor family<sup>14</sup>and the degree of commitment of the community in the education of its children).

For each factor, interaction with the school canteen is analyzed. The model which allows us to analyze these interactions is detailed in section 4 on the impact estimation method. The tables in annexes 12 and 13 present the results of this estimate. We find that only poverty and class size significantly influence the impact of the school canteen on cognitive acquisitions. Their impacts differ by student's age, his/her level of education and academic discipline (mathematics and French).

In effect, poverty increases the impact that the canteen has on the average mathematics score of students in the fourth grade who are 8 and 9 years of age. As for class size, it attenuates the effect of the canteen on the mathematics scores of the oldest students and also of those in the second and fourth grades. The trends for French are different, however. There is complementarity in the effects of poverty and class size, but only in the second year of primary studies. They attenuate the impact of the canteen on cognitive acquisitions.

Thus, based on the results analyzed above, the school canteen has substitution and complementary effects with the two traditional education quality factors: poverty and class size. The relations vary as a function of student's age, their level of study and academic discipline.

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<sup>13</sup>In interacting class size squared, after many trials we find a threshold effect at about 30 students per class. This threshold is used to separate students into two categories, depending on whether their class size exceeds 30 students.

<sup>14</sup> Here we are interested in poverty estimated using daily energy needs. The threshold of 2400 kcal/day is used to classify the students.

## VII. Conclusion

The objective of this study was to evaluate the potential contribution of experimental school canteen program towards improved academic results of students and performance of schools in rural Senegal. The experimental approach based on random selection of groups of schools and students prior to participation in the program is used to evaluate the impact of school canteens.

The baseline data allowed us to verify the random character of the treatment assignment. To this end, several tests (Kolmogorov-Smirnov, Mann-Whitney Levene,  $\chi^2$  and student) were performed. The results showed that, on average, the two groups are homogenous. Thus, to measure the impacts, the unbiased double difference estimator is used.

The results obtained are very conclusive. School canteens significantly improved the average score of student in standardized tests. However, this effect of canteens on cognitive acquisitions hides disparities by discipline, gender and level of study. The canteen has a positive and significant impact only on the average score of students in the second grade (CP). By specifying the impact on cognitive acquisitions by gender, we find interesting results. Overall, the canteen only improves the average score of girls and it is in mathematics that the results are most notable. Moreover, the results of the estimation on the overall scores are not statistically significant. These results appear to confirm those of studies by Ahmed (2004), Whaley and Neumann (2003), Agarwal (1989) and others.

The study is also interested in the impact of school canteens on the different areas of cognitive skills. To this end, the effect on four skills is analyzed: comprehension, memorization, reasoning and knowledge. The results reflect nearly the same trends as those for the global score. With the exception of level of knowledge, the impact of canteens is highest among the youngest children, in the second grade.

Moreover, school canteens did not lead to a substantial improvement in the internal efficiency of public primary schools. The dropout and repeat rates decreased, but the results are not statistically significant. However, the canteens improve the food intake of children benefitting from meals provided at school. Another interesting result is the presence of positive externalities between the canteen and siblings. Children living with students benefitting from the program also saw their food intake improve.

The research also shows that there is complementarity and substitutability between the school canteens and two traditional factors underlying education quality: poverty and class size. These both have a significant influence on the impact of school canteens on cognitive acquisitions. Their effect on the impact differs by age of the student, their level of study and

academic discipline (mathematics and French). Poverty strengthens the impact that the canteen has on the average mathematics score of students in the fourth grade aged 8-9. As for class size, it attenuates the effect of the canteen on mathematics scores among the older children in both the second and fourth grades. The trend is different for French, however. There is complementarity in the effects of both poverty and class size on the impact of the school canteen, but only in the second grade of primary. They attenuate the impact of the canteen on cognitive acquisitions.

Even if we have solid proof that school canteens are an effective method to improve progress towards quality education for all and to improve the nutritional situation of children, we should emphasize some shortcomings which no doubt lead to underestimation of the impact. The results would be much larger if we accounted for factors such as intensity of treatment, and if the nutrition indicators specifically referred to anthropomorphic measurements (weight, height and age) rather than intake (calories, protein, lipids and carbohydrates). Thus, the research has certainly filled in a factual gap in data on the impact of school canteens on the quality of education in Sub-Saharan Africa, but would do so more completely if links between school canteens and deworming had been performed. If students are not dewormed, the canteen is in part feeding the intestinal worm. That could considerably reduce the impact of the canteen on the quality of education and effective food intake of children.

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## ANNEX

**Table 1: Composition of rations and their energy values**

Type of food product	Individual ration (g /person/ day)	Caloric value per person (kcal)
Cereals (maize)	120	432
Legumes	30	102
Enriched oil	20	177
Iodized salt	5	0
<b>Total</b>	<b>175</b>	<b>712</b>

