Universal-Free and Eligibility-based School Breakfast Programs in Guilford County, NC: Student Outcomes

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Abstract

The Guilford County Schools (GCS) in North Carolina offered universal-free breakfasts under the School Breakfast Program (SBP) in 2007-08 in elementary schools with high proportions of economically disadvantaged students. In 2008-09, the GCS reduced its universal-free programs, with the affected schools returning to eligibility-based programs. We investigate student outcomes that were associated with those changes, examining how breakfast and lunch participation, attendance, and standardized reading, math, and science test scores changed across years at affected and unaffected schools. We find that the switch from a universal-free to an eligibility-based SBP reduced breakfast participation substantially, with the largest changes occurring among students who were not eligible for free- or reduced-price meals. The changes in SBPs were associated with changes in lunch participation for paid-eligible students but not for other students. The changes in SBPs did not harm test scores but were associated with improved attendance.

NOTE: See related CCR 73-1, *Process Analysis of Changes in Universal-Free and School Breakfast Programs in Guilford County, NC*.

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Executive Summary:

In this study, we investigate student outcomes that were associated with changes in the availability of universal-free breakfasts at elementary schools in the Guilford County Schools (GCS) in North Carolina. In 2007-8, the GCS offered universal-free breakfasts in 26 schools with high proportions of economically disadvantaged students (Title I schools). In 2008-9, budgetary pressures and a reinterpretation of state policy led the GCS to change to eligibility-based SBPs at three elementary schools, while adding a universal-free SBP at one other elementary school.

For this study, we examine several types of student outcomes: counts of breakfasts and lunches served by each school, attendance rates for each school grade, and standardized test score and additional attendance information for individual students. All of the data come from highly accurate administrative sources, including records from the GCS School Nutrition Services office, publicly-available information from the North Carolina Department of Public Instruction, and confidential information from the North Carolina Education Research Data Center. All of the data are also available longitudinally, allowing us to compare outcomes before and after the change in breakfast programs at affected and unaffected schools—that is, to conduct "difference-in-difference" analyses.

We examine these outcomes using descriptive statistical methods, restricting our analyses to schools that were comparable in terms of their programs, calendars, geography, Title I status, and other characteristics. We also estimate multivariate, fixed-effects, regression models that further account for changes in observed characteristics and for time-invariant unobserved characteristics at the schools and among the students.

Our study offers several advantages relative to previous research. First, it relies on a quasi-experimental source of program variation. Second, the variation that we examine includes a contraction of services from a universal-free program to a less generous eligibility-based program, while previous research on universal-free SBPs has mainly examined expansions in programs. Third, our analysis relies on highly accurate administrative data. Fourth, our study is one of only a few recent studies that have examined SPBs that are subject to the nutrition standards of the School Meals Initiative.

Our analyses reveal that breakfast participation rates fell substantially at the schools that switched to eligibility-based programs and rose just as substantially at the school that switched to a universal-free program. The participation results appear to be symmetric between the schools that gained and lost universal-free programs and indicate that universal-free breakfast provision was associated with a 12-16 percent increase in SBP participation. Participation changed the most for the students who were not otherwise eligible for free or reduced-price meals. However, participation also changed substantially for students who were eligible for free meals under either an eligibility-based or universal-free SBP.

We also examine participation in the school lunch program at the schools. We find evidence that changing from a universal-free SBP to an eligibility-based program was associated with lower lunch participation among paid-eligible students. Lunch participation among free- and reduced-price-eligible students was not changed, and because paid-eligible students were

only a small fraction of the students at our study schools, overall lunch participation was little changed.

Our analyses of attendance lead to an unexpected finding—schools that switched from universal-free SBPs to eligibility-based SBPs experienced small gains in attendance. These results appear in student- and grade-level analyses and are robust to alternative types of statistical controls.

We find little evidence that universal-free breakfast provision was associated with changes in students' standardized test performance. Over the period that we study, test results across our analysis schools improved markedly, with the improvements generally being just as strong at the elementary schools that "lost" universal-free breakfast programs as at the school that "gained" a program. The improvements were also similar to those at schools that did not change their programs.

1. Introduction

The School Breakfast Program (SBP) is intended to provide children with nutritious meals to facilitate their school performance and their nutritional well-being. The program offers free and reduced-price breakfasts to participating children from low-income households and subsidizes breakfasts for other children. The federal government provides cash subsidies and in-kind support for the program, and the local school systems (School Food Authorities, or SFAs) operate and administer the programs, often contributing funding of their own. In fiscal year 2009, the SBP served more than 11 million children at a federal cost of $2.6 billion.[1]

The general eligibility guidelines for the SBP are the same as the larger National School Lunch Program (NSLP). Children are categorically eligible for free school meals if they live in a household that receives benefits from the Supplemental Nutrition Assistance Program or the Temporary Assistance for Needy Families program. They are also eligible for free meals if they live in households with incomes below 130 percent of the federal poverty guidelines. Children are eligible for reduced-price meals if they live in households with incomes between 130 and 185 percent of the guidelines.

Although the SBP and NSLP share the same eligibility criteria, participation in the breakfast program has been substantially lower than participation in the lunch program. The differences in participation arise from lower participation by schools in the SBP but also from lower participation by students at schools that offer breakfasts. Improving SBP participation is important to the program reaching children in need and fulfilling its other objectives.

Schools have tried to encourage SBP participation in a variety of ways. One promising approach has been to offer "universal-free" school breakfasts, that is, to serve free breakfasts to

[1] U.S. Food and Nutrition Service, "School Breakfast Program: Program History" <http://www.fns.usda.gov/cnd/Breakfast/AboutBFast/ProgHistory.htm> and "Program Data" <http://www.fns.usda.gov/pd/cnpmain.htm>.

all children at a school regardless of eligibility. Schools can do this with federal funding under special provisions of the National School Lunch Act, or they can offer free breakfasts using state or local funding. A universal-free breakfast policy is thought to encourage participation in two ways. First, the reduction of meal prices from something to nothing creates an economic incentive to participate among children who would not otherwise qualify for free meals. Second, the policy may encourage participation generally, including participation among free-eligible students, by reducing the stigma associated with school breakfasts. Indeed, studies have consistently reported that the adoption of a universal-free breakfast policy substantially increases participation among all groups of students (see, e.g., Bernstein et al. 2004, Kleinman et al. 1998, Murphy et al. 1998, Peterson et al. 2004).

Some schools, however, that have been offering universal-free breakfasts are finding that they can no longer afford to do so. For instance, Bartlett et al. (2008) reported that the full per-student cost of providing a breakfast at an average SFA in 2005-6 exceeded the most generous federal reimbursement rate by nearly a dollar. Steep rises in food prices in subsequent years increased the cost pressures on schools. Deteriorating budget conditions brought on by the recent deep recession also led schools to revisit their universal-free school breakfast policies.

In this study, we investigate student outcomes that were associated with changes in the availability of universal-free breakfasts at elementary schools in one school district—the Guilford County Schools (GCS) in North Carolina. In academic-year (AY) 2007-8, the GCS offered universal-free breakfasts in 26 schools with high proportions of economically disadvantaged students. In the following year, budgetary pressures and a reinterpretation of state policy led the GCS to change to eligibility-based SBPs at three elementary schools, while adding a universal-free SBP at one other elementary school.

For this study, we examine several types of student outcomes drawn from different administrative sources: counts of breakfasts and lunches served by each school from the GCS, attendance rates for each school grade from the North Carolina Department of Public Instruction (NC DPI), and standardized test score and additional attendance information for individual students from the North Carolina Education Research Data Center (NCERDC). All of the data are available longitudinally allowing us to compare outcomes before and after the change in breakfast programs at affected and unaffected schools—that is, to conduct "difference-in-difference" analyses.

The outcomes that we examine provide information on different dimensions of program effectiveness. SBP participation is an obvious, direct outcome and the mechanism through which a universal-free structure should have its effect. It would be difficult to give causal interpretations to changes in other outcomes if switches between universal-free and eligibility-based SBPs did not affect breakfast participation. NSLP participation is a related, though indirect, outcome that provides information about nutritional well-being. Our examination of NSLP participation also serves a methodological purpose, providing a pseudo-control on the schools' meal program operations. Attendance is a school behavioral outcome that likely contributes to cognitive advancement. Test scores are direct indicators of cognitive development.

Although our study of these outcomes is limited to a modest number of schools in a single school district, it offers several advantages relative to previous research. First, it relies on a quasi-experimental source of program variation, at least from the perspective of the students. Some research on the effects of school meal programs is based on comparisons of students who do and do not participate. Estimates of program effects in these studies can by confounded by student and household characteristics that are associated with meal participation and the

outcomes of interest. Second, the variation that we examine includes a contraction of services from a universal-free program to a less generous eligibility-based program, while previous research on universal-free SBPs has mainly examined expansions in programs. Program take-up may be different in expanding and contracting environments if, for instance, parents and students are slow to discover the availability of a new universal-free SBP but immediately confront the consequences of a change to an eligibility-based program. Third, our analysis relies on highly accurate administrative data. Unlike survey data, the administrative data are not subject to recall errors, strategic or socially-motivated misreporting, or selective cooperation. Fourth, school meal programs have evolved over time. In particular, USDA set higher nutritional standards in 1995 under its School Meals Initiative. Our study joins just a few others (e.g., Bernstein et al. 2004, Peterson et al. 2004) that have examined student outcomes under the new standards.

Our empirical analyses reveal that the switch from a universal-free SBP to an eligibility-based program reduced breakfast participation substantially. Consistent with expectations, the largest changes occurred among students who were not eligible for free- or reduced-price meals; however, participation among free- and reduced-price eligible students also fell. The changes in breakfast programs and breakfast participation were associated with a decrease in lunch participation among paid-eligible students but with little change in lunch participation for other students. The changes in the SBPs did not harm students' math, reading, and science test scores. Over the period of the study, standardized test scores for elementary school students in the GCS improved, and the rates of improvement were similar at schools that did and did not lose universal-free SBPs. Unexpectedly, our analyses indicate that the change from a universal-free to an eligibility-based SBP was associated with an improvement in attendance.

