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Economies of Scale, the Lunch-Breakfast Ratio, and the Cost of USDA School Breakfasts and Lunches

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Abstract

Through USDA's National School Lunch and Breakfast Programs, schools receive financial support to assist them in serving nutritious meals to students. Meal reimbursements are provided to a school food authority (SFA) on the basis of a child's financial need, allowing schools to provide healthy meals to low-income students for free or at a reduced price. Reimbursement rates are set nationwide, yet variation in school location, size, and other factors may influence the costs to schools for providing meals, with implications for the adequacy of reimbursement. Previous ERS research using data from the 2002-03 school year found that school foodservice costs vary by location. This study uses those same data to build on that research by examining breakfast and lunch costs separately to assess how economies of scale and the balance between the number of breakfasts and lunches served affect costs. Costs of both breakfasts and lunches vary considerably across SFAs. Economies of scale exist for both breakfasts and lunches but are much stronger for breakfasts. The balance between breakfasts and lunches served also affects costs, with the cost per breakfast dropping dramatically as the number of breakfasts and lunches served become more balanced.

Keywords: National School Lunch Program, School Breakfast Program, school meals, school food service costs per meal.

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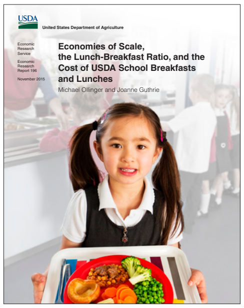

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Economies of Scale, the Lunch-Breakfast Ratio, and the Cost of USDA School Breakfasts and Lunches

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What Is the Issue?

Through USDA's National School Lunch Program (NSLP) and School Breakfast Program (SBP), schools receive financial support to assist them in serving nutritious meals to students. At the local level, the NSLP and SBP are administered by a school food authority (SFA), usually a unit of the school district. SFAs are reimbursed by USDA for the breakfasts and lunches they serve on the basis of students' financial need, allowing schools to provide free or reduced-price healthful meals to low-income students. Reimbursement rates are set nationwide, yet variations in school location, size, and other factors may affect the costs to schools for providing meals. Previous ERS research found school per-meal costs varied by location, but the analysis did not separate breakfast and lunch costs. This study builds on that previous research by examining how the costs of school breakfasts and of lunches are affected differently by economies of scale; the balance in the number of breakfasts and lunches served by a given SFA (lunch-breakfast ratio); factor (food, labor, and supplies) prices; and SFA characteristics. A better understanding of the extent of cost variation across SFAs for each type of school meal—breakfast and lunch—may benefit policy and program officials because schools have the option of choosing to serve breakfasts and/or lunches, and costs may influence that decision.

What Did the Study Find?

Based on a nationally and regionally representative sample of SFAs serving both breakfasts and lunches, SFAs served more lunches than breakfasts in 2002-03, with breakfasts making up only 25 percent of school meals served. However, the proportion of school breakfasts served in 2002-03 varied considerably across locations. For example, SFAs in the suburban Mountain Plains served 8 times as many lunches as breakfasts, whereas SFAs in the urban Southwest served 1.7 times as many. Generally, suburban SFAs served the smallest proportion of breakfasts to lunches. Other findings include the following:

- Consistent with findings in USDA's School Lunch and Breakfast Study II, the average cost per breakfast for schools in 2002-03 exceeded reimbursement rates, but costs per lunch were less than the reimbursement rate.

- For both breakfasts and lunches, the average cost to schools declined as the number of meals served increased. This effect of economies of scale was much stronger for break-

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fasts than for lunches. For SFAs serving the largest number of breakfasts, per-breakfast costs were estimated to be 51 percent of those for SFAs serving the lowest number of breakfasts. For SFAs serving the largest number of lunches, per-lunch costs were 81 percent of those for SFAs serving the lowest number of lunches.

- Differences in factor prices (for food, labor, supplies) across SFA locations, as well as in SFA characteristics such as use of foodservice management companies, influenced per-meal costs. However, their importance relative to economies of scale differed for breakfasts and lunches. For breakfast costs, scale effects were relatively stronger—more than two times the effects of factor-price differences and SFA characteristics. For lunch costs, the effects of factor prices and SFA characteristics were stronger—three times greater than those of scale effects.

- Within an SFA, the balance between breakfasts and lunches served had a large effect on breakfast costs. In areas with the highest imbalance, such as most suburban areas, the decline in per-meal breakfast costs is substantial, with per-meal breakfast costs potentially declining by about 50 percent if the number of breakfasts served were to equal that of lunches.

How Was the Study Conducted?

The study uses a translog multiproduct cost function that is adjusted for quality to examine the costs of preparing a school meal. The model accounts for a number of characteristics of school food authorities, including region and urbanicity of location; mix of elementary, middle, and high schools; and use of a foodservice management company. It calculates the costs of breakfasts and lunches and the contributions of economies of scale, factor prices (for food, labor, and supplies), and SFA characteristics. The model was also used to estimate the effect on costs accounted for by the balance between the number of breakfasts and lunches served.

Data were obtained from the School Food Authority Characteristics Study (SFACS), a nationally representative survey of public SFAs that was stratified to allow estimates by region and urbanicity. The survey was administered by USDA's Food and Nutrition Service. Operations and cost data were collected from a written survey for the 2002-03 school year. During the intervening years, breakfast participation rose from one-quarter to one-third of meals served. Some other operational characteristics were obtained in a fax-back survey for the 2003-04 school year. More recent data on school meal costs and numbers of breakfasts and lunches served by SFAs from a sufficiently large national and regionally representative dataset are not available. SFACS data were augmented by data on socioeconomic and school district characteristics from the National Center for Education Statistics and the U.S. Census Bureau. Food price data come from a computation based on ERS's Quarterly Food At-Home Price Database and the food menu plans of the schools surveyed in the School Nutrition and Dietary Assessment Study (SNDA) III.

Economies of Scale, the Lunch-Breakfast Ratio, and the Cost of USDA School Breakfasts and Lunches

Introduction

In fiscal year 2013, 31 million lunches and 13 million breakfasts were served each schoolday to children attending schools that participate in USDA's National School Lunch Program (NSLP) and School Breakfast Program (SBP) (Oliveira, 2014). Although participation in each program is voluntary, almost all public elementary and secondary schools participate in the NSLP, as do many private schools. Participation in the SBP is lower than in the NSLP but has increased in recent years. The SBP is now available in 90 percent of the schools that offer the NSLP.

Schools that participate in the programs are required to serve breakfasts and lunches that meet USDA nutrition standards. At the local level, school food authorities (SFAs), usually administrative units within the school districts, administer the programs. SFAs must make USDA meals available to all students at participating schools. SFAs can set the prices of meals served to students who do not come from low-income households, but students who qualify on the basis of financial need must be served meals for free or at a reduced price. USDA reimburses SFAs for the meals they serve on a sliding scale based on whether the meals are served for the SFA-set "full" price for nonpoor students.

All NSLP and SBP meals qualify for some level of reimbursement, but free and reduced-price meals are reimbursed at higher levels so that participating schools can make healthful meals available to all students. Students in households with incomes at or below 130 percent of the Federal poverty level are eligible for free meals. Those from households with incomes between 130 and 185 percent of the poverty level are eligible for reduced-price meals, for which they pay no more than $0.30 for breakfast and no more than $0.40 for lunch. USDA meal reimbursement rates are updated annually based on the national average Consumer Price Index for All Urban Consumers for Food Away From Home. Reimbursement rates are set nationally.

Most meals served through the SBP and NSLP are provided for free or at a reduced price, making them an important part of the nutrition safety net for low-income children. SFAs encourage meal participation among low-income and other students as a means of promoting both nutrition and learning (USDA, FNS, 2013a). SFAs are required by USDA to be nonprofit; however, school districts generally expect SFAs to cover their meal production costs. SFA annual revenues are obtained through per-meal reimbursements provided by USDA (50 percent of revenues), meal payments by students who are not income eligible for free meals (24 percent of revenues), a la carte sales and other nonreimbursable food sales (16 percent of revenues), and State and local funds (10 percent of revenues) (Bartlett et al., 2008; Newman et al., 2008).[1] Reliance on meal revenues gives SFAs incentive to provide meals that are both healthful and appealing to children, encouraging them to promote student participation (Newman et al., 2008). However, if reimbursement rates are too low, schools

[1]Per-meal reimbursements include cash reimbursements and donated commodities. Cash reimbursements account for 45 percent of revenues, and USDA-donated foods are 5 percent of revenues.

may struggle to offer meals that are healthful and appealing and may have less of an incentive to promote student participation in the SBP and NSLP.

A relatively low reimbursement rate for SBP breakfasts (Bartlett et al., 2008) may be a particular concern for broader participation in the SBP. A high cost of breakfasts relative to the reimbursement rate could discourage SFAs from participating in the SBP or from promoting broad participation by students despite the efforts of USDA's Food and Nutrition Service (FNS) and advocacy groups, such as the Food Research and Action Center (FRAC, 2014), to encourage increased school breakfast participation.

The School Lunch and Breakfast Cost Study (SLBCS-II) conducted by Abt Associates collected detailed cost and revenue data from a national sample of SFAs in 2005-06 and concluded that, on average, SFAs obtained sufficient revenues from USDA reimbursements and other sources to cover their reported costs (Bartlett et al., 2008). However, SFAs are located in rural, urban, and suburban areas across the United States and likely have very different labor and food costs, depending on their locality. In addition, SFAs vary considerably in size, with some serving hundreds of students and others serving hundreds of thousands of students. As the number of students served grows, SFAs may capitalize on volume discounts in purchases, economies of scale in meal production that may allow for greater labor efficiency, and other benefits that may lower their costs. Small SFAs, by contrast, may bear higher costs due to small purchasing volumes and diseconomies of scale in meal production. Such differences have raised concerns about the extent to which costs may vary across SFAs, the factors that may influence cost variation, and the appropriateness of adjusting costs for local variation (USGAO, 2014). A recent report to Congress by the U.S. Government Accountability Office investigated the implications of making subnational adjustments in meal reimbursement rates but concluded that sufficient information on drivers of cost variation was lacking (USGAO, 2014).

Ollinger et al. (2012) used a representative dataset, the School Food Authorities Characteristics Survey (SFACS) administered by FNS in 2002-03, and econometric methods to estimate costs per meal for each of 21 locations defined by FNS regions (Mid-Atlantic, Midwest, Mountain Plains, Northeast, Southeast, Southwest, and West) and urbanicities (urban, suburban, and rural) across the United States. Ollinger et al. found that average cost per meal varied substantially across locations and that about one-half the difference from cost estimates based on sample mean values was due to food prices and about one-third was due to economies of scale. The study examined cost per meal and did not distinguish breakfast costs from lunch costs. However, findings suggested that variation in breakfast cost could be a particularly important factor in overall school meal cost variation. School breakfasts are simpler meals with lower calorie and nutrient requirements than lunches and might be expected to have lower food and labor costs. In addition, SFAs might be expected to obtain economies of scope by producing both breakfasts and lunches—that is, producing two similar products might reduce the average cost of production. Combined, these attributes make it appear likely that SFAs in which breakfasts were served would have lower overall per-meal costs. However, Ollinger et al. found that when SFAs served relatively small numbers of breakfasts (33 percent or less of all meals served in a district), offering breakfast did not seem to have the expected effect of lowering average per-meal costs. The researchers hypothesized that this effect could be attributed to a lack of economies of scale when small numbers of breakfasts are produced.