**Source:** Ministry of Education, School Canteen Division/DPRE.

**Table 2: Student test applied on characteristics of the student and household, and of the school (individual level)**

Variables	Control (school with no canteens)		Treatment (schools with canteens)		Ho : equality of averages
	Observation	Average (standard error)	Observation	Average (standard error)	Difference (p-value)
<b>Characteristics of student and their household</b>					
Age of student	954	10.356 (0.0623)	1117	10.015 (0.0601)	0.341 (0.000)***
Sex of student (female=1)	1302	0.456 (0.013)	1586	0.528 (0.012)	-0.072 (0.000)***
Attended Koranic school (yes=1)	1302	0.236 (0.011)	1586	0.266 (0.011)	-0.029 (0.069)*
Health situation (sick=1)	1302	0.22 (0.011)	1586	0.258 (0.01)	-0.038 (0.017)**
Attended primary school (yes=1)	1302	0.043 (0.005)	1586	0.04 (0.004)	0.003 (0.647)
Received dewormer (yes = 1)	1302	0.163 (0.01)	1586	0.178 (0.009)	-0.014 (0.292)
<b>Characteristics of student's household</b>					
Age of household head (HH)	954	51.421 (0.4304)	1117	52.307 (0.395)	-0.886 (0.129)
Sex of HH (female=1)	1206	0.907 -0.008	1508	0.911 (0.007)	-0.003 (0.774)
Marital status of HH (married=1)	1200	0.947 -0.006	1505	0.952 (0.005)	-0.005 (0.526)
Religion of HH (Muslim=1)	1202	0.94 (0.01)	1507	0.960 (0.000)	-0.02 (0.01)**
HH is literate (yes=1)	218	0.527 (0.033)	254	0.492 -0.031	0.035 -0.444
Monthly food expenditures	941	67235.8 1304.95	1091	76005.14 1480.14	-8769.27 (0.000)***
Time to walk to school (minutes)	954	14.95 0.432	1117	16.760 0.432	-1.804 (0.003)
Household size of student	954	13.09 0.233	1117	13.742 0.171	-0.644 (0.023)
Number of rooms in students' household	922	5.434 0.103	1435	5.454 0.098	-0.0194 (0.895)
Annual education expenditures	927	31171.2 1072.62	1443	31949.2 1021.8	-777.96 (0.613)

Annual health expenditures	927	46918.21 2023.37	1443	44263.6 1511.50	2654.66 (0.285)
Distance to nearest health facility (in km)	1185	14.78 1.17012	1522	60.97 4.21	-46.18 (0.000)***

#### Characteristics of student's teacher and director of their school

Experience of student's teacher	954	5.43 (0.123)	1117	5.17 (0.123)	0.255 0.145
Age of student's teacher	954	31.7 0.1821	1117	31.58 0.1692	0.112 0.649
Qualification of teacher (BFEM=1)	1302	0.53 0.013	1586	0.59 0.012	-0.06 (0.001)***
Age of school director	921	38.83 0.26	1083	38.42 0.207	0.402 0.228
Experience of school director	725	14.314 0.314	943	11.303 0.18	3.011 (0.000)***
Qualification of director (CEAP=1)	1059	0.322 0.014	1284	0.159 0.233	0.162 (0.000)***
Number of schools in the village	1228	1.495 0.035	1609	1.224 0.012	0.271 (0.000)***

#### Characteristics of school and its environment

Distance from school to student's house (in km)	954	1.391 (0.032)	1117	1.45 (0.034)	-0.065 (0.166)
Existence of school project (yes=1)	1240	0.15 (0.01)	1532	0.16 (0.009)	-0.01 (0.36)
Class size of student	941	33.30 (0.52)	1072	30.98 (0.416)	2.316 (0.000)***
Existence of school management committee (yes=1)	1282	0.579 (0.013)	1572	0.582 (0.012)	-0.003 (0.866)
Existence of separated latrines for boys and girls (yes=1)	1282	0.372 (0.013)	1572	0.332 (0.011)	0.04 (0.023)**
<b>Aggregate score</b>	954	30.43 0.363	1117	29.92 0.342	0.514 (0.3043)
<b>Score in mathematics</b>	954	30.86 0.436	1117	29.92 0.434	0.94 (0.129)
<b>Score in French</b>	954	30.007 0.474	1117	29.96 0.435	0.041 (0.948)

**Notes:** Significant at the 1% (\*\*\*), 5% (\*\*) and 10% (\*) levels.

**Source:** Authors' calculations using survey on school canteens in Senegal (CRES, 2009-2010).

**Table 3: Overall impact of school canteens on cognitive acquisitions (aggregate scores) of students**

	Ordinary least squares		Fixed effects
	Without control	With control	Without control
Treatment*time	6.03 (2.522)**	5.51 (1.11)***	6.03 (2.521)**
Treatment	-0.514 (1.26)	-1.56 (.81)*	(omitted)
Time	20.70 (1.78)***	20.56 (.83)***	20.703 (1.77)***
<b>Characteristics of students</b>			
Sex (female=1)		-0.35 (0.56)	
Age		1.58 (.141)***	
Eats until full (yes=1)		3.53 (.69)***	

Good state of health <sup>15</sup> (yes=1)		-0.72 (.67)	
Interruption of studies (yes=1)		0.48 (1.212)	
Nutritional situation		0.602 (0.632)	
Attended primary school (yes=1)		-1.13 (1.26)	
<b>Characteristics of student's household</b>			
Household size		0.043 (0.044)	
Household head (HH) is literate (yes=1)		-2.16 (.74)***	
Age of HH		0.05 (.0213)**	
Religion of HH (Muslim=1)		2.05 (1.30)	
Marital status of HH (married=1)		1.68 (1.252)	
Sex of household head (female=1)		0.33 (1.033)	
<b>School characteristics</b>			
Existence of school management committee (yes =1)		-1.24 0.640*	
Time to walk between school and student's house		-0.042 0.021**	
Existence of separated latrines (yes=1)		-1.32 0.597**	
<b>Characteristics of teacher and director</b>			
Experience of teacher		-0.07 0.069	
Qualification of director (CAP=1)		0.76 0.71	
<b>Location</b>			
Location of school (centre=1)		5.54 0.63***	
<b>Sample size</b>	<b>4142</b>	<b>3334</b>	<b>4142</b>
<b>R2</b>	<b>0.3405</b>	<b>0.3965</b>	<b>Between = 0.029 Within = 0.4044 Overall = 0.3404</b>

**Notes:** (.) Standard error; significant at the 1% (\*\*\*), 5% (\*\*) and 10% (\*) levels; the cluster option is added to account for potential autocorrelation between the performance of students in the same school.

**Source:** Authors' calculations using survey on school canteens in Senegal (CRES, 2009-2010).

**Table 4: Overall impact of canteens on cognitive acquisitions by level of study**

Aggregate scores				
	CP		CE2	
Treatment*time	<b>11.86</b> (3.586)***	<b>10.56</b> ( 3.854)***	<b>3.81</b> (2.453)	<b>2.80</b> (2.712 )
Treatment	-2.58 (1.499)*	-3.65 (1.867 )*	.744 (1.559)	-0.628 (1.635)
Time	6.57 (2.483)**	7.13 (2.855)**	29.35 (1.699)***	29.24 (1.939)***
<b>Characteristics of student</b>				
Sex (female = 1)		1.58 (1.206)		-2.17 (1.023)**
Age		1.18		0.48

<sup>15</sup>The "state of health" variable refers to whether the student is sick or has had episodes of diarrhea in the 6 months preceding the baseline survey.