2. School Breakfasts in the Guilford County Schools

The GCS in North Carolina is a moderately large school system, with 119 schools and more than 70,000 students. The GCS covers all of Guilford County (population 450,000), including the cities of Greensboro (population 237,000) and High Point (population 98,000).[2] The system's student population is ethnically diverse: 42 percent of the students are white, 41 percent are black, 8 percent are Hispanic, 5 percent are Asian, and the rest are comprised of other groups or have mixed origins. Just under half of the students in the GCS are eligible for free or reduced-price meals.

The GCS operates breakfast and lunch programs throughout the system. Most GCS elementary schools operate eligibility-based SBPs. In the 2007-8 and 2008-9 academic years, breakfasts at those schools were offered at the following rates:

- free if the student qualified for free meals
- 30¢ if the student qualified for reduced-price meals, and
- 90¢ if the student did not qualify for free or reduced-price meals.

Breakfasts include choices of milk, juice, and cereal. In addition, there is a fruit serving and a breakfast entrée.[3]

In AY 2007-8, the GCS operated universal-free breakfast programs in 26 Title I schools in which at least 70 percent of the students were expected to qualify for free or reduced-price

[2] Guilford County has had a unified, county-wide school district since 1993. Prior to consolidation, separate school districts covered Greensboro, High Point, and the balance of Guilford County.

[3] Kimbrough et al. (2003) investigated student nutrition and health outcomes at several GCS schools in 2001-2 and noted several worrisome statistics. Kimbrough et al. reported that four out of nine students were overweight at the elementary schools that they examined (including one elementary school that we study) and that approximately half as many were obese. They found that GCS students who were overweight or obese were more frequently absent, received lower grades, and performed worse on standardized tests than other students. Discussions with parents, teachers, and staff revealed potential areas of concern with respect to nutrition services, including limited variety in meals, unappealing "healthy" meal choices, and little promotion of healthy offerings.

meals.[4] Universal-free breakfasts were offered in 23 of the system's 67 elementary schools and three of its 22 middle schools. Universal-free breakfasts were not offered in any of the system's high schools.

The state of North Carolina subsidizes universal-free breakfasts for kindergarten students at selected schools. All of the GCS elementary schools with "general" universal-free breakfast programs participate in the universal-free kindergarten program. All of the schools with general universal-free SBPs also qualify under the USDA guidelines as "severe need" schools, meaning that their programs receive more generous federal subsidies. For AY 2007-8, these subsidies were $1.61 for each free-eligible breakfast, $1.31 for each reduced-price breakfast, and 24¢ for each paid breakfast. The GCS calculated that it cost $1.38 to prepare each meal.

North Carolina allows school districts to operate universal-free SBPs at individual schools if those schools can do so without a loss (that is, can cover the costs from the federal subsidies).[5] During the spring of 2008, GCS officials became concerned that these financial conditions might not be met because of rising food prices and increasing breakfast participation among the reduced- and regular-price eligible students. The school system began considering whether and by how much it might reduce the number of universal-free programs.

During the summer of 2008, the GCS decided to alter its formula for selecting schools that would offer universal-free programs. In AY 2007-8, the GCS used calculations of federal subsidies from free and reduced-price meals to calculate whether schools would break even in

[4] Title I of the Elementary and Secondary Education Act of 1965 provides supplemental federal funding to schools with high numbers or proportions of economically disadvantaged students.

[5] Based on the cost and subsidy figures, the GCS had positive net revenues of 23¢ per breakfast for each free-eligible breakfast that it served. Ignoring the foregone revenue from not charging for breakfast, the GCS lost 7¢ for each free breakfast it served to reduced-price eligible grade school children at universal-free schools and $1.14 for each free breakfast it served to regular-price grade-schoolers at universal-free schools. For example, during AY 2007-8, one of the GCS schools with a universal-free SBP served 27,600 breakfasts to free-eligible grade-school students, 3,990 breakfasts to reduced-price-eligible grade-school students, and 4,769 breakfasts to "paid-eligible" grade-school students (figures taken from the fifth column of Table 3 of Haldeman et al. 2011). That combination of meals would have resulted in positive net revenues of $632.04 (= (23¢ x 27,600) - (7¢ x 3,990) - ($1.14 x 4,769)).

providing universal-free programs. Starting in AY 2008-9, the GCS only considered federal subsidies from free meals. The GCS also used a different projection of participation growth to forecast revenues and costs. As a result of these changes, the GCS switched back to eligibility-based programs at three elementary schools and one middle school that had initially been offering universal-free programs. It also began offering a universal-free program at one elementary school that had initially operated an eligibility-based program. The experiences of students at the elementary schools that changed their programs are the focus of this study.

3. Previous Research

Breakfast is often called "the most important meal of the day," a reputation that stems partly from a substantial body of research that links breakfast consumption to positive outcomes for children. Rampersaud et al. (2005) have recently conducted a systematic review of scientific studies of the impact of breakfast consumption on nutritional status, weight, cognitive performance, and academic outcomes. Hoyland et al. (2009) conducted a similar review of cognitive studies. The evidence is far from uniform but, on balance, seems to indicate that breakfast consumption is associated with better nutritional outcomes for children and a lower incidence of being overweight or obese. Evidence regarding cognitive outcomes is more equivocal. Several studies find a relationship between breakfast consumption and performance in short-term memory tasks but are less clear regarding whether breakfast improves longer-term academic performance. To the extent that relationships exist, they tend to be strongest for the most dramatic behavioral contrast—eating vs. skipping breakfast—and among children who are at the highest nutritional risk. There is scant direct evidence that marginal improvements in breakfast quality (e.g., changing a few breakfast items) have noticeable effects on cognitive

outcomes.

Despite the nutritional and other possible benefits of breakfast, national estimates from 2007-8 indicate that approximately one in nine elementary-school-aged children skip this meal on any given day. This rate rises to one in six for children who are near-poor (living in households with incomes between 130 and 185 percent of the poverty line).[6] The public provision of breakfasts through programs like the SBP represents one way to increase the frequency and reliability of eating breakfast and to activate the other beneficial outcomes that may be associated with breakfast.

Connell and Fox (2004) summarize numerous evaluations of the SBP that had been conducted through 2004, including several evaluations of universal-free programs. There is consistent evidence that universal-free programs increase school breakfast participation. Beyond that, the findings across studies diverge. Several studies have found that universal-free provision of breakfasts is associated with better nutritional outcomes, improved short-term cognitive performance, greater attendance, and higher academic achievement. For example, Kleinman et al. (1998) and Murphy et al. (1998) each examined the implementation of universal-free SBPs at three schools and found a near doubling of breakfast participation rates and evidence that participation was associated with lower absenteeism and higher math grades. A shortcoming with these studies was that they only compared outcomes over time within schools that changed their SBPs and did not examine comparison schools.

Some other recent studies with stronger research designs have also reported positive educational and behavioral outcomes. Belot and James (2009) evaluated a campaign to improve the quality of school meals in the United Kingdom; they found that students at participating

[6] Figures from U.S.D.A., Agricultural Research Service. 2010. Breakfast: Percentages of Selected Nutrients Contributed by Foods Eaten at Breakfast, by Family Income (as % of Federal Poverty Threshold) and Age, *What We Eat in America*, NHANES 2007-2008. Available: www.ars.usda.gov/ba/bhnrc/fsrg.

schools had better attendance and test scores than students in surrounding schools. Roustit et al. (2010) investigated how the availability of school meal programs in Canada affected scholastic performance. They reported that the availability of meal programs eliminated scholastic gaps between children living in food insecure households and other children.

In contrast, other recent studies with strong research designs have failed to detect associations for schooling outcomes. The most notable in this latter group is the School Breakfast Program Pilot Project (SBPP, Bernstein et al. 2004), a large-scale, random-assignment evaluation of universal-free programs in six school districts. Results from the SBPP indicated that offering free breakfasts boosted participation but did not lead to a consistent pattern of improvements in nutrition, attendance, or cognitive outcomes. Peterson et al. (2004) examined the implementation of universal-free programs in Minnesota schools from 1999-2002, comparing outcomes at schools that implemented the universal-free programs earlier to those that implemented programs later. Consistent with other research, Peterson et al. found sizeable gains in SBP participation. However, they found only weak evidence of test score improvements and some evidence of increased absenteeism. Murphy et al. (2010) investigated the effects of universal-free programs on breakfast consumption, meal attitudes, episodic memory, and class behavior in a random-assignment trial in Wales. They found that the programs improved diets and meal attitudes but had no other effects on student outcomes. Leos-Urbel et al. (2011) examined the implementation of universal-free programs in New York City and found only weak evidence that they improved test scores.

Another study points to the difficulties in trying to draw causal inferences from the associations between school meal operations and student outcomes. Figlio and Winicki (2005) examined menus for schools in Virginia during weeks when students were and were not taking

high-stakes tests. They found that the menus differed systematically, suggesting that schools manipulated the calorie and nutritional content of meals to improve test performance.

The methodologies of the different studies vary. Our investigation shares several key features with some of the most recent studies. In particular, we examine student outcomes associated with a quasi-experimental change in school breakfast provision. We utilize a pre-/post-change design but also compare outcomes across schools that did and did not change their SBPs. A distinctive feature of our study is that it examines changes from universal-free to eligibility-based programs; previous evaluations have considered changes in the other direction.