This study examines breakfast and lunch costs separately to determine the effects of economies of scale on the cost of each type of meal. It estimates the contributions of economies of scale and factor (food, labor, and supply) price differences across locations to differences in per-lunch and per-breakfast costs. In addition, the study assesses the effect of the ratio of lunches to breakfasts served, or "meal service balance," on the cost of providing NSLP lunches and SBP breakfasts. Meal service balance is achieved when the numbers of lunches and breakfasts served are equal. The study hypothesizes that meal service balance affects per-meal cost by, for example, allowing better use of kitchen staff and SFA resources across the schoolday.

Given previous research findings on the effects of location on foodservice costs, this study examines the effects of scale and meal balance on breakfast and lunch costs across 21 locations nationwide. Locations comprise three urbanicities (urban, suburban, and rural areas) and the seven regions (Mid-Atlantic, Midwest, Mountain Plains, Northeast, Southeast, Southwest, and West) administered by FNS.

Assessing the Effects of Scale and Meal Service Balance on Breakfast and Lunch Costs

This study uses a translog multiproduct cost function adjusted for meal quality to estimate school breakfast and lunch costs. Quality-adjusted translog cost functions were introduced by Gertler and Waldman (1992), extended by Antle (2000), and implemented for an analysis of NSLP meals by Ollinger et al. (2012). After estimating the model, we calculate the costs of breakfasts and lunches and compute the contributions of factor (i.e., food, labor, supplies) prices, SFA characteristics, and economies of scale to breakfast and lunch costs. We also estimate the impact of meal balance on costs.

Previous studies have used Cobb-Douglas, Constant Elasticity of Substitution (CES), and translog cost functions to examine costs. We use a translog cost function because (1) it places no a priori restrictions on substitution elasticities and is consistent with constraints typically assumed by economists (Berndt, 1991); (2) it is very general and permits a variety of possible production relationships, such as optimal factor shares that vary with the level of output and characteristics, and nonconstant elasticities of factor demand; (3) it can easily accommodate multiple meal types; and (4) it enables us to account for diverse SFA practices by allowing alternative ways in which attributes can be specified.

Specifically, we use a type of translog cost function called a translog multiproduct cost function because we want to estimate the costs of two products—breakfasts and lunches. Translog multiproduct cost functions have been used to examine costs in hospitals (Bilodeau et al., 2000), police departments (Gyimeh-Brempong, 1987), milk packing (Gallagher et al., 1993), childhood education (Powell and Cosgrove, 1992), and physician services (Gunning and Sickles, 2009).

Table 1 identifies the key prices, types of meals served by SFAs, and SFA characteristics that must be accounted for in analyses examining the costs of providing school breakfasts and lunches. All of the SFAs in our sample (see Data later in this section) serve breakfasts and lunches. Since fewer students participate in the SBP, SFAs serve fewer breakfasts than lunches. Using adjusted survey weights, the average public SFA that served both school lunches and breakfasts served about 410,000 lunches and 135,000 breakfasts in the 2002-03 school year. This estimate excludes about 15 percent of all public SFAs that served only lunches or were missing key data.

Most SFAs also sell unsubsidized snack foods, beverages, and side dishes in addition to USDA school meals. These items, commonly referred to as a la carte or competitive foods, are not meals, yet they impose costs and must be accounted for in the model. Average values for important SFA characteristics, such as a la carte foods sales, the provision of health insurance, and the use of food-service management companies, are also shown in table 1.

Translog cost functions are flexible, which enables us to account for a la carte foods and other SFA attributes directly in the model. We also account for meal quality because different SFAs may provide different quality meals.

Table 1
Descriptive statistics of sample school food authorities (SFA), 2002-03 school year[1]

Model variables	Weighted average across SFAs	Minimum across SFAs	Maximum of all SFAs
Cost per meal and factor-price measures		*Dollars*	
Cost per meal (total annual foodservice cost divided by total reimbursable lunches and breakfasts served)	2.63	0.23	9.76
Price of labor (mean wage plus fringe benefits per hour per cafeteria worker)	11.49	5.44	25.60
Price of food (Price Index based on author's estimates)	0.97	0.88	2.06
Price of supplies (MERIC Price Index for products excluding food, energy, transportation, housing, and medical costs)	1.00	0.94	1.32
Meal quality	1.41	0.84	2.88
Geography			
Urbanicity—			
Urban[2]	0.08	0	1
Suburban[2]	0.39	0	1
Rural[2]	0.53	0	1
USDA, Food and Nutrition Service region—			
Mid-Atlantic[2]	0.10	0	1
Midwest[2]	0.25	0	1
Mountain Plains[2]	0.17	0	1
Northeast[2]	0.12	0	1
Southeast[2]	0.08	0	1
Southwest[2]	0.15	0	1
Western[2]	0.13	0	1
SFA characteristics			
Lunches per year across SFAs (millions)	0.410	0.001	117.1
Breakfasts per year across SFAs (millions)	0.135	0.001	34.1
Share of revenues from a la carte foods	0.162	0.0	0.99
Average lunch price	1.54	0.40	3.39
SFAs with less than 30 percent elementary schools[2]	0.02	0	1
SFAs with more than 70 percent elementary schools[2]	0.47	0	1
SFAs using a traditional menu[2]	0.60	0	1
SFAs providing foodservice workers with health insurance[2]	0.91	0	1
SFAs with foodservice management companies providing some inputs[2]	0.14	0	1
Number of SFAs	**1,221**	-	-

[1]Values are based on adjusted survey sample weights.
[2]Variables are zero or one dummy variables. The average is the share across all SFAs.
Source: USDA, Economic Research Service using data from School Food Authority Characteristics Survey, Mathematica Policy Research, Inc. (2004), and analysis by the authors.

SFAs can influence school meal demand by changing food quality (Poppendieck, 2010). Food quality includes nutritional value, tastiness, and appearance. Although SFAs are required to serve school meals that meet USDA nutrition standards, other aspects of food quality may vary across SFAs (Gordon et al., 2007). For example, some SFAs may offer more choices among fruits and vegetables or provide a salad bar; others may offer only the minimum required options. Meals with higher quality may require more labor inputs to enhance presentation or more palatable (costly) ingredients, such as fresh versus canned fruit. While the nutritional value of these meals may not change, differences in other aspects of quality lead to cost differences (Ralston et al., 2008).

Failure to account for quality in cost function analyses may result in omitted variables bias (Braeutigam and Pauly, 1986). Gertler and Waldman (1992) overcame this bias by developing a quality-adjusted cost function of nursing home providers in which quality and costs were estimated jointly. Blank and Eggink (2001) followed Gertler and Waldman (1992) in their analysis of the Dutch nursing home industry. Antle (2000) extended Gertler and Waldman (1992) by including Rosen's (1974) model of a competitive industry with product differentiation into a quality-adjusted cost function model for food safety. Later, Ollinger et al. (2012) adapted Antle's (2000) approach to school meals in an analysis of cost differences across SFA locations.

Appendix A.1 discusses our multiproduct model in detail. The model accounts for the costs of breakfasts and lunches separately, as well as for a la carte foods, meal quality, input prices for labor (average wages per worker), the price of food, and the price of supplies. Meal quality is based on the cost of inputs and student demand for palatability. High-quality meals may include low-cost foods with a relatively large amount of labor inputs or vice versa. Meal quality is estimated from meal costs, the price of inputs, and factors known to affect demand, such as median household income and educational level of the SFA. Types of foods are not included in the measure, but their cost is derived from reported costs, input prices, and demand attributes.

We do not use a price of capital because (1) SFAs use school district facilities and do not pay rental fees, (2) about one-third of SFAs do not report any use of capital services, (3) median capital cost as a share of all costs was less than 0.5 percent for SFAs, and (4) the mean capital costs for SFAs as a share of all costs was about 1.0 percent.[2] The absence of a fixed factor does not preclude economies of scale because economies of scale can arise from volume discounts for larger buyers, specialization of labor in meal production, etc.

The cost function accounts for the location of the SFA, as defined by urbanicity and region, as well as for other key variables shown in table 1.[3] Those variables include the types of students served (i.e., elementary, middle school, and high school students) because meal size may vary by type of student served; the menu-planning option used by the SFA (i.e., traditional menu versus other USDA-approved option[4]); whether the SFA offers health insurance to its employees; and use of

[2]We also do not include unreported administrative costs. Capital costs and these unreported administrative costs were estimated by Bartlett et al. (2008) to be about 19 percent of the full cost of a school meal. Administrative costs comprise unreported labor (61 percent), unreported indirect costs (26 percent), unreported capital costs (10 percent), and other nonspecified costs.

[3]As pointed out by an anonymous reviewer, an "urban" SFA in one region may be more or less densely populated, geographically large, and geographically diverse than one in another region. Unionization of workers is an important factor that varies by urbanicity in some regions and less so in others.

[4]At the time, USDA permitted SFAs to use various types of menu planning approaches (traditional food-based menu versus three alternatives—enhanced food-based, nutrient-based, and other). All of these approaches were expected to result in meals that met USDA nutrition standards. Currently, USDA permits only one menu-planning approach, which is food-based.

foodservice management companies by the SFA. Table A.1 provides the definitions of all model variables. Appendix A.2 provides a detailed discussion of how we computed input prices for labor, food, and materials.

Data

SFA data used in this analysis come from the School Food Authorities Characteristics Survey (SFACS), a nationally representative sample of public SFAs stratified by FNS region and poverty level that was conducted on behalf of FNS by Mathematica Policy Research, Inc. (MPR) for the 2002-03 school years (MPR, 2004); some operating information also came from the 2003-04 school year. Several changes in USDA school meal programs have ensued in the decade following this survey, most notably updates to nutrition standards that have led to changes in the types of foods served. However, more recent data on school meal costs from a large national and regionally representative sample that reports number of breakfasts and lunches served are not available.[5] Moreover, economies of scale and meal balance are technical issues that require data that are available only in the SFACS. Those data include the number and types of meals served, factor prices, and SFA meal service practices and attributes.

Data were collected via three survey instruments: a one-page fax-back form, a brief telephone survey, and a four-page self-administered survey on costs and revenues and related meal and SFA characteristics. Information on school district enrollment and demographic and wealth characteristics was drawn from the National Center for Education Statistics Common Core Data (CCD) for the 2001-02 school year (NCES, 2004). The fax-back form requested general SFA attributes, such as student enrollment; the telephone survey collected non-numerical information, such as the use of a foodservice management company; and the self-administered cost and revenue survey collected detailed information on food, labor, and material costs for 1,665 SFAs. MPR asserts that these SFAs are nationally representative. After dropping the 211 SFAs that did not serve breakfast and the 233 SFAs with incomplete information, the final dataset contained 1,221 SFAs.

The public SFAs in the final dataset served nearly 11.5 million meals per day to more than 14 million children in schools across 21 U.S. locations in 2002-03. Removal of SFAs with incomplete information and those not serving breakfasts may have resulted in a less representative dataset. However, the dataset is broad—no location had fewer than 12 observations (SFAs). Moreover, the population of the dataset is consistent with those serving breakfasts—sample SFAs are more urban and larger than SFAs in the original sample.

Data are typically weighted to correct for different types of biases and then used for national estimates. Survey weights put greater or less emphasis on observations depending on the frequency with which they occur in a sample and their actual share in the population. In this way, underrepresented groups should be given a heavier weight. Our data originally had sample weights that could be used to obtain national estimates. However, those weights are no longer valid for our analysis because many observations were dropped.