Eats until full (yes=1)	(0.399)***	(0.210)**		
	3.72	2.88		
Good state of health (yes=1)	(1.804)**	(1.479)*		
	-2.61	1.27		
Interruption of studies (yes=1)	(1.099)**	(.802)		
	1.16	-0.64		
Nutritional situation	(2.466)	(1.253)		
	0.51	0.74		
Attends primary school (yes=1)	(1.897)	(1.257)		
	-3.63	0.36		
	(2.499)	(1.364)		
<b>Characteristics of student's household</b>				
Household size	0.07	0.03		
	(.040)*	(.0713)		
Household head is literate (yes=1)	-3.49	-1.05		
	(1.519)**	(0.914)		
Age of household head	0.07	0.01		
	(0.040)*	(.021)		
Religion of household head (Muslim=1)	2.25	1.69		
	(1.486)	(0.992)*		
Marital status of household head (married=1)	3.30	1.77		
	(2.343)	(1.814)		
Sex of household head (female=1)	4.37	-2.88		
	(1.797)**	(1.133)**		
<b>Characteristics of school</b>				
Existence of school management committee (yes=1)	-1.85	-.656		
	(2.465)	(1.732)		
Time to walk between school and student's house	-0.06	-0.03		
	(0.055)	(0.031)		
Existence of separated latrines (yes=1)	-1.36	-1.32		
	(2.319)	(1.802)		
<b>Characteristics of teacher and director</b>				
Experience of teacher	-0.01	-0.13		
	(.251)	(.201)		
Qualification of director (CAP=1)	-20.64	-2.03		
	(4.356)***	(6.566)		
Qualification of director (CEAP=1)	-22.26	-2.18		
	(4.074)***	(6.514)		
<b>Location</b>				
Location of school (centre=1)	4.82	5.74		
	(2.687)*	(1.80)***		
<b>Number of observations</b>	<b>1698</b>	<b>1352</b>	<b>2444</b>	<b>1978</b>
<b>R2</b>	<b>0.1493</b>	<b>0.2105</b>	<b>0.5507</b>	<b>0.5851</b>

**Notes:** (.) Standard error; significant at the 1% (\*\*\*), 5% (\*\*) and 10% (\*) levels; the cluster options is added to the estimates.

**Source:** Authors' calculations using survey on school canteens in Senegal (CRES, 2009-2010).

**Table 5: Impact of school canteens on scores in French and mathematics by student's level of study**

	Mathematics				French			
	CP		CE2		CP		CE2	
Treatment*time	12.577 (3.859)***	12.317 (3.983)***	3.797 (2.718)	2.837 (2.940)	10.99 (4.09)***	8.72 (4.480)**	3.69 (2.89)	2.57 (3.12)
Treatment	-4.102 (1.930)**	-5.408 (2.233)**	1.850 (1.802)	0.149 (2.010)	-0.10 (1.820)	-1.88 (2.22)	-0.33 (1.88)	-1.37 (1.82)
Time	9.740 (2.645)***	10.270 (2.953)***	32.266 (1.895)***	32.114 (2.044)***	3.32 (2.750)	3.95 (3.19)	25.92 (2.02)***	25.91 (2.29)***
<b>Characteristics of student</b>								
Sex (female=1)		0.357 (1.169)		-3.322 (1.148)***		2.77 (1.39)**		-0.84 (1.10)
Age		1.133 (0.408)***		0.598 (0.260)**		1.18 (0.50)**		0.35 (0.22)
State of good health (yes=1)		-1.523 (1.140)		1.183 (1.099)		-3.45 (1.30)		1.29 (0.75)*
Eats until full (yes=1)		3.527 (1.702)**		4.101 (1.584)**		4.04 (2.18)*		1.69 (1.94)
Nutritional situation		1.081 (1.835)		0.706 (1.482)		-0.30 (2.18)		0.66 (1.23)
Interruption of studies (yes=1)		2.963 (2.336)		0.262 (1.609)		-0.50 (3.20)		-1.56 (1.33)
Attended primary school (yes=1)		-1.488 (2.552)		2.702 (1.718)		-5.67 (2.77)**		-2.12 (1.41)
<b>Characteristics of household</b>								
Sex of HH (female=1)		4.140 (1.663)**		-3.117 (1.536)**		4.58 (2.25)**		-2.68 (1.26)**
Age of HH		0.069 (0.045)		0.008 (0.029)		0.08 (0.04)*		0.01 (0.02)
Household size		0.089 (0.071)		0.048 (0.082)		0.06 (0.08)		0.01 (0.07)
HH is literate (yes=1)		-1.204 (1.365)		-0.660 (1.065)		-5.45 (1.89)***		-1.49 (1.05)
Marital status of HH		2.340 (2.708)		3.264 (2.116)		4.21 (2.39)*		0.198 (1.76)
Religion of HH (Muslim=1)		2.636 (1.376)*		2.895 (1.422)**		1.91 (1.86)		0.39 (0.86)