4. Study Schools

Our empirical analyses compare student meal participation, attendance, and test performance outcomes at GCS elementary schools that did and did not experience changes in their school breakfast programs. As we discussed, there were four Title I elementary schools in the GCS that underwent changes in their SBPs: three schools that switched from universal-free to eligibility-based programs and another that switched from an eligibility-based program to universal-free.[7] The schools were not randomly chosen and were not representative of all schools, or even all Title I schools, in the GCS. For our analyses, we wanted to compare outcomes at these "change" schools to outcomes at other schools that did not experience changes in their SBPs but that matched closely in terms of their observed characteristics.

We began by considering public elementary schools in the GCS that received Title I funding. All of the schools that offered universal-free breakfasts in either 2007-8 or 2008-9 had

[7]There was also a GCS middle school (grades 6-8) that switched from a universal-free to an eligibility-based SBP. We do not examine outcomes for middle schools because of the smaller number of such schools and because of the lack of suitable comparisons for the "change" school.

Title I status. In the years of our study, there were 65 public elementary schools in the GCS. Of these, 30 received Title I funding.

We next considered school calendars and programs. Each of our change schools operated on a traditional 180-day calendar in AY 2007-8 and AY 2008-9, enrolled students on a "regular" rather than a magnet basis, and was accredited by the Southern Association of Colleges and Schools (SACS). We also wanted all of our comparison schools to be located in the cities of Greensboro or High Point, where the four change schools were located. The GCS is a county-wide school district with some schools outside these two cities.

Applying all of these criteria yielded 18 potential comparison schools: 14 schools that had universal-free programs in both years and four that had eligibility-based programs for both years. Within these sets, we looked for comparison schools that were similar in size, racial and ethnic make-up, and economic disadvantage to our change schools in AY 2007-8. Size was important because we wanted to examine schools with similar scales of meal operations. Racial and ethnic composition and economic disadvantage are likely to be directly associated with student outcomes but also have policy significance. For example, No Child Left Behind (NCLB) targets are set for these groups. Also, economic disadvantage was a key determinant in the school system's selection of schools that would change their SBP status. In particular, the change schools were more economically disadvantaged than GCS elementary schools as a whole but less disadvantaged than the GCS schools that continued to offer universal-free school breakfasts.

Ultimately, there were six comparison schools that closely matched the size, demographic, and economic characteristics of our change schools. These include five schools that maintained universal-free breakfast programs and one that maintained an eligibility-based program. Most of our empirical analyses focus on data from the four change and six matched-

comparison schools. However, we also conducted sensitivity analyses using the broader set of 22 traditional-calendar, non-magnet, SACS-accredited, Title I elementary schools. None of our reported findings are sensitive to the choice of comparison set.

Characteristics of the schools in our study, conditional on the types of breakfast programs they operated, are reported in Table 1. The top half of the table lists averages of the school size (average daily membership, or ADM), percentages of students who are black, Hispanic, female, free-meal eligible and reduced-price eligible, and percentages of teachers with different levels of experience and credentials for the 2007-8 (pre-change) academic year. The bottom half of the table lists the same statistics for the 2008-9 (post-change) academic year. The first column shows characteristics of the three schools that switched from universal-free to eligibility-based programs. The second column shows characteristics of the 14 study schools that maintained universal-free programs, while the third column lists characteristics of the narrower set of matched-comparison schools that maintained universal-free programs. On the right side of the table, the last three columns list characteristics for the four study schools that maintained eligibility-based programs, the comparison school that maintained an eligibility-based program, and the change school that switched to a universal-free program.

The statistics indicate that the study schools that had universal-free breakfast programs in 2007-8 had higher proportions of minority and economically disadvantaged students than the schools with eligibility-based breakfast programs. Recall that universal-free SBPs were assigned on the basis of students' economic disadvantage.

If we consider just the schools that initially had universal-free breakfast programs, we see that the change schools tended to be larger but also tended to have lower percentages of economically disadvantaged students than the non-change schools. The smaller set of universal-

free comparison schools matches the change schools in terms of class size but is only marginally more comparable in terms of economic disadvantage.

Among the schools that initially had eligibility-based programs, the comparison school is much closer to the change school in terms of racial composition, 2008-9 enrollment, and teacher experience than the other schools.

In addition to these comparisons of measured characteristics, we also observed cafeteria operations at the change and matched-comparison schools and conducted focus-group interviews at several of the schools (detailed results are reported in Haldeman et al. 2011). The meal observations indicated the schools operated comparable breakfast and lunch programs. All of the schools operated before-school breakfast programs, and all but one served breakfasts in the cafeteria (one school served half its breakfasts in the cafeteria and half in classrooms). The schools gave children similar amounts of time to eat, offered similar menus, and had similar line procedures. The comparability of meal operations is important because previous research has indicated the method of SPB delivery can make a substantial difference in participation rates (see, e.g., Rainville & Carr 2008).

Analyses of the focus group discussions revealed that parents at the schools were knowledgeable about the meal programs, that they held similar attitudes regarding the value of breakfasts, that many experienced food hardships, and that parents saw the school meal programs as helpful in addressing household food needs. Although the schools were comparable in these dimensions, some other differences did appear. In particular, parents from the school that gained a universal-free SBP spoke positively about the school meals that their children received, while parents from a school that moved to an eligibility-based program reported negative experiences. On balance, we found that the schools were broadly comparable in terms of parental perceptions

and knowledge.

5. Analysis Measures

To examine how school meal participation, school attendance, and test score performance varied with the availability of universal-free breakfast programs, we relied on a number of different data sources, including administrative records from the GCS School Nutrition Services office, publicly-available information from the North Carolina Department of Public Instruction, and confidential information from the North Carolina Education Research Data Center. Below we describe the student outcome measures and data sources in more detail. We also describe other explanatory measures that were derived from these sources.

Meal participation. To obtain reimbursement from the U.S.D.A., the GCS Office of School Nutrition Services maintains monthly counts of the breakfasts, lunches, and afterschool snacks schools serve to students who are eligible for different types of subsidies. The GCS provided us with these data.

The raw counts, however, are difficult to compare. Schools differ in their total enrollments as well as in the composition of their students. Other things equal, a school with 600 students would be expected to serve more meals than a school with 300 students. Similarly, a school with more free-eligible students would be expected to serve more free meals than a school with fewer free-eligible students. In addition, the counts will depend on the number of days on which particular types of meals were served. Some months have fewer attendance days (more breaks) than other months. Delayed openings could mean that fewer breakfasts are served than lunches.

To address these issues, we express the meal figures in terms of participation rates where

Participation = Meals served in period / Students in membership for that period. (1)

For example, to calculate the school breakfast participation rate among free-eligible students in a given month, we divide the number of school breakfasts served to free-eligible students during that month by the product of the number of free-eligible students in daily membership and the number of days that month that breakfasts were served. The numbers of students in membership for each eligibility group and the numbers of days on which meals are served are also obtained from the GCS Office of School Nutrition Services.

The participation rate gives the approximate average daily proportion of students of a given eligibility group taking a particular type of meal over the specified period. We calculate participation rates for all breakfasts and all lunches and participation rates for each type of meal by eligibility status (free breakfasts, free lunches, reduced-price breakfasts, etc.). For some descriptive analyses, we examine annual participation rates; however, for our multivariate analyses, we examine monthly participation rates.

Attendance. We examine student attendance data from two sources. The first source is the Principal's Monthly Report (PMR) on attendance which is publicly available from the NC DPI.[8] The PMR provides "monthly" counts of students in membership and in attendance by grade at each school.[9] We form measures of monthly, grade-specific attendance rates at the schools by dividing the number of students in attendance by the number of students in membership. For reasons of comparability with our other data sources and because the changes in SBPs were focused on children in the first grade and higher, we only analyze attendance outcomes for children in the first through fifth grades and omit children in kindergarten.

[8] See http://www.ncpublicschools.org/fbs/accounting/data/.
[9] The PMR attendance data are reported on the basis of "school months" rather than calendar months. The school months correspond to each set of 20 days that the school is open.

Because the grade-level attendance measures are aggregate figures, they cannot be linked to characteristics of particular students. To address this disadvantage, we also examine individual-level attendance data from the NCERDC. The NCERDC is a repository from the NC DPI, including student-level data on test scores, attendance and other characteristics. The NCERDC assigns internal identifiers that allow these data to be linked to schools and linked to individuals over time. We use attendance data from the spring test score files. These data indicate the number of days that the student was a member of a school as of that school's test date and the number of days on which the student was absent over the same period. A personal attendance rate is calculated as one minus the ratio of absences to membership days. The principal advantage of the NCERDC data is that they can be linked to other observable characteristics of the student and can be linked longitudinally (i.e., support before and after comparisons for the same student). The drawbacks of these data are that they capture attendance over most but not all of the year (i.e., attendance through the testing date) and that they lack some covariates for first- and second-grade students who do not take the standardized tests.

Test scores. The state of North Carolina has been using annual accountability tests ("The ABCs of Public Education") to measure performance in its schools for more than a decade. Elementary students in the state currently take the following "end-of-grade" (EOG) tests in the last three weeks of school:

- tests in reading comprehension administered in the third, fourth and fifth grades,
- tests in mathematics administered in the third, fourth, and fifth grades, and
- a test in science administered in the fifth grade.

All of these tests are multiple-choice tests. Results from these tests are used to determine levels of proficiency and rates of academic progress. The tests are also used to measure schools'

progress toward the NCLB goals. Through an agreement with the NCERDC, we obtained access to student-level EOG test data for GCS elementary students in 2007-8 and 2008-9.

About five-sixths of students take the "general" version of the reading and math tests. However, some students who require special testing accommodations take alternative versions of the tests. For each type of test, students' scores are mapped into one of four achievement levels, with level III representing performance that is "proficient" (consistent with grade-level expectations). For all students who take the tests, we form binary indicators of whether their scores were proficient or better.