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[5]Data on school lunch and breakfast costs were collected in 2005-06 for the School Lunch and Breakfast Cost Study (SLBCS) II. Although that study includes very detailed information on costs and revenues, the sample is much smaller and is not regionally representative. For these reasons, it could not be used for our analysis. However, our mean meal costs are very similar to those obtained by the SLBCS II. More recently, the Special Nutrition Program Operations Study 2011-12 includes cost data but does not include data on the number of breakfasts and lunches served, making it impossible to separate cost effects associated with each type of meal.

We adjusted the original weights and used those revised weights for the values displayed in tables 1 and 2. These revised weights were computed by adjusting the original weight by the relative loss of observations in the strata. Data were stratified by poverty level and FNS region. Observations in strata that lost a relatively large number of observations were given heavier weights than those that lost none or relatively few. As one would expect, the number of meals served per SFA was estimated to be much larger in the unweighted data than in the weighted data because large urban SFAs were relatively overrepresented in the unweighted data. Likewise, small rural and suburban SFAs were relatively underrepresented because they were less likely to serve both breakfasts and lunches.

The number of school meals served and the costs of school meals vary by region and urbanicity and are shown in table 2. The mean number of meals served per year across regions varies from 255,000 per year in the Mountain Plains to 1,199,000 per year in the Southeast, while the mean number of meals for urbanicities ranged from 221,000 in rural SFAs to 3,021,000 in urban SFAs. Moreover, the numbers of lunches and breakfasts served can differ sharply. The ratio of lunches to breakfasts ranged from 5 to 1 in the Northeast to 1.86 to 1 in the Southwest, and the mean cost per meal in 2002-03 varied from $2.32 in the Southwest to $2.86 in the Northeast. For urbanicities, the ratio of lunches to breakfasts ranges from nearly 4 to 1 in suburban SFAs to 2.50 to 1 in urban SFAs, and the mean cost per meal in 2002-03 varied from $2.39 in urban SFAs to $2.87 in suburban SFAs.

The measure of cost per meal equals all costs divided by all reported meals. Costs include those for a la carte food, which typically includes side dishes for a meal, snacks, drinks, or a meal in itself. These costs are not subsidized and are separate from the school lunch. Thus, our cost per meal measure should not be interpreted as the subsidized cost of a meal. This subsidized cost has been estimated in a very rigorous manner elsewhere (see SLBCS-II). Nevertheless, we must make cost comparisons on a common basis, so we must strip away the cost of a la carte foods.

Table 2
Mean meals served per year and mean cost per meal across seven regions and three urbanicities[1]

	Lunches	Breakfasts	Lunches/Breakfasts	Cost per meal
	Millions served		*Ratio*	*Dollars*
Region				
Mid-Atlantic	0.563	0.145	3.88	2.85
Midwest	0.300	0.084	3.57	2.76
Mountain Plains	0.204	0.051	4.00	2.48
Northeast	0.396	0.078	5.08	2.86
Southeast	0.869	0.330	2.63	2.42
Southwest	0.371	0.200	1.86	2.32
West	0.562	0.192	2.93	2.82
Urbanicity				
Rural	0.161	0.060	2.68	2.52
Suburban	0.463	0.117	3.96	2.87
Urban	2.159	0.862	2.50	2.39
Sample mean	**0.410**	**0.135**	**3.03**	**2.58**

[1]Sample and location mean values based on adjusted sample weights.
Source: USDA, Economic Research Service using data from School Food Authority Characteristics Survey, Mathematica Policy Research, Inc. (2004), and analysis by authors.

We estimated the cost of a subsidized meal (lunch or breakfast) by multiplying the total cost per meal times the revenues from school meals as a share of total revenues, where total revenues are revenues from subsidized school meals plus revenues from a la carte foods. We use a revenue basis for our adjustment because we have revenue data but no cost data for a la carte foods. The revised cost per meal for 21 locations is shown in appendix table B.1. Comparisons still cannot be made directly across SFAs, however, because meals include both breakfasts and lunches and breakfast participation varies across SFAs. Thus, the cost per meal can vary across SFAs due to the mix of meals served.

There is no direct way to correct for the mix of meals. However, we can remove SFAs with different production profiles. Thus, we created a subsample of SFAs in which at least 15 percent of all meals and no more than 30 percent of all meals were breakfasts. The cost per meal for this subsample of SFAs is reported in the final column of appendix table B.1. The data show that costs vary considerably.

For the remainder of this study, we use cost indices to facilitate cost comparisons across types of meals and locations. Indices are relative values that facilitate comparisons across different groups. In this study, we are interested in making comparisons of breakfast and lunch costs within and across urbanicities, regions, and locations. Cost indices are defined as costs of an urbanicity, region, or location of interest divided by a reference urbanicity, region, or location. The index varies depending on the analysis. For urbanicities, index values equal lunch or breakfast cost for an urbanicity divided by lunch cost for an urban urbanicity. For comparisons across regions, we used breakfast or lunch costs of a region relative to lunch costs for the Mid-Atlantic region. For locations, we used breakfast or lunch cost of a location relative to lunch costs for the urban, Mid-Atlantic location.

The major point of this paper is to evaluate how costs vary across SFAs for the production of lunches and breakfasts and assess the relative costs of breakfasts and lunches. In our subsequent analyses, we account for a la carte foods and distinguish the costs of a breakfast from the costs of a lunch to determine how costs vary across locations. Some research (Hilleren, 2007; Sackin, 2008) already provides evidence showing that costs per breakfast vary with the number of breakfasts served and service style (for example, serving breakfast in the classroom). We examine the issue using a larger, more representative sample with more detailed information.

Model Testing and Final Model

We used a series of log likelihood tests to select our model. Variables were included in the model based on their contribution to model fit. Appendix A.3 includes a discussion of the log likelihood estimates and how we arrived at our final model, along with other details concerning model diagnostics. The final model was highly significant; that is, it provided meaningful information on the variables that predict school lunch and breakfast costs. Table A.3 reports the estimated coefficients for the final model. Nearly two-thirds of the model variables are significant at the 90-percent-or-higher level. Coefficients for the first-order factor-price terms provide estimates of the share of costs devoted to labor (W_{LAB}), food (W_{FOOD}), and supplies (W_{SUPPLY}) at the sample mean. Food and labor inputs each account for about 44.3 percent (share as given by coefficient on the first-order labor or food term = 0.443) of meal costs; supplies account for about 11.4 percent of costs. These cost shares apply only to the reference category (urban Southeast SFAs) in which all dummy variables equal 0. Cost shares change under various circumstances and can easily be computed by adding the cost share to the same cost share interacted with a variable of interest. For example, the labor cost share for an urban Midwestern location would be 44.3 percent - 0.9 percent = 43.4 percent, the food cost share would be 44.3 percent + 2.7 percent = 47 percent, and the supplies cost share would be 11.4 percent - 1.8 percent = 9.6 percent. Different urbanicities have different cost shares as well. For example, the labor cost share for Midwestern rural locations would be 44.3 percent - 0.9 percent + 1.0 = 44.4 percent, the food share would be 44.3 percent + 2.7 percent - 0.7 percent = 46.3 percent, and the materials cost share would be 11.4 percent - 1.8 percent - 0.4 percent = 9.2 percent. Cost shares at various quality levels can be computed by adding the model cost share to the same cost share interacted with quality. See appendix A.3 for a further discussion of model testing. Here, we focus on the effects of economies of scale and meal-service balance.

Calculating Economies of Scale

Economies of scale are evaluated by taking the total differential of the cost function to obtain the cost elasticity, ηmodel (eq. 1). This elasticity indicates the percent change in costs for a 1-percent change in one or more outputs and equals the sum of coefficients on the first-order output terms ($M_{LUNCHES}+M_{BFASTS}$) at sample mean values. Since the sum of the coefficients on the first-order output terms equals 0.873 (table A.3) and economies of scale exist if this value is less than one at sample mean values, we conclude that the model exhibits economies of scale at sample mean values.

$$1)\quad \eta_{\mathrm{model}} = \frac{\partial C}{\partial M_{lunch}}\frac{M_{lunch}}{C} + \frac{\partial C}{\partial M_{bfast}}\frac{M_{bfast}}{C} = \eta_{lunch} + \eta_{bfast}$$

The variables included in our model enable us to explore the effects of other factors on cost elasticity. Most notably, (1) the interactions of breakfasts and lunches with the regional dummy variables (table A.3) suggest large differences in scale economies across regions, and (2) the values for quadratic meal terms ($M_{LUNCHES}*M_{LUNCHES}$ and $M_{BFASTS}*M_{BFASTS}$) are greater than zero, suggesting an increase in cost elasticity due to diseconomies of scale with more breakfasts or lunches served. These diseconomies of scale with added meal service are reduced by economies of scope because the economy of scope parameter, ($M_{LUNCHES}*M_{BFASTS}$), is negative (table A.3). A negative value implies that costs per lunch drop as more breakfasts are served.

The last three columns of table 3 show the mean cost elasticities at each of 21 SFA locations. All elasticities are highly significant. The total cost elasticity at each location (last column) ranges from 0.788 for suburban Northeast SFAs to 1.219 for urban Southwest SFAs. The mean total elasticity is 0.956 and significant. There were four urban and two rural SFA locations exhibiting diseconomies of scale. Note also that the means of the economies-of-scale parameter for urban SFAs, except those in the Southeast, are weaker than their rural and suburban counterparts, and that the means of the economies-of-scale parameter for all rural and suburban SFAs, except for those in the rural Southeast and Southwest, were less than one (ηmodel<1). The economies-of-scale parameter for breakfasts is lower than that for lunches in all cases except the rural Southeast and significantly lower overall, indicating that economies of scale are stronger for breakfasts.

Table 3

Mean of cost elasticities across 21 U.S. locations[1]

Region	Urbanicity	Cost elasticity at location mean		
		η**lunches**	η**breakfasts**	η**total**
			Elasticity	
Mid-Atlantic	Rural	0.711***	0.224***	0.935***
	Suburban	0.739***	0.107***	0.845***
	Urban	0.680***	0.267***	0.947***
Midwest	Rural	0.675***	0.231***	0.909***
	Suburban	0.661***	0.144***	0.805***
	Urban	0.670***	0.426***	1.100***
Mountain Plains	Rural	0.648***	0.300***	0.947***
	Suburban	0.733***	0.188***	0.921***
	Urban	0.825***	0.286***	1.111***
Northeast	Rural	0.542***	0.302***	0.844***
	Suburban	0.654***	0.134***	0.788***
	Urban	0.559***	0.409***	0.975***
Southeast	Rural	0.510***	0.538***	1.049***
	Suburban	0.590***	0.339***	0.928***
	Urban	0.502***	0.431***	0.934***
Southwest	Rural	0.630***	0.458***	1.088***
	Suburban	0.632***	0.310***	0.942***
	Urban	0.691***	0.528***	1.219***
West	Rural	0.516***	0.350***	0.867***
	Suburban	0.571***	0.322***	0.893***
	Urban	0.642***	0.384***	1.026***
Mean		**0.637*** **	**0.318*** **	**0.956*** **

Note: * = .10 level (10 percent); **= .05 level (5 percent); ***= .01 level (1 percent).

[1]Cost elasticities are evaluated at the mean of each location.

Source: USDA, Economic Research Service using data from School Food Authority Characteristics Survey, Mathematica Policy Research, Inc. (2004), and analysis by authors.