<b>Characteristics of school</b>	-	-	-	-	-
Time to walk to school (minutes)	-0.097 (0.055)		-0.057 (0.042)		-0.02 (0.07)
Existence of separated latrines	-1.660 (2.182)		-0.945 (2.162)		-1.04 (2.74)
Qualification of director (CAP=1)	-36.137 (4.306)***		-3.338 (5.371)		-5.53 (4.10)
Qualification of director (CEAP=1)	-37.700 (3.702)***		-3.757 (5.435)		-7.35 (4.95)
Experience of teacher	0.092 (0.241)		-0.039 (0.236)		-0.14 (0.31)
Existence of school management committee	-2.487 (2.459)		1.660 (2.010)		-1.36 (2.91)
					(1.80)*
<b>Location</b>	-	-	-	-	-
Location of school (centre=1)	5.744 (2.568)**		5.347 (1.973)***		3.69 (3.17)
					6.19 (2.04)***
<b>Number of observations</b>				<b>1698</b>	<b>1352</b>
<b>R<sup>2</sup></b>				<b>0.07</b>	<b>0.12</b>
					<b>2444</b>
					<b>1978</b>
					<b>0.44</b>
					<b>0.49</b>

**Notes:** HH: household head; (.): standard error; significant at the 1% (\*\*\*), 5% (\*\*) and 10% (\*) levels.

**Source:** Authors' calculations using survey on school canteens in Senegal (CRES, 2009-2010).

**Table 6: Impact of school canteens on French scores by age and level of study of student**

	CP						CE2			
	6 - 7 years		8 - 9 years		10 years and over		8 - 9 years		10 years and over	
Treatment*time	10.303 (7.479)	6.15 (7.174)	10.178 (4.05)**	8.46 (4.586)*	12.43 (5.44)**	10.88 (6.51)	0.777 (7.946)	-0.737 (8.175)	4.022 (2.627)	3.008 (2.878)
Treatment	-0.0389 (3.62)	-1.62 (3.699)	-0.932 (2.085)	-0.447 (2.452)	-0.453 (2.165)	-2.41 (3.707)	-2.69 (3.895)	-6.463 (4.113)	-0.084 (1.818)	-0.984 (1.763)
Time	3.188 (5.237)	3.687 (5.99)	4.81 (2.68)*	4.899 (3.102)	0.436 (3.975)	1.736 (4.78)	24.486 (3.999)***	23.63 (4.31)***	26.078 (1.96)***	26.154 (2.26)***
	Without control	Control	Without control	Control	Without control	Control	Without control	Control	Without control	Control
<b>Number of observations</b>	<b>250</b>	<b>198</b>	<b>1036</b>	<b>844</b>	<b>412</b>	<b>310</b>	<b>240</b>	<b>202</b>	<b>2204</b>	<b>1780</b>
<b>R<sup>2</sup></b>	<b>0.075</b>	<b>0.219</b>	<b>0.0821</b>	<b>0.137</b>	<b>0.062</b>	<b>0.115</b>	<b>0.352</b>	<b>0.451</b>	<b>0.455</b>	<b>0.501</b>

**Notes:** (.): Standard error; significant at the 1% (\*\*\*), 5% (\*\*) and 10% (\*) levels; the cluster option is added to account for variability within schools.

**Source:** Authors' calculations using survey on school canteens in Senegal (CRES, 2009-2010).

**Table 7: Impact of school canteens on mathematics scores of students by age and level of study of student**

		Score in mathematics									
Grade	CP						CE2				
Age	6 - 7 years		8 - 9 years		10 years and over		8 - 9 years		10 years and over		
Treatment*time	14.756 (7.73)*	13.719 (7.75)*	11.839 (3.66)***	12.703 (3.762)***	11.933 (5.25)**	10.099 (6.415)	3.490 (3.935)	3.533 (4.649)	3.847 (2.79)	2.908 (3.029)	
Treatment	-4.727 (3.445)	-7.551 (3.917)*	-3.871 (2.20)*	-4.178 (2.552)	-3.228 (2.496)	-5.908 (3.108)*	-1.366 (3.431)	-6.469 (3.804)	2.201 (1.80)	0.662 (2.025)	
Time	9.239 (4.945)*	9.188 (5.451)*	10.993 (2.706)***	10.821 (2.878)***	7.477 (3.64)**	9.510 (4.65)**	28.698 (2.01)***	28.647 (2.69)***	32.646 (1.99)***	32.38 (2.14)***	
	Without control	Control	Without control	Control	Without control	Control	Without control	Control	Without control	Control	
<b>Number of observations</b>	250	198	1036	844	412	310	240	202	2204	1780	
<b>R2</b>	0.209	0.323	0.206	0.28	0.139	0.263	0.421	0.50	0.519	0.546	

**Notes:** (.): Standard error; significant at the 1% (\*\*\*), 5% (\*\*) and 10% (\*) levels; the cluster option is added to account for variability within schools.

**Source:** Authors' calculations using survey on school canteens in Senegal (CRES, 2009-2010).

**Table 8: Impact of school canteens on cognitive acquisitions by gender of student, double differences, 2009-2010**

Gender of student	Boy		Girl	
Treatment*time	<b>4.33</b> (2.719)	<b>4.60</b> (2.987)	<b>7.71</b> (2.803)***	<b>6.39</b> (3.09)**
Treatment	0.10 (1.284)	-0.56 (1.435)	-1.09 (1.507)	-2.50 (1.797)
Time	21.41 (1.952)***	20.86 (2.282)***	19.87 (1.87)***	20.21 (2.071)***
	<b>Without control</b>	<b>Control</b>	<b>Without control</b>	<b>Control</b>

<b>Number of observations</b>	<b>2062</b>	<b>1660</b>	<b>2080</b>	<b>1674</b>
<b>R2</b>	<b>0.3305</b>	<b>0.4135</b>	<b>0.3512</b>	<b>0.3996</b>

**Notes:** (.): Standard error; significant at the 1% (\*\*\*) , 5% (\*\*) and 10% (\*) levels; the cluster option is added to account for variability within schools.

**Source:** Authors' calculations using survey on school canteens in Senegal (CRES, 2009-2010).

**Table 9: Impact of school canteens on cognitive acquisitions of treated students (instrumental variables method)**

	<b>Scores</b>	
Treatment*time	<b>9.11***</b> (1.592)	<b>8.33**</b> (4.134)
Treatment	-0.776 (0.754)	-2.11 (2.117)
Time	18.69*** (1.06)	18.72*** (2.772)
	<b>Without control</b>	<b>Control</b>
<b>Number of observations</b>	<b>4142</b>	<b>3334</b>
<b>R2</b>	<b>0.3405</b>	<b>0.3933</b>

**Notes:** (.): Standard error; significant at the 1% (\*\*\*) , 5% (\*\*) and 10% (\*) levels;the cluster option is added to account for variability within schools.