The binary proficiency measure only captures performance at one point along the potential score distribution and may miss changes in scores below or above this margin. To address this issue, we also examine continuous, grade-standardized scores of the general versions of the EOG reading and math tests and raw scores from the general version of the science tests. As mentioned, the students who took the general versions of the EOG tests are a selective (more-abled) group than the overall population of students. In the end, our findings are similar whether we use the binary or continuous test performance measures.

Our multivariate analyses use the individual-level data. However, for our descriptive analyses, we examine publicly-available test-score aggregates from the NC DPI "report card" database. [10] In particular, the NC DPI releases the percentages of students in each relevant grade at each school whose EOG test scores indicate that they are proficient in math, reading and science. For example, we have third, fourth and fifth grade reading proficiency levels in each year for each school.

Explanatory measures. For our multivariate analyses, we draw numerous explanatory

[10] To avoid inadvertent disclosure of individual results, the NCERDC discourages researchers from reporting descriptive statistics directly from the student-level data.

measures from the NC DPI and NCERDC data. From the NC DPI, we obtain school-level controls for the proportions of students that are black, Hispanic, female, free-meal eligible, and reduced-price eligible. From the NCERDC, we use individual-level controls for the students' race and ethnicity (black, Hispanic, and other non-white, non-Hispanic ethnicity), gender, meal subsidization status, limited English proficiency, math or reading giftedness, and disability status.

6. Multivariate methods

For our multivariate analyses, we utilize a "difference-in-difference" regression methodology. Let $Y_{i,s,t}$ represent an outcome (meal participation, attendance, or test performance) for student or student group *i* at school *s* at time *t*.[11] We assume that the outcome depends on whether universal-free or eligibility-based school breakfasts were offered; let $U_{s,t}$ be a binary variable that takes a value of one if universal-free breakfasts were offered by school *s* at time *t* and a value of zero if eligibility-based breakfasts were offered. We also assume that the outcome depends on other measured and possibly time-varying characteristics of the student or group, $X_{i,s,t}$, unmeasured period-specific characteristics (time fixed effects), τ_t, unmeasured time-invariant characteristics of the individual or group (individual or group fixed effects), $\eta_{i,s}$, and other unmeasured time-varying and individual-/group-specific characteristics, $\varepsilon_{i,s,t}$. We estimate models of the form

$$Y_{i,s,t} = \alpha U_{s,t} + \beta X_{i,s,t} + \tau_t + \eta_{i,s} + \varepsilon_{i,s,t} \quad (2)$$

[11] Recall that we examine monthly school-level breakfast and lunch participation rates, monthly grade-level attendance rates, individual attendance rates, and individual test scores. For the participation outcomes, the group is the meal eligibility group within the school, and for the aggregate attendance analyses, the group is the grade within the school.

where α and β are coefficients to be estimated. In this specification, α is the conditional association between offering universal-free school breakfasts and the outcome of interest, holding other observed characteristics, general time effects, and time-invariant individual or group characteristics constant. We operationalize specification (2) as a two-way fixed effects model.

Recall that our data include measures of student outcomes and other characteristics for the school year (2007-8) before the GCS changed its universal-free school breakfast policy and for the school year (2008-9) after it changed its policy. We also have observations at schools where the school breakfast policy did and did not change. The availability of these types of data allows us to estimate the difference-in-difference model. The principal advantage of this estimation approach is that it controls for unobserved time- and individual-/group-specific characteristics that might be associated with both student outcomes and the school breakfast policy. The time fixed effects account for things like system-wide curricular initiatives and general economic and social conditions. The individual/group fixed effects account for the general abilities of the students and conditions of the schools, such as the physical facilities, the characteristics of the teachers and the general administration of the schools.

7. Empirical analyses

7a. Meal participation

We begin our empirical analysis by examining monthly school meal participation rates among our matched-comparison elementary schools before and after the changes in SBPs. Table 2 lists breakfast and lunch participation rates among all students at the schools and rates specifically among free-eligible, reduced-price-eligible, and other (paid-eligible) students. Rates

are shown for elementary schools that changed from universal-free to eligibility-based programs (first three columns), matched-comparison schools that continued to offer universal-free SBPs (next three columns), the matched-comparison school that continued to offer an eligibility-based SBP (next three columns), and the school that changed from an eligibility-based program to a universal-free program (last three columns). For each type of school, the table reports participation rates for AY 2007-8 and AY 2008-9 as well as the changes in participation rates over the two years.

The figures in Table 2 indicate that GCS elementary schools that offered universal-free breakfasts had moderately high SBP participation rates. Depending on the year and the type of school, the total (all-student) participation rates at these schools ranged from 54 to 62 percent. SBP participation rates for the eligibility-based programs were much lower—about 30 percent in each year at the matched-comparison school and 44-45 percent at the change schools in the years that they offered eligibility-based programs. Similar patterns appear for each of the eligibility groups, with breakfast participation being higher when universal-free programs were offered. When we compare participation rates by eligibility group, free-eligible students tended to have the highest rates, and paid-eligible students, the lowest. These gradients in participation were much more pronounced at the schools operating eligibility-based programs than at the schools operating universal-free programs.

In addition to the differences in participation rates across groups of schools, we can also examine how breakfast participation changed within groups over time. The three elementary schools that switched from universal-free provision to eligibility-based provision experienced a nine percent average decline in their all-student SBP participation rates. SBP participation at these schools fell by seven percent among free- and reduced-price-eligible students and 17

percent among paid-eligible students. In contrast, SBP participation grew slightly at the matched-comparison schools that continued to offer universal-free programs, with the growth concentrated among reduced-price and paid-eligible students. Thus, whether we examine the change schools on their own or in relation to the matched-comparison schools, the switch to an eligibility-based program was associated with lower SBP participation, with declines occurring for all groups but most especially for paid-eligible students.

We see exactly the opposite pattern when we consider the elementary school that changed from an eligibility-based program to a universal-free program. All-student SBP participation at this school grew by 16 percent. The growth was greatest among reduced-price and paid-eligible students but nevertheless appreciable among free-eligible students. At the matched-comparison school, very little change was evident. Once again, taken on their own or relative to a comparison, the results indicate that offering breakfasts on a universal-free basis was associated with higher levels of participation.

In some additional analyses (not shown), we also examined the changes in SBP participation, using the larger set of 22 GCS analysis schools. The patterns are similar to those shown in Table 2. In particular, the changes in participation for the matched-comparison schools were similar to changes experienced by other regular, traditional-calendar, Title I elementary schools in the GCS.

Participation rates for the school lunch programs are shown at the bottom of Table 2. For every type of school and for all eligibility groups within the schools, lunch participation was higher than breakfast participation. Lunch participation varied only modestly across the different types of schools. Participation was highest (87-88 percent) at the schools that maintained universal-free breakfast programs and lowest (80-82 percent) at the school that maintained an

eligibility-based program. Much of the difference in levels of lunch participation can be traced to differences in the composition of eligibility groups across schools. Lunch participation rates tended to be very similar within eligibility groups at the different schools. A close examination of the figures also points to a data issue—lunch participation among paid-eligible students was estimated to exceed 100 percent in AY 2008-9 at the matched-comparison schools that maintained universal-free SBPs. This problem appears to be an artifact of the very small numbers of paid-eligible students at some matched-comparison schools and of the distribution of eligible students only being measured at one point during the school year.[12]

There are few changes in lunch participation rates and no discernable pattern when we examine how total rates changed within the groups of schools from AY 2007-8 to AY 2008-9. If we consider eligibility groups, lunch participation fell among free-eligible students at most of the schools (participation rose slightly in the schools that changed from universal-free to eligibility-based SBPs) but generally increased among reduced-price and paid-eligible students (participation for paid-eligible students fell in the schools that changed from universal-free to eligibility-based SBPs).

We next consider how meal participation changed on a month-by-month basis. A distinctive feature of our study is that we are able to examine changes in outcomes at one school that began and others that stopped offering universal-free breakfasts. Student responses to these changes might vary, for instance if students and parents learn more slowly about the adoption of a program than the loss of a program. Table 3 reports month-by-month participation rates, which would help us to detect these kinds of asymmetric response patterns.

The columns of Table 3 are arranged like those of the previous table, listing participation

[12] The numbers of free- and reduced-price-eligible students appear to be counts of students who ever had this status during the year. If a student became free- or reduced-price-eligible during the year, she could have received some paid meals but would not appear as a paid-eligible student.

rates for AY 2007-8, AY 2008-9 and the change across years for different types of schools. The rows in the top of Table 3 list all-student breakfast participation rates in each school month, while the rows at the bottom list corresponding lunch participation rates. The figures at the top of the table indicate that SBP participation in the opening month of AY 2008-9 increased at all of the schools. The increase was largest at the school that began offering a universal-free program but also moderately large at the three schools that switched to eligibility-based programs. The absence of differences across schools likely reflects the GCS accommodating students whose meal eligibility was being determined.

At the schools that switched to eligibility-based programs, there was a slight fall-off in year-over-year breakfast participation in October and a substantial fall-off in November and subsequent months. In the school that switched to a universal-free program, the increase in breakfast participation is evident in October and again continued through the rest of the year. The figures indicate that the participation responses were relatively fast but not immediate. However, they provide little evidence of asymmetric responses associated with adding or removing programs.

As with the figures from Table 2, the figures from Table 3 indicate that there were few discernable changes in all-student lunch participation rates across the schools, even when considered on a month-by-month basis.