Changes in Breakfast and Lunch Costs Associated With Economies of Scale

To estimate the effects of changes in the number of meals served on breakfast and lunch costs across SFA locations, we simulated the mean costs per breakfast and per lunch across four ranges of numbers of meals: 50-75, 75-125, 150-200, and 300-400 percentages of the location mean outputs. For simplicity, we report these at the midpoint of each range (i.e., 62, 100, 175, and 350 percentages).

We cannot directly compute the cost per lunch or per breakfast from equation 8 because there is one equation and two unknowns (lunches and breakfasts). As an alternative, we used the following procedure and equation A.2 (app. A.1) to estimate average cost per meal between points 1 and 2 for one kind of meal (e.g., lunches) while holding the output of the other meal (breakfasts) constant. First, we used equation A.8 (app. A.1) to calculate costs ($COST_1$) at one level of output ($LUNCH_1$ and $BFAST_1$). Next, we changed output for only one kind of meal (e.g., lunches) while holding the output of the other meal (breakfasts) constant. We then computed costs ($COST_2$) at a new number of meals served ($LUNCH_2$ and $BFAST_1$). Next, we computed the changes in cost ($COST_2$ - $COST_1$) and the change in number of meals served (($LUNCH_2$- $LUNCH_1$) + ($BFAST_2$ –$BFAST_1$)). Lastly, we divided the change in costs by the change in number of meals to get the mean cost per lunch over the range of lunches over $LUNCH_2$ to $LUNCH_1$ because only lunches changed ($BFAST_1$= $BFAST_2$). Mean cost per breakfast over a range of breakfasts was estimated similarly.

$$(2) \qquad LUNCH = \frac{COST_2 - COST_1}{(BFAST_2 - BFAST_1) + (LUNCH_2 - LUNCH_1)}$$

Cost comparisons across three urbanicities for breakfasts and lunches are shown in figures 1 and 2. Values are given in terms of a cost index, which makes all costs relative to mean lunch costs for urban SFAs. Cost indexes make all cost comparisons relative to 1 and make percentage differences easy to compute. A cost index value of 1.5 means that costs are 50 percent higher, and an index value of 0.5 means that index values are 50 percent lower.

Figures 1 and 2 illustrate the much sharper drop in costs for breakfasts than for lunches across three urbanicities as scale increases. Values are given in terms of a cost index, which makes all costs relative to mean lunch costs for an urban urbanicity. Thus, our cost index compares the cost of a breakfast or lunch at one urbanicity (e.g., rural) to an urban urbanicity, which is the base urbanicity. Cost differences found across size ranges of numbers of meals (size categories) and within urbanicities are due to economies of scale alone and not to differences in labor and other factor prices.

Breakfast costs dropped by about 50 percent for each urbanicity as meal service increased from 62 to 350 percent of the mean number of breakfasts served (fig. 1), whereas lunch costs dropped by about 20 percent over the same range of meals served (fig. 2). Higher cost index values for breakfasts than for lunches in most meal-type comparisons indicate that breakfast costs are usually higher at the same scale and do not reach parity with lunches until the highest scale (350 percent of the mean).[6]

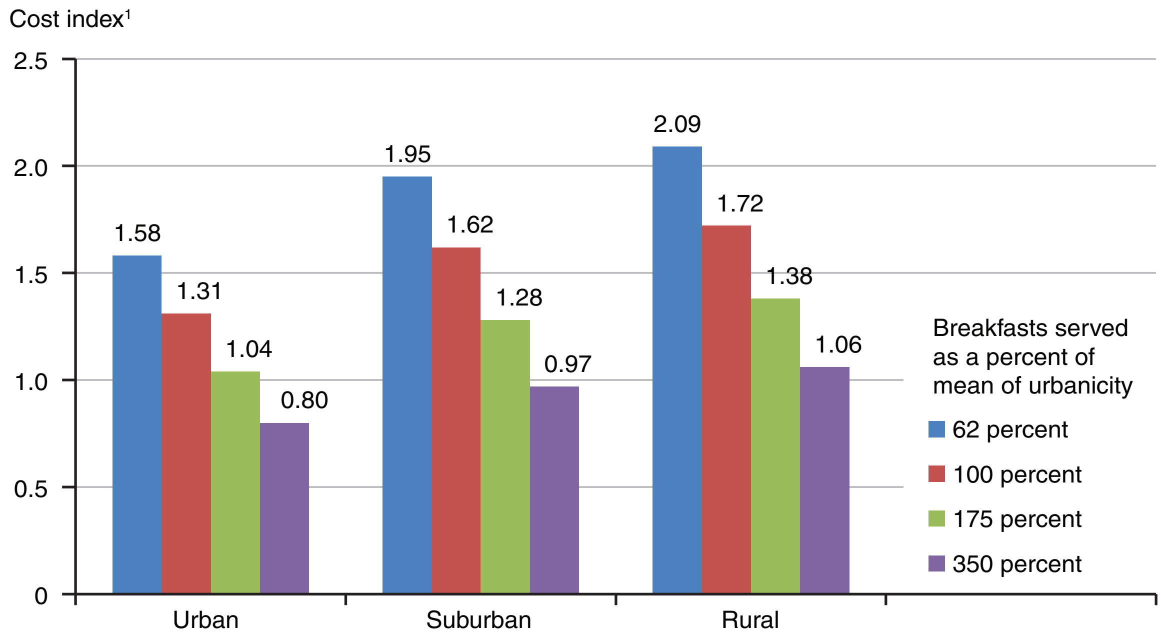
[6]Our econometric model reveals that SFAs offering few breakfasts have high overall meal costs. Schools serving the same number of lunches and with the same prices and characteristics but more breakfasts had lower costs per meal due to economies of scale.

Costs for the seven regions are shown in figures 3 and 4. Values are given in terms of a cost index, which makes all costs relative to mean lunch costs for the Mid-Atlantic region. Our cost index compares the cost of a breakfast or lunch at one region (e.g., Midwest) to a "base" region, the Mid-Atlantic. Using this technique, the cost index value per breakfast at its regional mean level and sample mean price varied from an index value of 0.88 in the Southwest to 1.69 in the Northeast. That is, if all prices and characteristics except region are the same, a Northeast SFA will have breakfast costs that are nearly twice as high as a Southwest SFA. Differences were lower for other regions. The average cost index value per lunch at the mean regional number of lunches served and at sample mean prices varied from 0.69 in the Northeast to 1.15 in the Southwest. Cost differences across the regions (i.e., Mid-Atlantic versus Southeast) are due to differences in regional dummy variables and output. Cost differences across size ranges of numbers of meals (size categories) and within regions are due to economies of scale alone and not to differences in labor and other factor prices.

Note that economies of scale for breakfasts at the region level are much stronger than for lunches (i.e., the mean breakfast cost index dropped about 50 percent while the average lunch cost index dropped about 20 percent over the four size categories, using the mean of the regional cost estimates). In SFAs serving the largest number of breakfasts, per-breakfast index cost values were estimated to be 51 percent of those in SFAs serving the lowest number of breakfasts (see fig. 1). For lunches, per-lunch index cost values in SFAs serving the largest number of lunches were 81 percent of those in the lowest serving SFAs (see fig. 2).

Figure 1

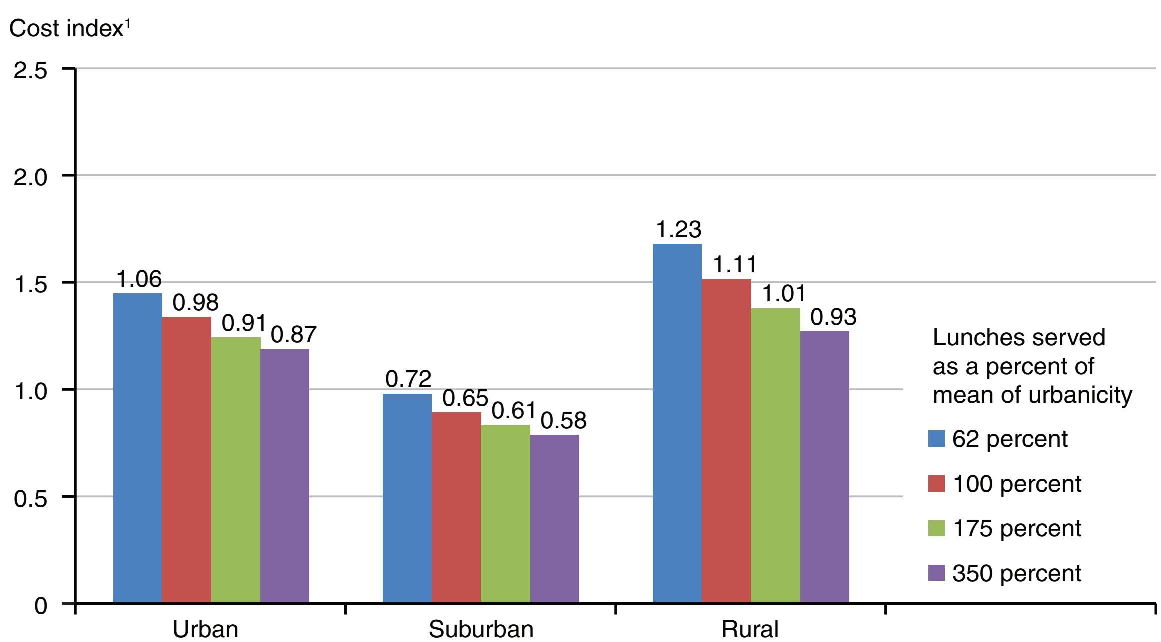
Breakfast costs drop sharply with an increase in breakfasts served in all urbanicities



[1]Cost index = cost index of urbanicity divided by lunch cost for urban urbanicity.
Prices of food and other inputs are the same for all school food authorities, only scale changes.
Source: USDA, Economic Research Service analysis using data from School Food Authority Characteristics Survey, Mathematica Policy Research, Inc. (2004).

Figure 2

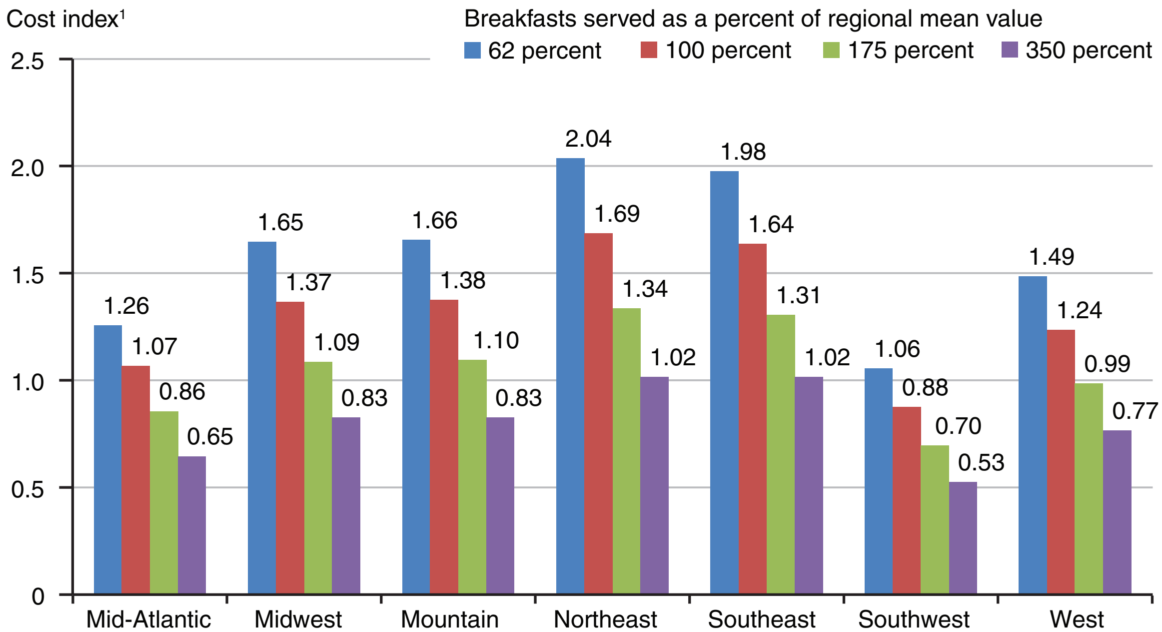
Lunch costs have modest decline with an increase in lunches served in all urbanicities



[1]Cost index = cost index of urbanicity divided by lunch cost for urban urbanicity.
Prices of food and other inputs are the same for all school food authorities, only scale changes.
Source: USDA, Economic Research Service analysis using data from School Food Authority Characteristics Survey, Mathematica Policy Research, Inc. (2004).