**Source:** Authors' calculations using survey on school canteens in Senegal (CRES, 2009-2010).

**Table 10: Overall impact of school canteens on cognitive acquisitions of students, by discipline**

	<b>Scores</b>			
	<b>French</b>		<b>Mathematics</b>	
Treatment*time	<b>5.59</b> (1.162)***	<b>4.60</b> (3.05)	<b>6.35</b> (2.69)**	<b>6.32</b> (2.88)**
Treatment	-1.06 (.825)	-1.29 (1.544)	.094 (1.53)	-1.79 (1.796)

Time	17.35 (.854)***	17.29 (2.31)***	23.72 (1.91)***	23.49 (2.052)***
	<b>Without control</b>	<b>Control</b>	<b>Without control</b>	<b>Control</b>
<b>Number of observations</b>	<b>4142</b>	<b>3334</b>	<b>4142</b>	<b>3334</b>
<b>R2</b>	<b>0.2359</b>	<b>0.269</b>	<b>0.3725</b>	<b>0.4115</b>

**Notes:** (.): Standard error; significant at the 1% (\*\*\*), 5% (\*\*) and 10% (\*) levels; the cluster option is added to account for variability within schools.

**Source:** Authors' calculations using survey on school canteens in Senegal (CRES, 2009-2010).

**Table 11: Determination of the minimum detectable effect of selected variables of interest**

<b>Variable</b>	<b>Number of observations</b>	<b>Standard deviation</b>	<b>Minimum detectable effect (MDE)</b>
Aggregate score	2897	11.65755	1.477330
Score in French	2897	14.66361	1.885515
Score in mathematics	2897	14.15826	1.810089
Repeat rate	116	9,104585	1.165652
Dropout rate	116	6,938063	0.888274

**Source:** Authors' calculations using survey on school canteens in Senegal (CRES, 2009-2010).

**Table 12: Impacts on cognitive acquisitions in mathematics; interactions between school canteen and tradition schooling quality inputs**

	MATHEMATICS									
	CP						CE2			
	6 - 7 years		8 - 9 years		10 years and over		8 - 9 years		10 years and over	
Treatment*time	15.87 (21.77)	13.87 (23.38)	2.43 (15.50)	0.58 (11.26)	24.30 (25.57)	24.34 (19.60)	-12.18 (20.64)	-8.45 (22.03)	9.63 (12.34)	0.21 (6.82)
Treatment	-10.13 (12.22)	-20.57 (15.61)	-7.38 (8.60)	-9.09 (7.59)	-11.54 (11.22)	-9.34 (14.12)	11.48 (9.39)	-14.43 (16.39)	7.88 (6.00)	7.67 (4.473)*
Time	-4.84 (15.33)	1.36 (16.17)	13.12 (11.44)	14.52 (8.045*)	-14.58 (14.03)	-15.02 (12.09)	20.37 (8.557)**	18.64 (13.08)	20.84 (7.48)***	23.76 (4.23)***
Interactions										
T**committee	3.32 (12.71)	-2.39 (14.06)	-2.83 (8.59)	-1.07 (6.06)	-0.57 (11.08)	-5.45 (9.26)	10.20 (7.19)	14.75 (12.75)	4.37 (5.45)	2.42 (3.49)
T**textbooks	3.40 (15.21)	1.41 (15.8)6	8.93 (8.10)	8.27 (7.11)	-0.29 (12.99)	-1.73 (12.34)	21.32 (9.317)**	23.43 (14.84)	1.72 (7.61)	2.93 (4.66)
T**qualification	21.72 (15.57)	21.33 (16.51)	5.48 (16.24)	4.46 (11.87)	-1.98 (13.30)	-1.10 (14.90)	3.24 (11.24)	4.25 (12.96)	-5.13 (7.29)	-3.62 (3.98)
T**poor	-17.48 (10.58)	-12.02 (12.44)	-3.31 (3.99)	-3.24 (5.42)	5.61 (7.34)	6.67 (9.15)	4.77 (10.64)	1.44 (11.16)	5.05 (3.036)*	5.11 (3.12)
T**classsize	0.10 (0.38)	0.16 (0.45)	0.01 (0.21)	0.09 (0.14)	-0.44 (0.261)*	-0.42 (0.232)*	-0.48 (0.278)*	-0.65 (0.332)*	-0.34 (0.1781)*	-0.06 (0.10)
Other control variables										
	Without control	Control	Without control	Control	Without control	Control	Without control	Control	Without control	Control
Observations	248	196	972	788	390	292	218	180	2198	1774
R2	0.3690	0.4254	0.2449	0.2809	0.2475	0.3713	0.5079	0.5899	0.5540	0.5628

**Notes:** T: treatment; t: time; the interaction effect is captured by the coefficient of the interaction T\*\*variable; (.): standard error; significant at the 1% (\*\*\*), 5% (\*\*) and 10%(\*) levels. Due to the nature of the sample (by cluster) the cluster option is added to account for variability within schools.