The descriptive comparisons in Tables 2 and 3 indicate that universal-free school breakfast provision is associated with substantially higher rates of breakfast participation but not strongly associated with lunch participation. Although the descriptive analyses are based on before and after comparisons at matched sets of schools, it still is possible that the associations are confounded by other characteristics. To address this concern, we re-examine the relationships

using multivariate linear regression models. Coefficient estimates of the associations between universal-free breakfast provision and the monthly school-level meal participation outcomes are reported in Table 4. The top rows in Table 4 list estimates from models that only account for general school- and month-specific (fixed) effects. The bottom rows list estimates from models that add controls for the race/ethnicity, gender, and eligibility composition of the students.

The models with just school and month controls are essentially summaries of the descriptive results from Tables 2 and 3. The principal distinction is that instead of reporting several difference-in-difference results, the model reports one. In particular, the changes in participation that are associated with adding or removing a universal-free program are modeled as being symmetric; the changes occurring in each month are also modeled as being uniform. The estimates indicate that the universal-free provision of school breakfasts is associated with approximately a 12 percent increase in all-student breakfast participation. In the analyses of specific eligibility groups, the provision of universal-free breakfasts is associated with a nine percent increase in SBP participation among free-eligible children, a 16 percent increase in participation among reduced-price-eligible children, and a 28 percent increase in participation among paid-eligible children. The coefficients in the free-eligible and reduced-price-eligible models are precisely estimated. For example, the 95 percent confidence interval for the coefficient on universal-free SBP provision in the free-eligible model is [.059, .117]. All of the estimated associations are statistically distinguishable from zero.

The associations between operating a universal-free SBP and breakfast participation are estimated to be even stronger when observed controls are included in the models. The coefficients for universal-free provision for the all-student, free-eligible, and reduced-price eligible breakfast participation outcomes are each about one-third larger when demographic and

economic controls are added, while the coefficient for paid-eligible participation is unchanged. All of the coefficients remain statistically distinguishable from zero. Regressions (not shown) that are estimated with the broader analysis sample produce similar results.

As with the descriptive analyses, universal-free breakfast provision is not consistently associated with lunch participation. The coefficient in the all-student participation model is zero when controls are omitted but small and positive when controls are added. If we focus on the models with controls for students' demographic and economic characteristics, the provision of universal-free breakfasts is associated with an increase in lunch participation among paid-eligible students but not among free- or reduced-price eligible students. The positive association would be consistent with exposure to breakfasts possibly causing some families to either become more aware or more accepting of school meals generally.

7b. Attendance

We next examine how attendance changed at the schools. Table 5 first lists attendance rates for first- through fifth-grade students at the matched-comparison schools for the entire school year and for each school month in AY 2007-8 and AY 2008-9 based on publicly-available data from the NC DPI. The last row of Table 5 lists attendance rates calculated from the student-level data from the NCERDC. The columns for all of these statistics are organized in the same way as our previous descriptive tables.

The figures from the first row of Table 5 indicate that attendance measured on an annual basis increased by half a percent at the three schools that switched from universal-free to eligibility-based provision of school breakfasts. However, the figures also indicate that annual attendance increased by exactly the same amount at the school that switched from eligibility-

based to universal-free SBP provision. In contrast, annual attendance fell slightly at the schools that did not experience changes in their breakfast programs. The statistics in the bottom row that are calculated from the individual-level data from the NCERDC show a similar pattern of attendance changes. When we consider attendance on a month-by-month basis, we see that the increases at the change schools were largest in the fifth and sixth months of the school year (approximately January and February).

The increase in attendance at the school that changed to a universal-free breakfast program may be an artifact of its very low attendance in AY 2007-8, when that school's attendance was generally below the rates at the other schools. Restated, the attendance increase at that school may reflect "regression to the mean." When viewed in this light, however, the increases among the schools that switched to eligibility-based provision become all the more remarkable because those schools started with the highest levels of attendance among the groups that we examine. The attendance rates and patterns at the comparison schools do not appear to be unusual; they are very similar to attendance rates and patterns at the larger set of GCS Title I elementary schools.

Results from multivariate regression analyses of the association between universal-free breakfast provision and the monthly grade-level attendance rates are reported in Table 6. As with the analyses of meal participation rates, the models of attendance outcomes include controls for school-, year-, and month-specific effects. Because the attendance figures are reported separately by grade, the models also include controls for grade-specific effects. The estimates listed in the first column are from restricted models that only include these controls. The estimates listed in the second and third columns are from models that add controls for the demographic and economic characteristics of the schools' students. The models in columns 2 and 3 have the same

types of controls but use controls from different data sources. The model in column 2 uses the proportion of economically-disadvantaged students that was reported by the GCS Nutrition Services office, while the model in column 3 uses the proportion reported by the NC DPI.

The coefficient estimate for universal-free breakfast provision in the restricted model in the first column indicates that such provision was associated with lower attendance in the study schools. The negative coefficient results from the negative associations between universal-free provision and attendance at the three schools that changed to eligibility-based provision outweighing the positive association at the one school that changed to a universal-free program. Similar results appear in the models that add demographic and economic controls.

The negative association between universal-free breakfast provision and attendance—at least at the three schools that changed to eligibility-based programs—is something of a puzzle, although the study by Peterson et al. (2004) also found a modest negative association. The puzzle arises because universal-free provision has such a strong positive association with breakfast participation, which can only occur if more students show up in the cafeteria in the morning. Two explanations might reconcile these results. The first potential explanation is that the increased use of school breakfasts may interfere with families' morning routines. For example, parents and children living in households that depend on school breakfasts may sleep later in the morning, increasing the risk that children miss their school buses.[13] More generally, the structure of a family morning meal may help parents and children to organize their time. A second potential explanation is that participating in the school breakfast program may increase children's

[13] Consider the schedules of two children living in separate households who differ in their SBP participation. Assume that each child requires 30 minutes to rise, wash, dress, and gather things for school and 15 minutes to eat a meal. Suppose that because of these requirements, the child who participates in the SBP typically wakes up 30 minutes before the school bus arrives, while the child who does not participate in the SBP typically wakes up 45 minutes before the bus arrives. If something goes wrong (e.g., an alarm fails or a child oversleeps), the SBP participant will have 15 fewer minutes to recover than the non-participant and be at higher risk of missing her bus.

exposure to colds and the flu. Cauchemez et al. (2011) studied a 2009 H1N1 flu outbreak in an elementary school in Pennsylvania and found that class structure and children's play patterns were important factors affecting transmission. Calatayud et al. (2010) conducted a case study of an outbreak of the same flu strain in a London school and found that class structure and attendance at a large social event may have spread transmission. At lunch time in the schools we study, students generally stand on line and sit with their own class, so exposure to illness would not be much greater than in the classroom and would not be much affected by meal participation. During breakfast, however, students get into the meal line as they arrive at school and are free to sit with children who are not their class-mates, which could increase exposure and contagion rates. One piece of evidence supporting this potential explanation is that the attendance differentials in the data were highest during the winter months.

Table 7 lists results from regression analyses of the student-level data from the NCERDC. An advantage of these data is that we can include student-level controls in the models. The top panel of Table 7 reports results from models estimated using data on all first through fifth graders at the analysis schools. The first column lists results from a model that only includes school and grade controls. The next column lists results from a model that adds controls for students' demographic characteristics, while the final column lists results from a model that includes general controls for each student (i.e., student-specific fixed effects). Results from all of these specifications indicate that universal-free breakfast provision is associated with a half percent decrease in attendance. This is equivalent to the loss of almost a full day over the school year.

The NCERDC data for the first and second graders only have a limited set of covariates. More measures, including controls for economic disadvantage, limited English proficiency, giftedness, and exceptionality, are available for the older students who were subject to testing. In

the second panel of Table 7, we report results from models estimated using these older students. The specifications for these models are similar to those from the first panel, except that we included the additional controls in the model in the middle column. The coefficients for all three specifications are smaller in magnitude than the coefficients in the first panel, but they remain negative and statistically significant.

The last two panels of Table 7 list results from models of attendance rates that are estimated separately for third through fifth graders who qualified for free and reduced-price meals (were economically disadvantaged) and who did not qualify for these subsidies (were not disadvantaged). One motivation for dividing the students this way is that economically disadvantaged students tend to have lower attendance rates than more advantaged students. Thus, it is important to examine outcomes for this vulnerable group. Another reason, however, for conditioning the data set is that breakfast participation among the disadvantaged students is less responsive to the provision of universal-free breakfasts than participation among other students. If changes in students' own breakfast participation are directly responsible for their changes in attendance, such as by interfering with family routines, we might see larger attendance associations among the non-disadvantaged students. As it turns out, no such effect is apparent. In the models with only school and grade controls and the models that include observed student characteristics, the estimated associations between universal-free breakfast provision and attendance are almost identical, though the estimates for non-disadvantaged students are imprecise and fall short of being statistically significant. When student-specific effects are included in the last column, the results diverge more, with the association for economically disadvantaged students becoming especially negative. The pattern of results suggests that the attendance associations are not monotonically tied to students' own breakfast participation. This

could arise if economically disadvantaged students just respond differently or if the effects of universal-free breakfast provision are indirect, such as by increasing exposure to illnesses.

7c. Test scores

In Table 8, we report percentages of students at the GCS matched-comparison schools whose scores on their EOG math, reading and science tests were at or above the proficiency levels established by the NC DPI. The statistics in Table 8 are calculated from publicly-available, grade-level data that are released as part of North Carolina's "school report card" program. Math and reading scores for all third- through fifth-grade students at the schools are listed at the top of Table 8, and results for individual grades, including the science test results for fifth-grade students, are listed lower in the table. The columns of statistics are organized in the same way as our other descriptive tables with results reported separately for groups of schools with different types of breakfast programs.