Figure 3

Regional breakfast costs drop sharply with an increase in the number of breakfasts served

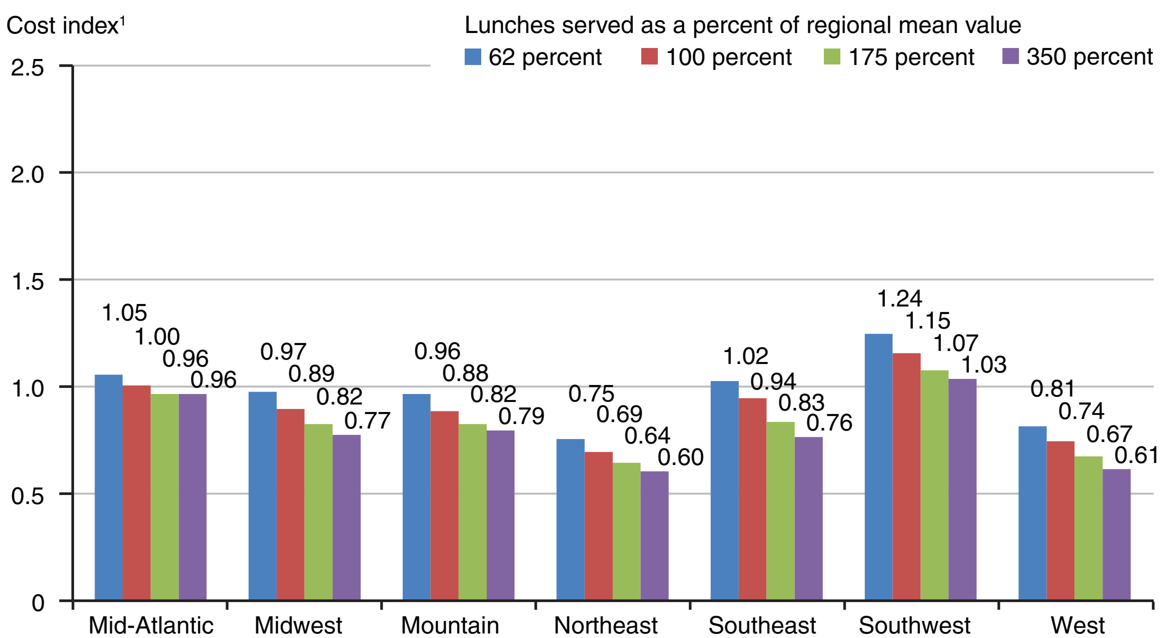


[1]Cost index = cost index of region divided by lunch cost for Mid-Atlantic region. Prices of food and other inputs are the same for all school food authorities, only scale changes.

Source: USDA, Economic Research Service analysis using data from School Food Authority Characteristics Survey, Mathematica Policy Research, Inc. (2004).

Figure 4

Regional lunch costs decline modestly with an increase in lunches served



[1]Cost index = cost index of region divided by lunch cost for Mid-Atlantic region. Prices of food and other inputs are the same for all school food authorities, only scale changes.

Source: USDA, Economic Research Service analysis using data from School Food Authority Characteristics Survey, Mathematica Policy Research, Inc. (2004).

Contribution of Economies of Scale, Factor Prices, and SFA Characteristics to Breakfast and Lunch Cost Variation

The model also enables us to assess the relative contribution of economies of scale, factor (food, labor, and supply) prices, and SFA characteristics to breakfast and lunch cost variation. Table 4 shows the contributions of prices, SFA characteristics, and scale to breakfast costs at each location. Values are given in terms of a cost index that is defined as costs relative to the mean lunch costs for urban Mid-Atlantic SFAs. The mean average cost index value of a breakfast is 1.23. This implies that the average breakfast is 23 percent more costly than the cost of a lunch in urban Mid-Atlantic SFAs at the sample mean number of breakfasts served and sample mean prices and characteristics. Column three in the table shows average costs at each location at the sample mean number of meals served and at sample mean prices and characteristics. The cost index value per breakfast varies from 0.83 in the rural Mid-Atlantic to 1.87 in the urban Southeast. These values imply that the estimated cost of a breakfast in the rural Mid-Atlantic was about 83 percent of the estimated cost of a lunch in the urban Mid-Atlantic. The estimated cost of a breakfast in the urban Southeast was 87 percent higher than the estimated cost of a lunch in the urban Mid-Atlantic. These values are computed using average prices of all inputs (labor and food) and average characteristics. Because food costs for breakfasts are likely to be no greater and perhaps less than food costs for lunches, most of the difference in estimated costs is likely due to lower labor efficiency stemming from diseconomies of scale.

Price/characteristics and scale have strong influences on mean costs per breakfast. The effect of prices and characteristics are shown in column (b);[7] scale effects are shown in column (c). The net change in average cost index values per breakfast due to the price/characteristics and scale effects (column (b+c)) varies from -0.28 in the urban Southwest to 1.36 in the suburban West. The mean absolute difference of the net change in the cost index is about 0.48 per breakfast (column (b+c)), with about two-thirds of the cost due to scale effects and one-third due to the price effect. The mean cost index value per breakfast, which includes scale and price and characteristics effects (column (a+b+c)), varies from 0.88 in the urban Southwest to 2.35 in the suburban Northeast. The mean cost index value is about 1.59 per breakfast at the location mean prices and number of meals served. This implies that the average school breakfast costs about 59 percent more than the average lunch in an urban Mid-Atlantic SFA.

Table 5 provides information on effects of price/SFA characteristics and scale on school lunch costs. Again, values are given in terms of a cost index that is defined as costs relative to the mean lunch costs for urban Mid-Atlantic SFAs. Column (a) in table 5 shows that the average cost index value per meal at the sample mean number of lunches and sample mean values is 0.85 and varies from 0.68 in the rural West to 1.07 in the suburban and urban Southwest. Differences in the cost index value are attributed to region and urbanicity because other values are at sample means.

Columns (b) and (c) in table 5 provide the same type of information for lunches as was provided for breakfasts in table 4. The scale effect per lunch varies from an index value of -0.07 in the suburban Northeast to 0.22 in the rural Southwest. The mean absolute difference of the scale effect is less than one-half that of the price effect. Column (a+b+c) shows the average cost index value per lunch

[7]We did not examine the effects of SFA characteristics separately from price effects. However, Ollinger et al. (2012) found that the impacts of price and characteristics on costs were approximately equal for school meals in general.

after accounting for price/SFA characteristics and scale effects. The cost index value varies from 0.79 per lunch in the rural Southeast to 1.31 per lunch in the suburban Mid-Atlantic. The mean cost index value is 0.99 per lunch at the location mean. Our estimated average lunch cost is similar to that obtained by the accounting methodology employed by the SLBCS-II, supporting the validity of the results obtained by our econometric methodology. Note that the relative importance of price and scale for lunch costs is the reverse of those for breakfasts. Also noteworthy, scale effects at urban SFAs result in larger cost reductions because urban SFAs are larger than other SFAs, and price/SFA characteristics effects are most positive for suburban SFAs. Finally, note also that the net change in costs is nearly three times greater for breakfasts than for lunch.

Table 4

Impact of location, prices and characteristics, and scale on the estimated cost of USDA breakfasts at the location mean number of breakfasts served[1]

Region	Urbanicity	Breakfast cost at location and using sample mean values	Change in cost per breakfast due to changes in factor prices and SFA characteristics and scale from sample mean values			Average breakfast cost index
			Price and characteristics effect	Scale effect	Net change in costs	Cost at location plus net change in costs
		(a)	(b)	(c)	(b+c)	(a+b+c)
		Cost index/breakfast				
Mid-Atlantic	Rural	0.83	-0.03	0.34***	0.31***	1.14***
	Suburban	0.97	0.27***	0.45***	0.72***	1.69***
	Urban	1.10	-0.05	-0.01	-0.06	1.04***
Midwest	Rural	1.09	0.06	0.72***	0.77***	1.86***
	Suburban	1.24	0.38***	0.67***	1.05***	2.29***
	Urban	1.37	0.07	0.05	0.12	1.49***
Mountain	Rural	0.94	-0.15***	0.80***	0.65***	1.59***
	Suburban	1.07	0.12**	0.53***	0.65***	1.72***
	Urban	1.19	0.05	0.07***	0.12***	1.31***
Northeast	Rural	1.23	0.13	0.85***	0.98***	2.21***
	Suburban	1.38	0.29*	0.68***	0.97***	2.35***
	Urban	1.51	-0.30***	0.04***	-0.26***	1.25***
Southeast	Rural	1.54	-0.25***	0.14***	-0.11***	1.44***
	Suburban	1.72	0.04	0.03**	0.07***	1.79***
	Urban	1.87	-0.06	-0.16**	-0.22***	1.65***
Southwest	Rural	0.87	-0.21***	0.38***	0.17***	1.04***
	Suburban	1.02	-0.02	0.18***	0.16***	1.18***
	Urban	1.16	-0.07	-0.21***	-0.28***	0.88***
West	Rural	1.14	0.21**	0.56***	0.77**	1.91***
	Suburban	1.28	0.37***	0.31***	1.36***	1.96***
	Urban	1.40	0.28***	-0.02	0.26***	1.66***
Mean absolute difference		-	0.16***	0.34***	0.48***	-
Mean cost		1.23***	-		-	1.59***

Notes: * = .10 level (10 percent); ** = .05 level (5 percent); *** = .01 level (1 percent).

[1]Costs are index values defined as predicted breakfast cost at a location divided by predicted lunch cost at the urban Mid-Atlantic location.

Source: USDA, Economic Research Service using data from School Food Authority Characteristics Survey, Mathematica Policy Research, Inc. (2004), and analysis by authors.