**Source:** Authors' calculations using survey on school canteens in Senegal (CRES, 2009-2010).

**Table 13: Impacts on the cognitive acquisitions in French; interactions between school canteens and traditional quality factors**

	FRENCH									
	CP						CE2			
	6 - 7 years		8 - 9 years		10 years and over		8 - 9 years		10 years and over	
Treatment*time	29.59 (26.85)	33.69 (28.50)	6.27 (20.39)	0.93 (21.53)	75.98 (30.92)**	79.82 (33.10)**	-4.45 (13.88)	-3.47 (14.62)	8.95 (12.36)	2.32 (12.70)
Treatment	-12.47 (14.62)	-36.51 (13.88)**	-12.01 (6.426)*	-13.03 (7.476)*	-29.14 (8.82)***	-16.33 (13.60)	22.07 (10.88)**	11.49 (13.15)	5.38 (7.69)	5.34 (7.23)
Time	-46.51 (17.27)***	-39.04 (17.51)**	-0.92 (12.28)	0.57 (13.15)	-40.98 (12.78)***	-48.73 (13.27)***	4.11 (11.20)	0.51 (11.60)	17.22 (7.01)**	16.19 (7.43)**
Interactions										
T**committee	5.81 (13.09)	-9.62 (15.74)	12.93 (8.73)	8.58 (10.76)	3.36 (10.05)	-3.47 (12.83)	3.87 (12.14)	-0.22 (9.13)	1.69 (5.04)	-0.50 (5.07)
T**textbooks	3.33 (22.28)	2.01 (23.36)	11.39 (13.82)	11.28 (14.32)	-26.67 (21.63)	-30.11 (21.70)	19.87 (11.304)*	14.78 (11.58)	3.29 (9.01)	2.88 (9.67)
T**teacher.qual	15.12 (9.93)	16.71 (11.72)	1.29 (16.02)	1.49 (15.99)	2.72 (12.21)	0.55 (14.43)	-7.01 (10.15)	-2.41 (7.49)	-3.03 (5.40)	-2.16 (5.95)
T**poverty	-11.97 (9.34)	-8.40 (11.02)	-9.73 (4.866)**	-5.49 (5.68)	-6.48 (7.71)	-7.66 (8.87)	0.57 (6.72)	0.71 (7.91)	1.05 (3.27)	2.26 (3.57)
T**classsize	-0.62 (0.3584)*	-0.73 (0.412)*	-0.28 (0.30)	-0.17 (0.30)	-0.96 (0.34)***	-0.84 (0.38)**	-0.29 (0.22)	-0.15 (0.22)	-0.27 (0.17)	-0.05 (0.15)
Other control variables										
	Without control	Control	Without control	Control	Without control	Control	Without control	Control	Without control	Control
Observations	248	196	972	788	390	292	218	180	2198	1774
R2	0.3242	0.3894	0.1223	0.1585	0.1922	0.2741	0.5279	0.6422	0.4897	0.5246

**Notes:** T: treatment; t: time; the interaction effect is captured by the coefficient of the interaction T\*\*variable; (.): standard error; significant at the 1% (\*\*\*), 5% (\*\*) and 10% (\*) levels; the cluster option is added to account for variability within schools.

**Source:** Authors' calculations using survey on school canteens in Senegal (CRES, 2009-2010).

**Table 16: Overall impact of school canteens on repeat rate (double difference, 2009-2010)**

	Without control	With control
Treatment*time	1.475 (1.742)	-0.179 (2.288)
Treatment	1.273 (1.662)	0.941 (1.852)
Time	-4.746 (0.908)***	-3.609 (1.549)**
Constant	6.293 (1.010)***	26.489 (17.374)
<b>Characteristics of student</b>		
Age of student		-0.005 (0.759)
Sex of student		6.096 (5.039)
Attended Koranic school (yes=1)		0.110 (2.279)
Attended primary school (yes=1)		14.977 (4.576)***
Time to get to school		0.108 (0.090)
Health situation (sick=1)		-4.475 (4.189)
Received dewormer (yes=1)		-2.125 (4.052)
<b>Characteristics of student's household</b>		
SexofHH (male=1)		2.651 (7.353)
HH is literate (yes=1)		-2.155 (1.872)
Household size		0.591 (0.335)*
Marital status of HH (married=1)		-27.465 (10.210)**
Household spending on health (FCFA per year)		-0.00003 (0.00002)*
Religion of HH (Muslim=1)		-4.052 (4.805)
<b>Characteristics of school</b>		
Existence of separated latrines (yes=1)		-1.617

Existence of school management committee (yes=1)		(1.391)
		-0.981
		(1.306)
<b>Characteristics of teacher and director</b>		
Experience of teacher		0.483
		(0.195)**
Experience of director		-0.150
		(0.065)**
Director trained prior to taking position (yes=1)		0.129
		(1.752)
Qualification of teacher (BFEM+=1)		0.197
		(1.361)
Qualification of director(CEAP=1)		0.443
		(1.811)
<b>Number of observations</b>	<b>232</b>	<b>100</b>
<b>R2</b>	<b>0.089</b>	<b>0.349</b>

**Notes:** (.):Standard error; significant at the 1% (\*\*\*) , 5% (\*\*) and 10% (\*) levels; the cluster option is added to account for variability within schools.

**Source:** Authors' calculations using survey on school canteens in Senegal (CRES, 2009-2010).

**Table 17: Impact of school canteens on dropout rate (double difference regression)**

	Without control	With control
Treatment*time	-0.662	-1.168
	(1.623)	(2.186)
Treatment	1.091	1.516
	(1.286)	(1.367)
Time	-0.009	-0.782
	(1.236)	(1.764)
<b>Characteristics of student</b>		
Age of student		-1.809
		(0.832)**
Sex of student		-12.861
		(5.839)**
Attended Koranic school (yes=1)		1.053
		(2.379)
Attended primary school (yes=1)		-11.924
		(3.628)***
Time to get to school		-0.024
		(0.042)
Health situation (sick=1)		-2.197

Received dewormer (yes=1)		(3.098) 2.415 (3.346)
<b>Characteristics of student's household</b>		
Sex of HH (male=1)		2.872 (4.019)
HH is literate (yes=1)		0.360 (1.427)
Household size		-0.626 (0.319)*
Marital status of HH (married=1)		36.492 (12.662)***
Health spending of household (FCFA per year)		0.00005 (0.00002)**
Religion of HH (Muslim=1)		10.176 (3.514)***
<b>Characteristics of school</b>		
Existence of school management committee (yes=1)		-0.546 (1.403)
Existence of separated latrines (yes=1)		2.099 (1.352)
<b>Characteristics of teacher and director</b>		
Experience of teacher		0.141 (0.199)
Experience of director		0.162 (0.102)
Director trained prior to taking position (yes=1)		3.187 (1.539)**
Qualification of teacher (BFEM plus=1)		-1.243 (1.479)
Qualification of director (CEAP=1)		1.765 (1.187)
<b>Number of observations</b>	<b>232</b>	<b>100</b>
<b>R2</b>	<b>0.0037</b>	<b>0.368</b>

**Notes:** (.):Standard error; significant at the 1% (\*\*\*), 5% (\*\*) and 10% (\*) levels; the cluster option is added to account for variability within schools.