The most striking feature of Table 8 is the substantial increase in proficiency rates across all of the schools. The smallest gains occurred at the school that maintained an eligibility-based SBP where proficiency rates increased by 8-10 percent. At the other schools, proficiency rates generally increased by double-digit amounts. The gains were spread across grades. Nearly all of the grades experienced gains, and most experienced double-digit gains. Thus, any interpretations of the associations between universal-free breakfast provision and test performance must be made in the context of these large and widespread improvements.[14]

There are no consistent patterns in the differences in growth rates across different types

[14] The gains appear to reflect genuine improvements in student performance. Although North Carolina changes its EOG tests and proficiency thresholds periodically, the tests and standards in 2008 and 2009 were comparable. Statewide third- through fifth-grade math and reading proficiency rates improved by two percent over the same period, while fifth-grade science proficiency rates improved by nine percent (NC DPI 2011).

of schools. For example, math proficiency increased more at the elementary schools that switched from universal-free SBPs to eligibility-based SBPs than at the matched-comparison schools that maintained universal-free SBPs, but reading and science proficiency showed the opposite patterns. Math, reading, and science proficiency each increased more at the elementary school that switched to a universal-free SBP than at the matched-comparison school that maintained an eligibility-based program. The patterns are different still considering specific grades. Taken together, the results from Table 8 suggest that universal-free provision of school breakfasts was not associated with test performance.

Regression results from models estimated using student-level test data from the NCERDC are reported in Table 9. We use the models to examine binary indicators of whether the students achieved proficiency in math, reading, and science, continuous standardized measures of math and reading test scores for the students who took the general versions of those tests, and a continuous raw score for students who took the general test in science.[15]

The results in the top row of Table 9 are from restricted models that only include controls for schools, grades, and the year of the observation. The estimated associations of universal-free breakfast provision and students' math and reading test outcomes are all small and statistically insignificant. For example, the point estimates on the math test results indicate that universal-free breakfast provision is associated with a one percent increase in proficiency and a 0.07 standard-deviation increase in the test score. Universal-free breakfast provision is estimated to be associated with a marginally significant seven percent increase in science proficiency but only a small (one point or 0.1 standard deviation) and statistically insignificant increase in the science test raw score.

[15] The science general test raw score had a possible range of 120 to 180. Statewide, the mean was just over 150 and the standard deviation was 9.5.

In the next row of Table 9, we report results from models that also included student-level observed controls for gender, race/ethnicity, meal subsidy status, limited English proficiency, giftedness, disability status, and days in school membership. The proportion of explained variance (fit) of the models improved markedly when these controls were added (the controls were jointly significant in all of the models). However, the estimated associations between universal-free breakfast provision and the test outcomes are little changed from the restricted models. The models continue to indicate a marginally significant, 7 percentage point positive association with science proficiency rates and small, statistically insignificant associations with all of the other test outcomes.

Elementary school students take EOG reading and math tests each year, starting in the third grade. Thus, for children who were in the third or fourth grade in AY 2007-8 and who continued attending our analysis schools, it is possible to estimate models for math and reading test outcomes that include student fixed effects (this is equivalent to including indicator variables for every student). These models are useful because they control for many characteristics of students that might be hard to measure, such as students' general motivation and home environments. We report results from student fixed-effect models of math and reading test results in the third row of Table 9. The estimates from these models are qualitatively similar to the estimates from the more restrictive models and continue to indicate that there is little association between universal-free breakfast provision and students' test outcomes.[16]

The availability of student-level controls in the NCERDC data also allows us to examine test outcomes separately for students who are and are not economically disadvantaged. The remaining rows in Table 9 report results from models that were estimated separately for these

[16] We would have liked to have run similar specifications for students' science test outcomes; however, this is not possible because students only take this test once while they are in elementary school. We would need repeated outcomes to estimate a student fixed-effects model.

two groups. The separate models, however, do not lead to substantive changes in the results. There is no evidence for either group that universal-free breakfast provision is associated with reading or math test results or with science raw scores. Universal-free breakfast provision continues to be associated with science test proficiency among economically disadvantaged children but not among other children.

8. Conclusions

In this report, we examine how students' school meal participation, attendance and standardized test performance changed after elementary schools in the Guilford County School system in North Carolina changed the way that they operated their school breakfast programs. In particular, three Title I schools that had been serving breakfasts on a "universal-free" basis to all students regardless of eligibility changed to less-generous eligibility-based programs, while one school that had operated an eligibility-based program initiated a universal-free breakfast program.

Although universal-free breakfast provision has been studied before, all of the previous research has been in the context of changing eligibility-based programs to universal-free programs rather than changing back to eligibility-based SBPs. Thus, our study is able to examine outcomes as programs become less rather than more generous. As we discuss below, however, most of our findings point to responses to changes to and from universal-free provision being symmetric.

Our analyses employ a "difference-in-difference" methodology in which we examine student outcomes at GCS elementary schools in the year before and the year after the breakfast programs changed and at schools that did and did not experience these changes. For the non-

changing schools, we consider schools that were exactly comparable to the changing schools in terms of their calendars, programs, Title I status, and geography and mostly comparable in their student characteristics. We conduct simple, descriptive comparisons of outcomes at these schools, but also conduct multivariate analyses that incorporate controls for other characteristics of the schools.

The analyses of meal participation outcomes reveal that breakfast participation rates fell substantially at the schools that switched to eligibility-based programs and rose just as substantially at the school that switched to a universal-free program. The participation results were symmetric between the schools that gained and lost universal-free programs in terms of their magnitudes; in each case, our estimates indicate that universal-free breakfast provision was associated with a 12-16 percent increase in SBP participation. The results were also similar in terms of timing, with changes appearing within a month or two of school opening.

There were differences in participation between different types of students. Participation changed the most for the students who faced the largest change in their effective costs—students who were not otherwise eligible for free or reduced-price meals. However, participation also changed substantially for students who were eligible for free meals under either an eligibility-based or universal-free SBP. The latter result is consistent with universal-free SBP provision reducing the stigma associated with participating in the SBP.

We also examine participation in the school lunch program at the schools. We find evidence that changing from a universal-free SBP to an eligibility-based program was associated with lower lunch participation among paid-eligible students, another result that seems consistent with universal-free programs reducing the stigma or improving the perceptions of school meals. Lunch participation among free- and reduced-price-eligible students was not changed, and

because paid-eligible students were only a small fraction of the students at our study schools, overall lunch participation was little changed. To the extent that paid-eligible students contribute revenues to school meal programs through their purchases and through government subsidies, the fall in lunch participation may have inadvertently increased financial pressures on the GCS.

Our analyses of attendance lead to an unexpected finding—schools that switched from universal-free SBPs to eligibility-based SBPs experienced small gains in attendance. Put another way, universal-free breakfast provision was associated with slightly lower levels of attendance. We are able to examine attendance using two different data sources: monthly, publicly-reported, grade-level data for each school and confidential student-level data. Similar findings appear in both sources. We also employ several different statistical methods, but the results are robust to these differences as well. Although the result is unexpected, it is not unprecedented; a study of the implementation of universal-free programs by Peterson et al. (2004) found a similar result. The difference that we find is small; it works out to about one day a year in attendance. We speculate that school breakfast participation may interfere with families' morning routines, possibly leading some children to miss transportation connections. Breakfast participation may also increase children's exposure to colds and other illnesses. When we examine attendance on a month-by-month basis, the largest differences appear in the winter months when colds and flu are especially prevalent.

We find little evidence that universal-free breakfast provision was associated with changes in students' standardized test performance. Over the period that we study, test results across our analysis schools improved markedly. The improvements were generally just as strong at the elementary schools that "lost" universal-free breakfast programs as at the school that "gained" a program. The improvements were also similar to those at schools that did not change

their programs. One area where there might have been an association was in fifth graders' science scores, which appeared to be positively related to universal-free breakfast provision. We do not place much confidence in this result, however, because it was limited to one measure of test performance and not robust when using another measure. Also, science tests are administered less frequently than the other math and reading tests that we examine; because of this, we could not implement some of the more rigorous statistical techniques for science tests that we could with the other tests.

The available evidence points to few academic harms from the GCS decision to scale back its universal-free breakfast programs. Attendance at the affected schools increased, and strong gains in test scores were achieved. These findings are consistent with those of some other recent, careful studies of universal-free programs. At the same time, it is important to note that the change from universal-free programs to eligibility-based programs was associated with a large drop in breakfast participation, which may have led to changes in breakfast consumption, nutritional intakes, and health outcomes that we were not able to observe. Subsequent research should collect information on these domains of possible outcomes.

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Table 1. Characteristics of students and teachers at analysis schools

	Universal-free SBP 2007-8			Eligibility-based SBP 2007-8		
	Elig.-based	Univ.-free SBP 2008-9		Elig.-based SBP 2008-9		Univ.-free
	SBP 2008-9	all	comparison	all	comparison	SBP 2008-9
AY 2007-8 characteristics						
Students (ADM)	485	391	454	452	605	533
% students black	68.4%	68.5%	66.4%	61.0%	51.2%	46.5%
% students Hispanic	13.3%	17.4%	15.7%	14.1%	12.4%	24.0%
% students female	48.7%	48.8%	47.8%	48.7%	49.8%	48.6%
% students free-eligible	66.1%	81.8%	79.3%	58.4%	55.8%	74.2%
% students red.-price elig.	14.3%	9.7%	9.6%	14.8%	12.7%	7.5%
% teachers 0-3 years exp.	26.2%	34.1%	29.0%	30.4%	18.8%	21.7%
% teachers 4-10 years exp.	30.6%	31.6%	39.2%	26.4%	31.3%	21.7%
% teachers adv. degrees	23.0%	18.5%	19.8%	16.7%	16.7%	26.1%
AY 2008-9 characteristics						
Students (ADM)	491	401	462	427	522	505
% students black	68.6%	67.2%	63.8%	61.7%	48.7%	49.5%
% students Hispanic	14.8%	18.5%	17.1%	15.5%	14.0%	22.8%
% students female	50.0%	49.3%	49.1%	48.7%	47.3%	47.9%
% students free-eligible	65.2%	81.5%	80.9%	56.3%	56.3%	72.1%
% students red.-price elig.	13.6%	7.2%	7.7%	12.8%	11.7%	7.0%
% teachers 0-3 years exp.	23.2%	33.9%	29.6%	26.8%	15.9%	8.7%
% teachers 4-10 years exp.	27.7%	30.1%	32.3%	25.4%	29.5%	34.8%
% teachers adv. degrees	23.1%	17.2%	18.9%	17.3%	20.5%	34.8%
Schools	3	14	5	4	1	1

Note: Authors' calculations from NC DPI attendance and "school report card" data and from GCS meal participation data.