Table 5

Impact of location, prices and characteristics, and scale on the estimated cost of USDA lunches at the location mean number of lunches served[1]

Region	Urbanicity	Lunch cost at location with sample mean values	Change in cost per lunch due to changes in prices and SFA characteristics and scale from sample mean values			Average lunch cost index
			Price and characteristics effect	Scale effect	Net change in costs	Cost at location plus net change in costs
		(a)	(b)	(c)	(b+c)	(a+b+c)
			Cost index/lunch			
Mid-Atlantic	Rural	0.93	-0.05	0.07	0.02	0.95***
	Suburban	0.99	0.34***	-0.02	0.32***	1.31***
	Urban	0.98	0.01	0.01	0.02	1.00***
Midwest	Rural	0.80	0.04	0.06	0.10	0.90***
	Suburban	0.86	0.48***	-0.06	0.42***	1.28***
	Urban	0.85	0.09	0.01	0.10	0.95***
Mountain	Rural	0.80	-0.14***	0.20***	0.06	0.86***
	Suburban	0.85	0.12**	0.01	0.13	0.98***
	Urban	0.84	0.08*	-0.02	0.06	0.90***
Northeast	Rural	0.69	0.10	0.10	0.20	0.89***
	Suburban	0.74	0.31***	-0.07	0.24***	0.98***
	Urban	0.73	0.08	0.00	0.08	0.81***
Southeast	Rural	0.84	-0.15***	0.10***	-0.05	0.79***
	Suburban	0.90	0.05	-0.02	0.03	0.93***
	Urban	0.88	-0.01	0.03	0.02	0.90***
Southwest	Rural	1.02	-0.25***	0.22***	-0.03	0.99***
	Suburban	1.07	0.00	0.09**	0.09	1.16***
	Urban	1.07	-0.06	0.04	-0.02	1.05***
West	Rural	0.68	0.17**	0.12**	0.29***	0.97***
	Suburban	0.72	0.40***	0.01	0.41***	1.13***
	Urban	0.71	0.27***	-0.01	0.26**	0.97***
Mean absolute difference		-	0.15**	0.06**	0.14***	-
Mean cost		0.85***	-	-	-	0.99***

Notes: * = .10 level (10 percent); ** =.05 level (5 percent); *** = .01 level (1 percent).

[1]Costs are index values equal to predicted lunch cost at a location divided by predicted lunch cost at the urban Mid-Atlantic location.

Source: USDA, Economic Research Service using data from School Food Authority Characteristics Survey, Mathematica Policy Research, Inc. (2004), and analysis by authors.

Balance Between Number of Breakfasts and Lunches Served Affects Cost

Insufficient economies of scale in school breakfasts help account for the higher cost of breakfasts relative to lunches but do not account for all of the difference. The highest cost breakfasts are in suburban locations (see table 4), whereas the smallest SFAs are in rural locations. Factors other than economies of scale contribute substantially to cost.

Suburban locations serve, on average, about four times more lunches than breakfasts. Rural and urban SFAs have 25 percent lower costs of breakfasts than suburban SFAs, and their ratios of lunches to breakfasts are much lower, at 2.68 and 2.50 (table 2). Does this more balanced distribution matter?

Table 6

Meal balancing: Breakfast costs if the number of breakfasts served equaled the number of lunches served at location mean values[1]

Region	Urbanicity	Lunches / Breakfast	Average breakfast cost index	Average cost per breakfast if number of breakfasts = number of lunches
		Ratio	*Cost index /breakfast*	
Mid-Atlantic	Rural	3.45	1.14***	0.47***
	Suburban	4.95	1.69***	0.76***
	Urban	2.22	1.04***	0.50***
Midwest	Rural	3.96	1.86***	0.80***
	Suburban	6.57	2.29***	1.07***
	Urban	2.36	1.49***	0.77***
Mountain Plains	Rural	4.03	1.59***	0.68***
	Suburban	8.09	1.72***	0.73***
	Urban	2.71	1.31***	0.64***
Northeast	Rural	3.66	2.21***	1.08***
	Suburban	7.17	2.35***	1.06***
	Urban	5.07	1.25***	1.09***
Southeast	Rural	2.32	1.44***	0.82***
	Suburban	3.07	1.79***	0.86***
	Urban	2.24	1.65***	0.83***
Southwest	Rural	1.93	1.04***	0.55***
	Suburban	2.47	1.18***	0.59***
	Urban	1.71	0.88***	0.54***
West	Rural	3.31	1.91***	1.10***
	Suburban	3.35	1.96***	1.13***
	Urban	2.55	1.66***	0.93***
Mean		3.68	1.59***	0.81***

Notes: * = .10 level (10 percent); ** = .05 level (5 percent); *** = .01 level (1 percent).
[1]Costs are index values equal to predicted breakfast cost at a location divided by predicted lunch cost at the urban Mid-Atlantic location.
Source: USDA, Economic Research Service using data from School Food Authority Characteristics Survey, Mathematica Policy Research, Inc. (2004), and analysis by authors.

SFAs that serve a balanced number of lunches and breakfasts may be able to lower costs by more fully occupying workers across the school day. If many more lunches than breakfasts are served, kitchen staff likely have idle time during the less busy breakfast period. Food may be used more efficiently when a larger share of students participate in breakfast—some evidence suggests that low breakfast participation is more common when factors such as late bus arrivals limit the time that students have to eat breakfast at school. Besides lowering overall participation, such factors could make participation more variable, resulting in wasted food.

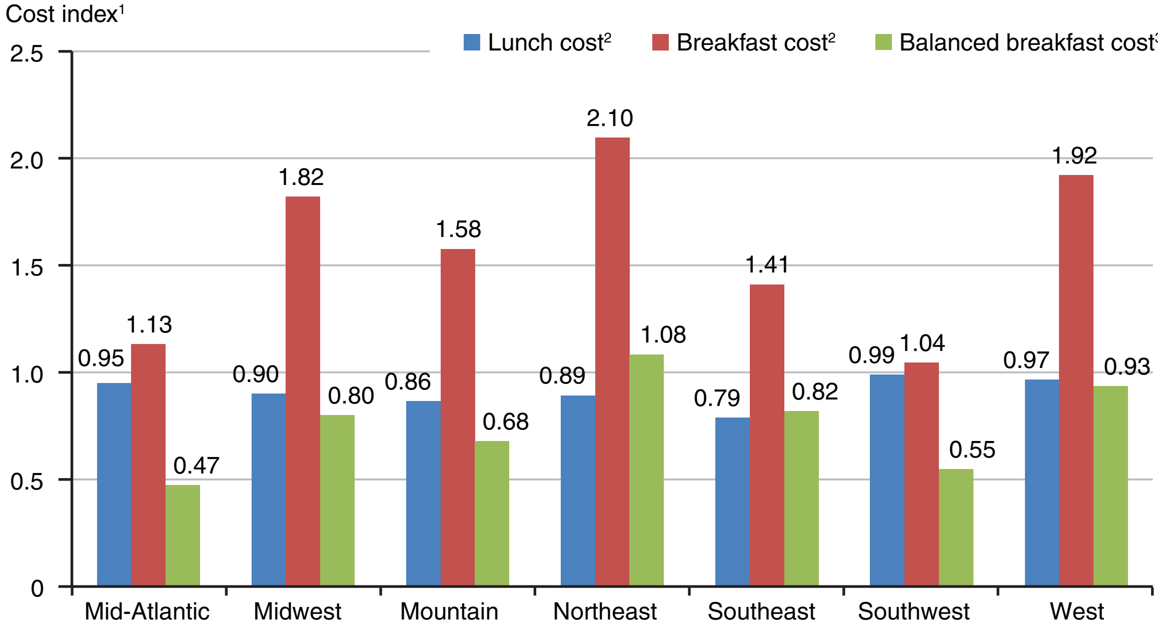
Data from table 6 offer some support for the importance of lunch-breakfast balance, showing that the two locations with the highest average cost index value per breakfast—the suburban Northeast and suburban Midwest—served about seven times more lunches than breakfasts (table 1). In comparison, the three locations with the lowest average cost index value per breakfast had the lowest ratio of lunches to breakfasts and served no more than 2.3 times more lunches than breakfasts. The five locations with the least imbalance had an average per breakfast cost index value of 1.2 while the five locations with the greatest imbalance had an average per breakfast cost index value of 1.9.[8] These results are consistent with Hilleren (2007) and Sackin (2008), who found that breakfast costs are high when few are served. Figures 5-7 show how breakfast costs would change if the numbers of breakfasts and lunches served were equal (i.e., they are balanced)[9] for rural, suburban, and urban SFAs in the seven regions. The figures show that the per-meal breakfast cost index value substantially exceeded the per-meal lunch cost index value in all cases. When the numbers of lunches and breakfasts served are in balance, however, the per-meal breakfast cost index values are marginally higher in just 3 cases—2 rural and 1 suburban location out of 21 locations. Moreover, the average breakfast cost index values drop by about 50 percent to a level equal to about 80 percent of the cost of a lunch served by urban Mid-Atlantic SFAs (table 6).

[8]Cost index values were computed using location-specific mean input values and the cost function.

[9]Since all SFAs serve fewer breakfasts than lunches, bringing the number of breakfasts served into balance with the number of lunches served makes the number of breakfasts served equal to the number of lunches served and means that greater economies of scale are achieved from breakfasts. Making lunches equal to breakfasts provides a least cost scenario in which participation rates are identical for lunches and breakfasts and puts the number of breakfasts served at their maximum and costs at their lowest. We use this example of perfect balance for illustrative purposes, while acknowledging that it may be unlikely to occur in most SFAs.

Figure 5

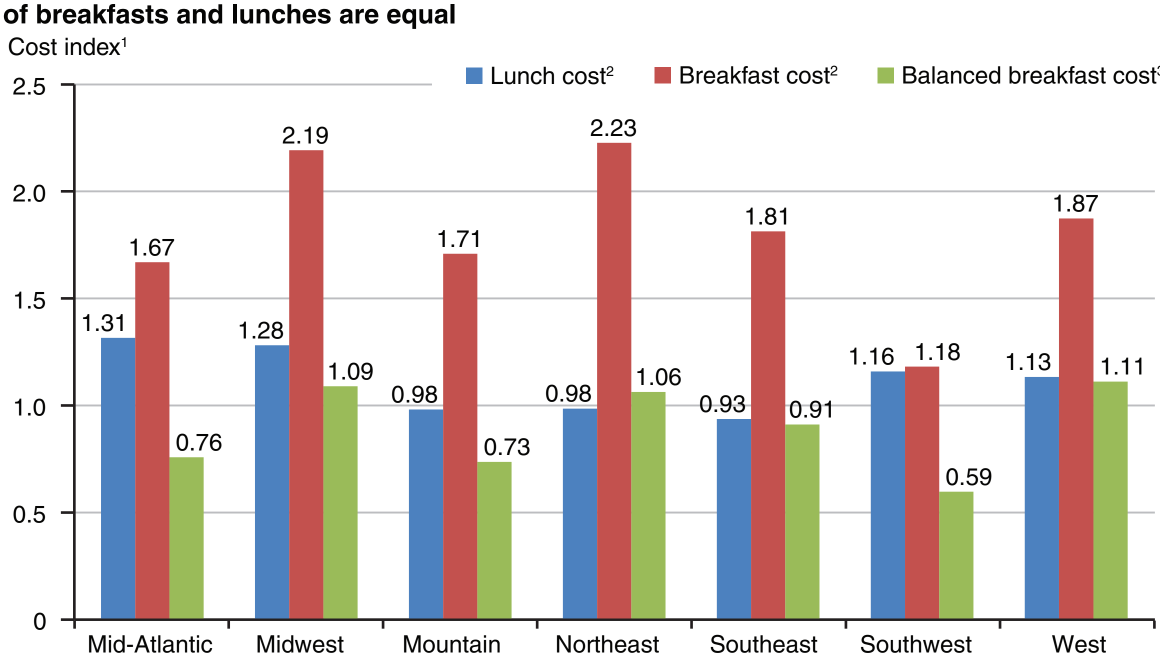
Rural breakfast costs are cut in half when the numbers of breakfasts and lunches served are equal



[1]Cost index= cost index of region divided by lunch cost for Mid-Atlantic region. The lunch cost for Mid-Atlantic region is based on location mean prices and number of meals served. [2]Cost at location means of prices and number of meals served. [3]Cost if the number of lunches and breakfasts is equal and input prices equal their location mean values.
Source: USDA, Economic Research Service.