**Source:** Authors' calculations using survey on school canteens in Senegal (CRES, 2009-2010).

**Table 18: Impact of school canteens on repeat rate in treated schools (double difference, 2009-2010)**

<b>Linear regression</b>			
	Observations	=	100
	F (23, 49)	=	11.32
	Prob > F	=	0.0000
	R-squared	=	0.3498
	Root MSE	=	7.8827
	(Standard error adjusted for 50 clusters in NumSchools)		
<b>Repeat rate</b>	<b>Coefficient</b>	<b>Standard error</b>	<b>P&gt; t </b>
<b>Treatment*time</b>	<b>-0.267</b>	3.408	<b>0.938</b>
Treatment	1.401	2.758	0.614
Time	-5.375	2.307	0.024**
Time to walkto school (minutes)	0.160	0.134	0.239
Health situation (sick=1)	-6.665	6.239	0.291
Experience of teacher	0.719	0.291	0.017**
Age of student	-0.008	1.130	0.994
Household size	0.880	0.499	0.084*
Sex of student (female=1)	9.079	7.504	0.232
Attends Koranic school (yes=1)	0.164	3.395	0.962
Attended primary school (yes=1)	22.307	6.816	0.002***
Received dewormer (yes=1)	-3.164	6.035	0.602
Marital status of HH (married=1)	-40.906	15.207	0.010***
Qualification of teacher (BFEM+=1)	0.294	2.028	0.885
Religion of HH (Muslim=1)	-6.035	7.156	0.403
Sex of HH (male=1)	3.949	10.952	0.720
Experience of director	-0.224	0.097	0.025**
Director trained prior to taking position (yes=1)	0.192	2.610	0.942
Health spending of household (FCFA per year)	0.000	0.000	0.088*
HH is literate (yes=1)	-3.210	2.788	0.255
Qualifications of director (CEAP=1)	0.659	2.697	0.808
Existence of separated latrines (yes=1)	-2.408	2.072	0.251
Existence of school management committee (yes=1)	-1.461	1.946	0.456

**Notes:** significant at the 1% (\*\*\*) .5% (\*\*) and 10% (\*) levels; the cluster option is added to account for variability within schools.

**Source:** Authors' calculations using survey on school canteens in Senegal (CRES, 2009-2010).

**Table 19: Impact of school canteens on school dropout rate in treated schools (double difference. 2009-2010)**

<b>Linear regression</b>			
	Nb observations	=	100
	F (23. 49)	=	4.02
	Prob > F	=	0.0000
	R-squared	=	0.3683
	(Standard error adjusted for 50 clusters in NumSchools)		
<b>Dropout</b>	<b>Coefficient</b>	<b>Standard error</b>	<b>P&gt;  t </b>
<b>Treatment*time</b>	<b>-1.738</b>	3.256	<b>0.596</b>
Treatment	2.259	2.036	0.273
Time	-1.165	2.628	0.659
Time to get to school (minutes)	-0.035	0.063	0.582
Health situation (sick=1)	-3.273	4.614	0.481
Experience of teacher	0.210	0.297	0.484
Age of student	-2.695	1.239	0.034**
Household size	-0.932	0.475	0.055*
Sex of student (female=1)	-19.154	8.696	0.032**
Attends Koranic school (yes=1)	1.568	3.544	0.660
Attended primary school (yes=1)	-17.760	5.405	0.002***
Received dewormer (yes=1)	3.597	4.983	0.474
Marital status of HH (married=1)	54.351	18.859	0.006***
Qualification of teacher (BFEM+=1)	-1.851	2.203	0.405
Religion of HH (Muslim=1)	15.157	5.233	0.006***
Sex of HH (male=1)	4.278	5.986	0.478
Experience of director	0.241	0.152	0.119
Director trained prior to taking position (yes=1)	4.747	2.292	0.044**
Health spending of HH (FCFA per year)	0.000	0.000	0.031**
HH is literate (yes=1)	0.537	2.125	0.802
Professional qualification of director (CEAP=1)	2.628	1.768	0.144
Existence of separated latrines (yes=1)	3.127	2.014	0.127
Existence of school management committee (yes=1)	-0.813	2.089	0.699
<b>Constant</b>	<b>-25.397</b>	<b>27.895</b>	<b>0.367</b>

**Source:** Authors' calculations using survey on school canteens in Senegal (CRES, 2009-2010).

**Table 20: Impact of school canteens on memorization capacities, by age of students in grade CP**

	Memorization in French					
	6 - 7 years		8 - 9 years		10 years and over	
Treatment*time	31.96 (14.10)**	33.23 (14.40)**	21.14 (8.87)**	17.20 (9.60)*	20.15 (9.37)**	16.28 (9.82)
Treatment	-5.64 (9.97)	-9.56 (12.42)	-6.87 (6.47)	-2.41 (7.24)	-1.75 (7.20)	5.17 (9.68)
Time	-30.80 (10.05)***	-35.07 (12.06)***	-21.21 (6.72)***	-17.96 (7.46)**	-33.85 (6.72)***	-29.65 (7.26)***
	<b>Without control</b>	<b>Control</b>	<b>Without control</b>	<b>Control</b>	<b>Without control</b>	<b>Control</b>
<b>Number of observations</b>	<b>228</b>	<b>178</b>	<b>955</b>	<b>771</b>	<b>371</b>	<b>279</b>
<b>R2</b>	<b>0.077</b>	<b>0.217</b>	<b>0.034</b>	<b>0.054</b>	<b>0.135</b>	<b>0.152</b>

**Notes:** (.): Standard error; significant at the 1% (\*\*\*) , 5% (\*\*) and 10% (\*) levels; the cluster option is added to account for variability within schools.