Table 2. Meal participation at GCS comparison schools

	Universal-free SBP 2007-8						Eligibility-based SBP 2007-8					
	Eligibility-based 2008-9			Universal-free 2008-9			Eligibility-based 2008-9			Universal-free 2008-9		
	2007-8	2008-9	Change	2007-8	2008-9	Change	2007-8	2008-9	Change	2007-8	2008-9	Change
Total SBP participation	54.1%	45.0%	-9.1%	58.7%	62.0%	3.3%	29.8%	30.5%	0.7%	43.6%	59.8%	16.2%
Free-eligible SBP participation	56.7%	49.8%	-6.9%	60.9%	60.4%	-0.5%	38.1%	37.5%	-0.6%	50.5%	63.6%	13.1%
Reduced-price eligible SBP participation	51.1%	43.8%	-7.3%	49.1%	60.3%	11.2%	26.3%	29.7%	3.4%	39.4%	62.2%	22.8%
Paid-eligible SBP participation	48.2%	31.2%	-17.0%	55.4%	79.5%	24.1%	16.6%	18.6%	2.0%	17.4%	45.7%	28.3%
Total lunch participation	85.3%	85.3%	0.0%	87.3%	87.9%	0.6%	81.8%	80.0%	-1.8%	84.6%	83.7%	-0.9%
Free-eligible lunch participation	88.4%	89.0%	0.6%	88.5%	85.8%	-2.7%	88.9%	82.8%	-6.1%	89.4%	86.9%	-2.5%
Reduced-price eligible lunch participation	81.9%	84.1%	2.2%	82.2%	89.7%	7.5%	76.6%	83.5%	6.9%	90.0%	91.9%	1.9%
Paid-eligible lunch participation	77.4%	74.7%	-2.7%	86.1%	106.5%	20.4%	71.5%	73.7%	2.2%	63.1%	70.1%	7.0%
Schools	3			5			1			1		
Monthly observations	27			45			9			9		

Note: Author's calculations from GCS meals data.

Table 3. Month-by-month meal participation at GCS comparison schools

	Universal-free SBP 2007-8						Eligibility-based SBP 2007-8					
	Eligibility-based 2008-9			Universal-free 2008-9			Eligibility-based 2008-9			Universal-free 2008-9		
	2007-8	2008-9	Change	2007-8	2008-9	Change	2007-8	2008-9	Change	2007-8	2008-9	Change
Total SBP participation												
September	41.6%	47.4%	5.8%	59.3%	62.1%	2.8%	30.1%	33.8%	3.7%	42.6%	51.3%	8.7%
October	47.5%	45.9%	-1.6%	60.4%	62.7%	2.3%	32.1%	33.9%	1.8%	44.0%	64.8%	20.8%
November	56.7%	43.3%	-13.4%	60.3%	61.2%	0.9%	32.5%	29.6%	-2.9%	48.0%	60.3%	12.3%
December	60.2%	44.8%	-15.4%	61.1%	62.4%	1.3%	31.3%	30.6%	-0.7%	44.6%	60.4%	15.8%
January	51.7%	44.7%	-7.0%	51.1%	62.5%	11.4%	26.2%	30.1%	3.9%	39.4%	60.5%	21.1%
February	54.2%	42.3%	-11.9%	55.2%	59.1%	3.9%	28.1%	28.0%	-0.1%	41.3%	55.4%	14.1%
March	56.5%	42.7%	-13.8%	57.9%	58.8%	0.9%	27.9%	27.0%	-0.9%	40.9%	57.5%	16.6%
April	58.3%	45.4%	-12.9%	60.0%	62.6%	2.6%	29.5%	30.3%	0.8%	46.0%	61.8%	15.8%
May	60.1%	48.1%	-12.0%	62.5%	66.8%	4.3%	30.9%	31.4%	0.5%	45.8%	66.0%	20.2%
Total lunch participation												
September	84.2%	86.0%	1.8%	85.8%	83.7%	-2.1%	82.1%	79.5%	-2.6%	84.8%	79.9%	-4.9%
October	85.5%	87.7%	2.2%	86.0%	86.6%	0.6%	82.3%	79.8%	-2.5%	83.8%	83.5%	-0.3%
November	85.6%	86.4%	0.8%	86.0%	87.6%	1.6%	83.5%	80.2%	-3.3%	86.2%	84.4%	-1.8%
December	85.0%	85.3%	0.3%	87.0%	88.0%	1.0%	82.3%	81.4%	-0.9%	84.9%	83.5%	-1.4%
January	86.0%	85.6%	-0.4%	87.4%	88.7%	1.3%	82.3%	81.8%	-0.5%	85.5%	84.4%	-1.1%
February	85.4%	83.0%	-2.4%	86.2%	88.3%	2.1%	80.4%	79.3%	-1.1%	84.1%	83.2%	-0.9%
March	84.6%	85.4%	0.8%	87.8%	88.8%	1.0%	80.0%	77.7%	-2.3%	84.5%	84.2%	-0.3%
April	85.2%	82.2%	-3.0%	89.5%	88.0%	-1.5%	81.8%	78.9%	-2.9%	84.3%	82.8%	-1.5%
May	85.8%	85.8%	0.0%	90.3%	91.0%	0.7%	81.9%	81.1%	-0.8%	83.6%	87.6%	4.0%
Schools		3			5			1			1	

Note: Author's calculations from GCS meals data.

Table 4. Monthly meal participation regression results for GCS comparison schools

	SBP participation				Lunch participation			
	Total	Free-eligible	RP-eligible	Paid-eligible	Total	Free-eligible	RP-eligible	Paid-eligible
Models estimated only with school, month and year controls								
Universal-free SBP	0.124***	0.088***	0.158***	0.276***	-0.003	-0.024**	0.016	0.100**
	(0.016)	(0.015)	(0.023)	(0.042)	(0.006)	(0.010)	(0.023)	(0.045)
2008-9 AY	0.031***	0.007	0.092***	0.155***	-0.001	-0.025***	0.057***	0.123***
	(0.010)	(0.010)	(0.015)	(0.026)	(0.004)	(0.006)	(0.014)	(0.028)
R^2	0.874	0.838	0.769	0.800	0.511	0.334	0.446	0.551
Models estimated with school, month, year, and student demographic controls								
Universal-free SBP	0.164***	0.133***	0.209***	0.275***	0.022**	0.001	-0.007	0.129**
	(0.021)	(0.021)	(0.032)	(0.060)	(0.008)	(0.015)	(0.032)	(0.064)
2008-9 AY	-0.005	-0.026	0.025	0.135***	-0.001	-0.022*	0.047*	0.126**
	(0.017)	(0.017)	(0.026)	(0.049)	(0.007)	(0.012)	(0.026)	(0.052)
R^2	0.899	0.868	0.806	0.816	0.616	0.383	0.531	0.595

Note: Coefficients and standard errors estimated from OLS models with school and month fixed effects. Models estimated for 10 comparison schools each contributing 18 monthly observations (180 observations total). Student demographic controls include percentages black, Hispanic, female, free-meal eligible, and reduced-price eligible.

Table 5. Grade 1-5 attendance at GCS comparison schools

	Universal-free SBP 2007-8						Eligibility-based SBP 2007-8					
	Eligibility-based 2008-9			Universal-free 2008-9			Eligibility-based 2008-9			Universal-free 2008-9		
	2007-8	2008-9	Change	2007-8	2008-9	Change	2007-8	2008-9	Change	2007-8	2008-9	Change
Average daily attendance from NC DPI grade-level data												
Entire school year	96.0%	96.5%	0.5%	95.2%	95.0%	-0.2%	95.7%	95.6%	-0.1%	94.9%	95.4%	0.5%
School month 1	97.4%	97.5%	0.1%	97.1%	96.5%	-0.6%	97.3%	97.0%	-0.3%	97.1%	96.5%	-0.6%
School month 2	96.8%	97.3%	0.5%	96.0%	95.9%	-0.1%	96.5%	96.5%	0.0%	96.0%	96.1%	0.1%
School month 3	96.5%	97.2%	0.7%	95.5%	96.2%	0.7%	96.0%	96.3%	0.3%	95.8%	96.3%	0.5%
School month 4	96.0%	96.4%	0.4%	95.1%	94.5%	-0.6%	96.0%	95.5%	-0.5%	94.9%	95.5%	0.6%
School month 5	95.3%	96.5%	1.2%	94.2%	94.4%	0.2%	95.4%	95.1%	-0.3%	93.0%	94.5%	1.5%
School month 6	94.8%	95.9%	1.1%	93.8%	94.6%	0.8%	94.1%	95.1%	1.0%	93.7%	95.6%	1.9%
School month 7	95.7%	96.0%	0.3%	95.0%	94.9%	-0.1%	94.9%	94.3%	-0.6%	94.5%	95.2%	0.7%
School month 8	96.2%	96.2%	0.0%	95.4%	94.7%	-0.7%	96.4%	95.5%	-0.9%	94.6%	94.5%	-0.1%
School month 9	95.4%	95.1%	-0.3%	94.6%	93.3%	-1.3%	94.5%	95.1%	0.6%	94.4%	93.9%	-0.5%
Attendance rates calculated from NCERDC student-level data												
August - May	96.0%	97.0%	1.0%	95.4%	95.3%	-0.1%	95.9%	95.8%	-0.1%	95.1%	95.5%	0.4%
Schools		3			5			1			1	

Source: Authors' calculation from NC DPI grade-level attendance and NCERDC student-level data. "School months" refer to each 20 days of school operation.