Figure 6

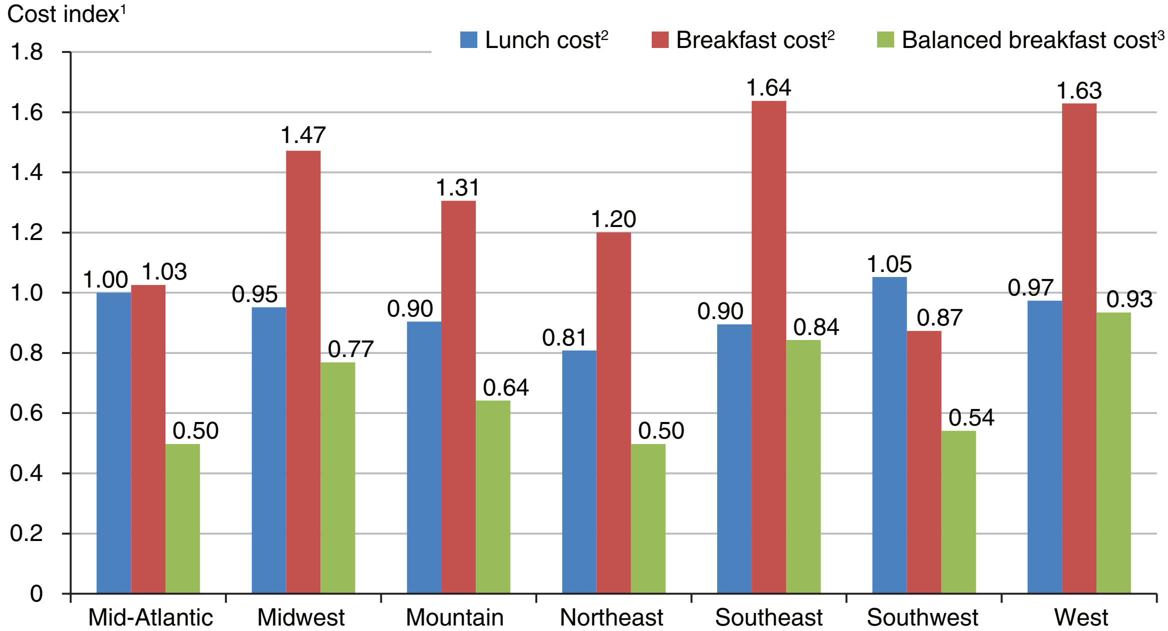
Suburban breakfast costs are very high but are cut in half when the numbers of breakfasts and lunches are equal



[1]Cost index= cost index of region divided by lunch cost for Mid-Atlantic region. The lunch cost for Mid-Atlantic region is based on location mean prices and number of meals served. [2]Cost at location prices and number of meals served. [3]Cost if the number of lunches and breakfasts is equal and input prices equal their location mean values.
Source: USDA, Economic Research Service.

Figure 7

Change in urban breakfast costs when the numbers of breakfasts and lunches are equal



[1]Cost Index= cost index of region divided by lunch cost for Mid-Atlantic region. The lunch cost for Mid-Atlantic region is based on location mean prices and number of meals served. [2]Cost at location means of prices and number of meals served. [3]Cost if the number of lunches and breakfasts is equal and input prices equal their location mean values.
Source: USDA, Economic Research Service.

Conclusions

USDA school breakfasts and lunches are important sources of basic nutrition for children, especially those from food-insecure households (Potamites and Gordon, 2010). In participating schools, reimbursements for free and reduced-price meals make it possible for children of all economic backgrounds to receive nutritious breakfasts and lunches. However, concerns have been raised about the adequacy of USDA school meal reimbursements, given that food and labor costs may vary across the United States and other differences in SFA characteristics, such as size, may also affect costs. Previous ERS research found school meal costs varied by SFA location. Although that analysis was not designed to distinguish breakfast and lunch costs, its results suggested that breakfast costs might be especially variable. This study builds on that previous research by examining breakfast and lunch costs and the factors influencing their variation separately. More specifically, it uses a quality-adjusted multiproduct translog cost function to examine variations in the costs of providing school lunches and breakfasts by SFA size and the mix of meals served.

Our econometric analysis of SFA data estimated that at the mean, costs per breakfast are higher than the reimbursement rate while costs per lunch were lower than the reimbursement rate, findings consistent with those obtained via detailed accounting methods in the SLBCS II. However, the larger sample in the SFA Characteristics dataset enabled us to use econometric methods to obtain more information about cost variation. We found that (1) the cost of both breakfasts and lunches vary considerably across SFAs, (2) economies of scale exist in both lunches and breakfasts but are much stronger for breakfasts, and (3) the cost per breakfast drops dramatically as the numbers of breakfasts and lunches served by an SFA become more balanced. The main conclusion is that the high cost of breakfasts in many SFAs is largely attributable to a lack of economies of scale and to the relatively small ratio of breakfasts to lunches served. It should be noted that these costs include reported administrative costs and all other costs indicated by the SFA as a cost of meal preparation and service and do not include unreported administrative costs and capital costs. According to estimates from Bartlett et al. (2008), unreported costs are about 19 percent of the full cost of a school meal and consist of unreported labor costs (61 percent), indirect costs (26 percent), capital costs (10 percent), and other nonspecified costs (3 percent). Unreported indirect costs include accounting and finance, data processing, human resources, and other costs.

It is important to note two other limitations of our study. First, the age of the data is a concern, but the data we used are still relevant and newer data are not currently available. We remain confident that the data yield good results because the factors affecting costs have not changed over time. Second, although the survey sampling design ensured broad representation of SFAs across regions, it did not take into account whether SFAs offered breakfast, so the sample may not be perfectly representative of SFAs offering breakfast. Also, the number of schools offering breakfast programs has increased considerably in recent years, with the SBP now offered in approximately 90 percent of the schools offering the NSLP (USDA, FNS keydata May 2013, 2013b). However, the dataset is a large, regionally diverse sample of the type required for our analysis; no better sample is available.

Our reported descriptive statistics are representative because we adjusted sample weights to account for changes. However, we could not use weights in our analytical model due to the characteristics of the statistical model, and no suitable alternative exists for a cost function analysis. Nevertheless, the econometric model we used is more rigorous than that used in Bartlett et al. (2008), is well-grounded in economic theory, and yields highly plausible results. Moreover, the coefficients of our model yield results that are consistent with the findings of SLBCS-II. Finally, school breakfast service may have changed in recent years, with many schools now using alternative service styles, such as grab'n'go and breakfasts in the classroom (FRAC, 2014). Some of these approaches may have reduced the cost per breakfast in SFAs with higher breakfast costs. For example, grab'n'go breakfast service may be less expensive than opening up the cafeteria line in schools with low breakfast participation. Nevertheless, we believe our findings offer insights that continue to be relevant to the discussion of school meal cost variation.

The results are useful in pointing out that breakfasts can be costly to produce for small SFAs and those with a large imbalance between breakfasts and lunches served. These findings may inform efforts to manage program costs while meeting the nutritional needs of the children served by the program. Economies of scale can greatly reduce costs of meal production. Our cost model suggests that large economies of scale exist in breakfast production, mainly because few breakfasts were prepared. Our results are consistent with those of smaller studies. Both Hilleran (2007) and Sackin (2008) found that participation rates must be high enough to overcome the basic preparation and service costs associated with offering a breakfast program. Sackin (2008) estimated that schools needed to serve at least 91 breakfasts to cover costs associated with the minimal extra labor hours needed for breakfast preparation and service. Small schools or those with low participation rates may find it difficult to serve this many breakfasts.

Low breakfast production means that SFAs have underused resources and high costs. Costs drop sharply as the number of prepared breakfasts rises because SFA resources are used more efficiently. The cost per breakfast drops by 50 percent across ranges of number of meals served varying from one-half to four times the mean number of breakfasts served. Cost per lunch, by contrast, dropped only about 20 percent over these ranges of numbers of lunches served.

We hypothesized that an imbalance in the number of breakfasts and lunches served may also contribute to variation in breakfast costs. An unbalanced number of breakfasts and lunches served may raise costs through inefficient staff and resource use. To see how cost per breakfast changes under balanced meal production, we calculated costs assuming that the number of breakfasts and lunches served were equal. We found that costs per breakfast drop by about 50 percent when the number of breakfasts and lunches served are equal. We also examined the effects of factor (food, labor, supplies) prices, SFA characteristics, and scale on per-meal costs across SFAs. The effect of factor prices and SFA characteristics on lunch costs was found to be three times greater than the effect of scale on lunch costs. For breakfast, scale effects were found to be two times larger than the effects of factor price and SFA characteristics. These findings suggest that differences between the number of lunches and breakfasts served explain, in large part, the relatively high costs per breakfast found in many SFAs.

Although more schools now offer breakfast, students' breakfast participation is still less than half that of lunch participation. Participation remains highly concentrated among the neediest children, with 85 percent of breakfasts served for free or at a reduced price (Oliveira, 2014), making any disincentive to offering breakfast a particular concern for those striving to meet the needs of low-income children. Our findings have useful implications for local SFAs striving to provide nutritious meals while meeting cost constraints. For larger SFAs producing a more balanced mix of NSLP lunches and SBP breakfasts, reimbursement rates appear to be adequate. However, smaller SFAs and those with a substantial imbalance between lunches and breakfasts served may struggle to balance nutrition and financial goals.

Small SFAs might obtain economies of scale by collaborating with other SFAs on food purchases and/or the use of nutritionists and other skilled staff for menu planning or analysis. They may also offer less costly forms of breakfast, such as grab'n'go bagged breakfasts or breakfast in the classroom.

Grab'n'go bagged breakfasts or breakfast in the classroom may be more feasibly served within the regular school day. Bartfeld and Kim (2010) found breakfast in the classroom increased breakfast participation rates. An increase in participation, by achieving a better balance between breakfasts and lunches served, would also be expected to reduce breakfast costs. Serving meals at the beginning of the schoolday may also help SFAs avoid uncertainties associated with late-arriving buses or other scheduling constraints, resulting in improved production planning and reduced waste. Other strategies to increase breakfast participation, such as those promoted by USDA and child health advocates (USDA, FNS, 2013a), could also help.

Legislative changes enacted by Congress in 2010 as part of the Healthy, Hunger-Free Kids Act may also assist SFAs to cover meal costs. The act increased reimbursement rates by 6 cents per lunch for those schools serving meals that met updated nutrition standards. In addition, Congress created the Community Eligibility Provision, an option that allows schools in which at least 40 percent of students are directly certified (as evidenced by living in a household that receives benefits from the Supplemental Nutrition Assistance Program (SNAP) or some other Federal programs for needy households) to serve meals to all students at no charge. By simplifying eligibility determination, this provision reduces administrative costs. The provision also makes breakfast in the classroom more feasible because all children can participate without having to pay for some of the meal. This effect may further encourage participation in schools serving needy children, increasing program effectiveness in meeting needs and likely reducing per-meal costs. These options for reducing costs merit investigation because in their absence, SFAs may lack the incentive to offer breakfasts.