**Source:** Authors' calculations using survey on school canteens in Senegal (CRES, 2009-2010).

**Table 21: Impact of school canteens on level of knowledge, by age of students in grade CP**

	Knowledge of French					
	6 - 7 years		8 - 9 years		10 years and over	
Treatment*time	0.41 (9.49)	2.08 (8.22)	10.004 (4.71)**	10.31 (4.92)**	15.77 (6.62)**	13.35 (7.45)*
Treatment	2.83 (2.97)	-6.76 (5.31)	-1.26 (2.28)	-3.91 (3.33)	-1.87 (2.62)	-3.86 (5.006)
Time	24.06 (7.67)***	20.40 (5.52)***	19.03 (3.29)***	18.21 (2.96)***	15.59 (4.919)***	17.53 (5.003)***
	<b>Without control</b>	<b>Control</b>	<b>Without control</b>	<b>Control</b>	<b>Without control</b>	<b>Control</b>
<b>Number of observations</b>	<b>228</b>	<b>178</b>	<b>955</b>	<b>771</b>	<b>371</b>	<b>279</b>
<b>R2</b>	<b>0.181</b>	<b>0.341</b>	<b>0.208</b>	<b>0.271</b>	<b>0.201</b>	<b>0.275</b>

**Notes:** (.): Standard error; significant at the 1% (\*\*\*) , 5% (\*\*) and 10% (\*) levels; the cluster option is added to account for variability within schools.

**Source:** Authors' calculations using survey on school canteens in Senegal (CRES, 2009-2010).

**Table 22: Impact of school canteens on level of understanding by age and level of study of student**

	Level of comprehension									
	CP						CE2			
	6 - 7 year		8 - 9 years		10 years and over		8 - 9 years		10 years and over	
Treatment*time	7.67 (8.018)	4.55 (8.069)	9.08 (3.862)**	7.61 (4.352)*	12.61 (5.764)**	11.00 (6.827)	0.76 (8.416)	5.34 (7.412)	5.05 (3.036)*	2.10 (3.237)
Treatment	.25 (4.064)	-1.49 (5.606)	-1.49 (2.507)	-1.27 (3.490)	-3.17 (2.322)	-6.84 (4.041)*	-2.31 (4.144)	-8.27 (4.512)*	-.85 (2.316)	.816 (2.328)
Time	10.71 (6.31)***	9.92 (7.290)	9.328188 (3.023)***	9.21 (3.542)**	5.48 (4.827)	6.65 (5.654)	23.49 (3.65)***	20.89 (5.06)***	27.22 (1.91)***	29.42 (1.84)***
	<b>Without control</b>	<b>Control</b>	<b>Without control</b>	<b>Control</b>	<b>Without control</b>	<b>Control</b>	<b>Without control</b>	<b>Control</b>	<b>Without control</b>	<b>Control</b>
<b>Nb observations</b>	<b>228</b>	<b>178</b>	<b>955</b>	<b>771</b>	<b>371</b>	<b>279</b>	<b>203</b>	<b>175</b>	<b>1991</b>	<b>1642</b>
<b>R2</b>	<b>0.1443</b>	<b>0.2417</b>	<b>0.1304</b>	<b>0.1775</b>	<b>0.1051</b>	<b>0.2063</b>	<b>0.2776</b>	<b>0.3830</b>	<b>0.4667</b>	<b>0.4877</b>

**Notes:** (.): Standard error; significant at the 1% (\*\*\*) , 5% (\*\*) and 10% (\*) levels; the cluster option is added to account for variability within schools.

**Source:** Authors' calculations using survey on school canteens in Senegal (CRES, 2009-2010).

**Table 23: Impact of school canteen on reasoning capacities, by age and level of study of student**

	Reasoning capacity									
	CP						CE2			
	6 - 7 years		8 - 9 years		10 years and over		8 - 9 years		10 years and over	
Treatment*time	19.45 (6.7)**	23.92 (9.66)**	11.25 (2.83)**	15.59 (4.93)***	8.69 (4.07)	10.27 (8.099)	0.88 (7.273)	3.66 (9.167)	6.28 (1.84)*	2.53 (3.885)
Treatment	-6.13 (5.253)	-13.21 (6.05)**	-3.15 (2.123)	-7.28 (4.331)*	-.03 (3.055)	-7.87 (5.149)	-.73 (5.646)	-6.12 (5.433)	-1.75 (1.393)	-1.03 (3.026)
Time	.918 (5.676)	-2.91 (7.166)	4.03 (2.258)	2.23 (3.685)	1.91 (3.008)	1.52 (6.194)	25.72 (5.553)***	23.40 (5.96)***	31.73 (1.40)***	34.70 (2.38)***
	<b>Without control</b>	<b>Control</b>	<b>Without control</b>	<b>Control</b>	<b>Without control</b>	<b>Control</b>	<b>Without control</b>	<b>Control</b>	<b>Without control</b>	<b>Control</b>
<b>Nb observations</b>	<b>228</b>	<b>178</b>	<b>955</b>	<b>771</b>	<b>371</b>	<b>279</b>	<b>201</b>	<b>173</b>	<b>1990</b>	<b>1641</b>
<b>R2</b>	<b>0.1181</b>	<b>0.2968</b>	<b>0.0837</b>	<b>0.1858</b>	<b>0.0509</b>	<b>0.1656</b>	<b>0.2160</b>	<b>0.2836</b>	<b>0.4328</b>	<b>0.4684</b>

**Notes:** (.): Standard error; significant at the 1% (\*\*\*) , 5% (\*\*) and 10% (\*) levels; the cluster option is added to account for variability within schools.

**Source:** Authors' calculations using survey on school canteens in Senegal (CRES, 2009-2010).