Table 6. Monthly grade-level attendance regression results for GCS comparison schools

	(1)	(2)	(3)
Universal-free SBP	-0.0020*	-0.0017	-0.0027**
	(0.0011)	(0.0011)	(0.0011)
2008-9 AY	0.0006	0.0011	0.0018**
	(0.0007)	(0.0010)	(0.0008)
School controls	Yes	Yes	Yes
Month controls	Yes	Yes	Yes
Grade controls	Yes	Yes	Yes
Student char. 1	No	Yes	No
Student char. 2	No	No	Yes
R^2	0.545	0.557	0.561

Note: The table lists coefficients and standard errors that are estimated from OLS models with school, month, and grade fixed effects. The models are estimated for 10 comparison schools each contributing 18 monthly observations on five grades (900 observations total). Student demographic controls include percentages black, Hispanic, and female. Control set 1 also includes GCS-supplied free-meal eligible and reduced-price eligible student percentages, while control set 2 includes NC DPI supplied economically disadvantaged percentages.

Table 7. Student-level attendance regression results for GCS comparison schools

	(1)	(2)	(3)
ALL STUDENTS IN GRADES 1-5 (*N* = 8,078)			
Universal-free SBP	-0.0054***	-0.0053***	-0.0050***
	(0.0016)	(0.0015)	(0.0011)
2008-9 AY	0.0021**	0.0018*	0.0035**
	(0.0010)	(0.0010)	(0.0007)
School controls	Yes	Yes	No
Grade controls	Yes	Yes	No
Student characteristics	No	Yes	No
Student fixed effects	No	No	Yes
R^2	0.032	0.045	0.906
ALL STUDENTS IN GRADES 3-5 (*N* = 4,797)			
Universal-free SBP	-0.0043**	-0.0040**	-0.0052***
	(0.0020)	(0.0020)	(0.0016)
2008-9 AY	0.0025*	0.0028**	0.0021**
	(0.0013)	(0.0013)	(0.0010)
School controls	Yes	Yes	No
Grade controls	Yes	Yes	No
Student characteristics	No	Yes	No
Student fixed effects	No	No	Yes
R^2	0.031	0.073	0.917
ECONOMICALLY DISADVANTAGED STUDENTS IN GRADES 3-5 (*N* = 3,773)			
Universal-free SBP	-0.0042*	-0.0043*	-0.0058***
	(0.0024)	(0.0024)	(0.0020)
2008-9 AY	0.0023	0.0023	0.0023*
	(0.0015)	(0.0015)	(0.0012)
School controls	Yes	Yes	No
Grade controls	Yes	Yes	No
Student characteristics	No	Yes	No
Student fixed effects	No	No	Yes
R^2	0.029	0.069	0.924

NON- DISADVANTAGED STUDENTS IN GRADES 3-5 (N = 1,024)			
Universal-free SBP	-0.0040	-0.0037	-0.0034
	(0.0035)	(0.0035)	(0.0023)
2008-9 AY	0.0036	0.0041*	0.0007
	(0.0024)	(0.0023)	(0.0016)
School controls	Yes	Yes	No
Grade controls	Yes	Yes	No
Student characteristics	No	Yes	No
Student fixed effects	No	No	Yes
R^2	0.039	0.075	0.962

Note: Coefficients and standard errors estimated from OLS models with school and grade fixed effects. Models estimated for 10 comparison schools. Student demographic controls include percentages black, Hispanic, and female.

Table 8. End-of-grade test proficiency at GCS comparison schools.

	Universal-free SBP 2007-8						Eligibility-based SBP 2007-8					
	Eligibility-based 2008-9			Universal-free 2008-9			Eligibility-based 2008-9			Universal-free 2008-9		
	2007-8	2008-9	Change	2007-8	2008-9	Change	2007-8	2008-9	Change	2007-8	2008-9	Change
3rd-5th grade students												
Math proficient	57.9%	72.7%	14.8%	56.2%	69.5%	13.3%	65.1%	74.4%	9.3%	64.1%	78.1%	14.0%
Reading proficient	38.3%	52.1%	13.8%	31.6%	47.8%	16.2%	48.3%	56.8%	8.5%	41.7%	52.0%	10.3%
3rd grade students												
Math proficient	63.7%	74.5%	10.8%	60.5%	75.0%	14.5%	76.2%	70.9%	-5.3%	68.5%	81.8%	13.3%
Reading proficient	42.1%	50.2%	8.1%	29.4%	49.2%	19.8%	54.3%	59.3%	5.0%	45.7%	51.5%	5.8%
4th grade students												
Math proficient	56.6%	75.3%	18.7%	54.0%	66.8%	12.8%	68.8%	82.8%	14.0%	61.9%	80.8%	18.9%
Reading proficient	39.3%	52.6%	13.3%	30.2%	45.5%	15.3%	47.3%	69.0%	21.7%	41.7%	53.8%	12.1%
5th grade students												
Math proficient	52.9%	67.6%	14.7%	54.0%	66.4%	12.4%	50.9%	69.9%	19.0%	60.9%	72.0%	11.1%
Reading proficient	33.3%	53.9%	20.6%	35.8%	48.5%	12.7%	43.4%	43.0%	-0.4%	36.2%	50.7%	14.5%
Science proficient	25.7%	35.1%	9.4%	24.5%	40.9%	16.4%	24.5%	34.4%	9.9%	36.2%	56.0%	19.8%

Note: Author's calculations from NC DPI "report card" data.

Table 9. End-of-grade test score regression results for GCS comparison schools

	Math		Reading		Science	
	Proficiency	Standardized score	Proficiency	Standardized score	Proficiency	Raw score
RESULTS FOR ALL TESTED STUDENTS						
Models estimated only with school, grade, and year controls						
Universal-free SBP	0.010	0.071	0.005	0.052	0.071*	0.950
	(0.023)	(0.046)	(0.024)	(0.047)	(0.040)	(0.779)
2008-9 AY	0.129***	0.209***	0.137***	0.206***	0.141***	3.013***
	(0.015)	(0.029)	(0.015)	(0.030)	(0.026)	(0.493)
R^2	0.038	0.055	0.033	0.040	0.046	0.078
Models estimated with school, grade, year, and student characteristic controls						
Universal-free SBP	0.014	0.045	0.006	0.029	0.068*	0.740
	(0.022)	(0.040)	(0.022)	(0.041)	(0.037)	(0.683)
2008-9 AY	0.144***	0.229***	0.147***	0.216***	0.148***	3.151***
	(0.014)	(0.026)	(0.014)	(0.026)	(0.023)	(0.435)
R^2	0.133	0.275	0.172	0.270	0.226	0.303
Models estimated with grade, year, and student fixed-effect controls						
Universal-free SBP	-0.017	-0.015	-0.006	0.0002		
	(0.021)	(0.029)	(0.021)	(0.029)		
2008-9 AY	0.087***	0.176***	0.141***	0.139***		
	(0.013)	(0.019)	(0.013)	(0.019)		
R^2	0.892	0.949	0.904	0.952		
Tests	4,579	4,310	4,571	4,261	1,474	1,374
RESULTS FOR ECONOMICALLY-DISADVANTAGED STUDENTS						
Models estimated with school, grade, year, and student characteristic controls						
Universal-free SBP	0.023	0.048	0.008	0.027	0.080*	0.404
	(0.025)	(0.046)	(0.025)	(0.047)	(0.041)	(0.785)
2008-9 AY	0.139***	0.218***	0.145***	0.199***	0.160***	2.973***
	(0.016)	(0.029)	(0.016)	(0.030)	(0.026)	(0.492)

R^2	0.127	0.248	0.151	0.234	0.191	0.255
Models estimated with grade, year, and student fixed-effect controls						
Universal-free SBP	0.001	0.004	-0.006	0.010		
	(0.026)	(0.036)	(0.024)	(0.035)		
2008-9 AY	0.085***	0.189***	0.132***	0.135***		
	(0.016)	(0.023)	(0.015)	(0.022)		
R^2	0.898	0.950	0.901	0.955		
Tests	3,597	3,367	3,589	3,321	1,159	1,066
RESULTS FOR NON-DISADVANTAGED STUDENTS						
Models estimated with school, grade, year, and student characteristic controls						
Universal-free SBP	-0.010	0.048	-0.003	0.052	0.015	2.119
	(0.042)	(0.082)	(0.047)	(0.081)	(0.081)	(1.438)
2008-9 AY	0.168***	0.284***	0.159***	0.288***	0.091	3.664***
	(0.028)	(0.056)	(0.032)	(0.055)	(0.056)	(0.981)
R^2	0.142	0.325	0.193	0.318	0.306	0.385
Models estimated with grade, year, and student fixed-effect controls						
Universal-free SBP	-0.067	-0.049	-0.021	-0.036		
	(0.042)	(0.057)	(0.051)	(0.065)		
2008-9 AY	0.088***	0.148***	0.135***	0.112**		
	(0.029)	(0.040)	(0.036)	(0.046)		
R^2	0.918	0.969	0.908	0.958		
Tests	982	943	982	940	315	308

Note: The table reports coefficients and standard errors from OLS regression models estimated using NCERDC student-level data. The models with student characteristic controls include controls for gender; black, Hispanic, or other non-white race/ethnicity; economic disadvantage, limited English proficiency; math or reading giftedness; exceptionalness (disability); and days in membership. In the models with student fixed effects, only the economic disadvantage and days in membership controls are used.