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Appendix A.1: A Quality-Adjusted Cost Function Model

Below, we develop a model in which SFAs produce a quality-differentiated product for students who pay full or reduced price or get meals for free. SFAs want to serve all students eligible for a free or reduced-price meal and any student wanting to pay full price for a meal, but at the same time, they must minimize costs.

We follow Ollinger et al. (2012) in specifying a quality-adjusted variable-cost function with no fixed factor in which **w** is a vector of factor prices; M is a vector of meals, including lunches and breakfasts; l represents a la carte food service; q is meal quality; **o** is a vector of other meal characteristics; and **z** is a vector of other SFA attributes.

(A.1) $C(\mathbf{w}, \mathbf{M}, l, q, \mathbf{o}, \mathbf{z}, k) = VC(\mathbf{w}, \mathbf{M}, l, q, \mathbf{o}, \mathbf{z})$

SFAs have very low capital costs and appear to view themselves as foodservice organizations with very limited use of capital services (i.e., school districts provide the eating and cooking facilities while SFAs prepare and serve meals). SFAs pay no rental fees, about one-third of SFAs do not report any use of capital services, median capital costs as a share of all costs was less than 0.5 percent, and the mean capital costs as a share of all costs was about 1.0 percent. Thus, we do not include a fixed factor (for plant and equipment) in our model.[10] The absence of a fixed factor does not preclude economies of scale because economies of scale can arise from volume discounts for larger buyers, specialization of labor in meal production, etc.

The total number of meals SFAs serve (**M**) shown in equation 1 is defined in equation (2) and equals the number of full-price meals ($\mathbf{M}_{FP}$) plus the number of reduced price meals ($\mathbf{M}_R$) plus the number of free meals ($\mathbf{M}_{FR}$). The number of meals served is less than the number of students because some students will be absent from school and others will carry meals from home.

(A.2) $\mathbf{M} = \mathbf{M}_{FP} + \mathbf{M}_R + \mathbf{M}_{FR}$

Following Rosen's (1974) model of a competitive industry with product differentiation and Antle (2000), the demand for full-price meals is $\mathbf{M}_{FP} = \mathbf{M}_{FP}(P, Q, \mathbf{O}, \mathbf{D})$, demand for free meals is $\mathbf{M}_{FR}=\mathbf{M}_{FR}(Q, \mathbf{O}, \mathbf{D})$, and the demand for reduced-price meals is $\mathbf{M}_R = \mathbf{M}_R(X, Q, \mathbf{O}, \mathbf{D})$, where P is the price of full-price meals, Q is meal quality, and **O** is a vector of meal characteristics that accounts for differences in serving sizes between high school and elementary school students, the type of menu plan (traditional versus three alternatives—enhanced food-based, nutrient-based, and other), and whether the SFA offers a la carte foods. The vector **D** represents demand variables and is reflected in market size (total student enrollment), and X is a co-payment made by students eligible for a reduced-price meal. Substituting the values for **M** into equation (2) and simplifying gives:

(A.3) $\mathbf{M}^D = \mathbf{M}^D(P, X, Q, \mathbf{O}, \mathbf{D})$.

[10] An anonymous reviewer points out that some SFAs may pay an unreported indirect fee to school districts for some capital expenditures. Thus, our measure of capital costs may be too low.

Following Antle (2000), we set market supply equal to a function of the price of a meal, the average subsidy per student eligible for a reduced-price or free meal (R), other meal characteristics, and a vector of factor prices (**W**):

(A.4) $\mathbf{M}^S = \mathbf{M}^S(P, R, \mathbf{O}, \mathbf{W})$

Now, we let $\mathbf{M^S} = \mathbf{M^D}$ to get

(A.5) $\mathbf{M}^D (P, X, Q, \mathbf{O}, \mathbf{D}) = \mathbf{M}^S (P, R, \mathbf{O}, W)$

Then, we solve for quality and obtain equation 6.

(A.6) $Q = F(P, R, X, \mathbf{O}, \mathbf{D}, \mathbf{W})$

Finally, we substitute the value of Q into the cost function and drop the subsidy paid by USDA (R) and the co-payment made by some students (X) because they are constant across the United States and do not enter the empirical analysis. Lunch price and demand variables vary across SFAs and can be used to identify the cost-function parameters.

(A.7) $C (\mathbf{w}, \mathbf{M}, l, q, \mathbf{o}, \mathbf{z}) = C (\mathbf{w}, \mathbf{M}, l, F (p, o, \mathbf{D}, \mathbf{W}), \mathbf{o}, \mathbf{z})$.

Empirical Specification

We specify a translog cost function model of school meal costs in which ln is the operator for the natural log; Ci is the cost of school meals in SFA "i," **W**i represents prices for labor (W_{LAB}), food (W_{FOOD}), and nonfood supplies (W_{SUPPLY}); the **M** stands for the number of USDA-reimbursable lunches ($M_{LUNCHES}$) and the number of USDA-reimbursable breakfasts (M_{BFAST}). The other variables are a la carte service ($C_{LACARTE}$), a vector of other meal characteristics (**O**), a vector of SFA attributes (**Z**), and $C_{QUALITY}$, which is meal quality. Other meal characteristics include variables representing meal serving size ($C_{ELEMENTARY\_LO}$ and $C_{ELEMENTARY\_HI}$) and the menu option (C_{TRAD_MENU}). SFA characteristics account for (1) whether the SFA offers health care to cafeteria workers and outsources some administrative, cooking, or other tasks to foodservice management organizations (C_{HEALTH} and $C_{FOOD\_SERVICE}$), (2) SFA urbanicity (C_{SUBURB} and C_{RURAL}), and (3) SFA Region ($C_{ATLANTIC}$, $C_{MIDWEST}$, $C_{MOUNTAIN}$, $C_{NORTHEAST}$, $C_{SOUTHWEST}$, and C_{WEST}).

(A.8)

$$
\begin{aligned}
\ln C_i = {} & \alpha_0 + \sum_i \beta_i \ln W_i + \frac{1}{2}\sum_i\sum_j \beta_{P_iP_j} \ln W_i * \ln W_j \\
& + \sum_k \gamma_k \ln M_k + \sum_k\sum_l \gamma_{kl} \ln M_k * \ln M_l + \sum_k\sum_i \gamma_{ki} \ln M_k * \ln W_i \\
& + \varphi_C \ln C_{LACARTE} + \frac{1}{2}\varphi_{CC} (\ln C_{LACARTE})^2 + \sum_i \varphi_{Ci} \ln C_{LACARTE} * \ln W_i \\
& + \sum_k \varphi_{CM_k} \ln C_{LACARTE} * \ln M_k + \sum_l \lambda_l O_l + \sum_l\sum_i \lambda_{li} O_l \ln W_i + \sum_l\sum_k \lambda_{lk} O_l \ln M_k \\
& + \sum_m \phi_m Z_m + \sum_m\sum_i \phi_{mi} Z_m * \ln W_i + \sum_m\sum_k \phi_{mk} Z_m * \ln M_k \\
& + \delta_Q \ln C_{QUALITY} + \frac{1}{2}\delta_{QQ} * (\ln C_{QUALITY})^2 + \sum_i \delta_{Qi} * \ln C_{QUALITY} * \ln W_i \\
& + \sum_k \delta_{Qk} \ln C_{QUALITY} * \ln M_k + \varepsilon
\end{aligned}
$$

We obtain factor-demand equations by applying Sheppard's lemma to the cost function. As noted by many researchers, such as MacDonald et al. (1999), gains in efficiency can be obtained by estimating these factor-demand equations jointly with the cost function.

$$\text{(A.9)}\quad \frac{\partial lnC}{\partial lnP_i} = \frac{P_i X_i}{C} = SH_i = \beta_i + \sum_j \beta_{ij} \ln W_j + \sum_K \gamma_{ki} * \ln M_K + \varphi_{Ci} \ln C_{LACARTE} + \sum_l \lambda_{li} O_l + \sum_m \phi_{mi} Z_{mi} + \delta_{Qi} \ln C_{Quality,i}$$

All variables are divided by their means, so the first-order price terms can be interpreted as estimated cost-shares at mean values. The other coefficients capture size, quality, and meal and SFA characteristics. The reference urbanicity is urban, and the reference region is the Southeast.

The quality function is jointly determined with costs and is affected by factor prices, other meal characteristics, demand variables, and numbers of meals.

$$\text{(A.10)}\qquad C_{Quality} = \delta_0 + \tau_p P + \sum_k \sigma_k O_k + \sum_r \rho_r D_r + \sum_i \upsilon_i W_i + \sum_k \alpha_k M_k$$

Meal quality is a latent variable in that food appearance, tastiness, and other intangible attributes are valued by consumers but have no direct units of measurement. Aigner et al. (1984) and Gertler and Waldman (1992) remind us that latent variables can be identified up to an arbitrary factor of proportionality, and Gertler and Waldman (1992) point out that an arbitrary metric can be assigned. Thus, we follow Antle (2000) in setting the coefficient on meal price equal to one ($\tau p=1$), and we follow Gertler and Waldman (1992) and Antle (2000) in normalizing the coefficient on the intercept ($\delta 0$) to zero. Antle (2000) indicates there is no loss of generality in following this procedure, and Gertler and Waldman (1992) point out that this procedure combined with the system of structural equations completely identifies the cost function.

The variables for other meal characteristics, factor prices, and meals—O, W_i, and M_k—are included in the quality equation and have been discussed. The demand for food quality has been examined by many researchers. Cox and Wohlgenant (1986) show that income, education, and wealth (property values) positively affect food quality. Other researchers (Drewnowski and Darmon, 2005; Patrick and Nicklas, 2005; Beydoun and Wang, 2008) provide further support. Thus, median income of the SFA (C_{INCOME}), education achievement ($C_{EDUCATION}$), the student-teacher ratio ($C_{STUDENT\_TEACHER}$), and housing values (C_{HOUSE}) were included as determinants of food demand. Student enrollment ($C_{ENROLLMENT}$), the size of the school meal market for each SFA, should also affect food demand. Demand can also be affected by the provision of a la carte foods. We tested a la carte foods, donated commodities, the unemployment rate, and education test scores, but they were not significant and were dropped.

Translog cost functions are continuous, monotonic in factor prices and outputs, concave in factor prices, linearly homogeneous in factor prices, and have the following properties:

$\sum\beta_i=1, \sum\beta_{i,j}=0, \sum \gamma_{ki}=0, \sum \phi_{ci}=0, \sum \lambda_{li} =0, \sum \varphi_{mi}, = 0$, and $\sum \delta_{Q,i} =0$.

Symmetry and homogeneity of degree one are imposed on the cost function to gain improvements in efficiency and reduce the number of parameters to be estimated (Berndt, 1991). Symmetry implies that the coefficients $\beta_{ij}=\beta_{ji}, \Upsilon_{ki} = \Upsilon_{ik}, \lambda_{il}=\lambda_{li}$, $\omega,_{mi} = \omega,_{im}$, $\delta_{Q,i} =\delta_{i,Q}$. The omitted variables are not reported because they are implied.

Appendix A.2: Definitions of Factor Prices

Below we provide more detail on our definitions of wage, food, and supply practice prices, including a description of the food price index created for this analysis.

Worker wages for three types of SFA kitchen workers are included in the data and are compiled into a weighted average of the wages and fringe benefits of a typical allocation of kitchen staff. Pannell-Martin (1999) indicates that a typical staffing proportion of workers is 22 assistants, 3 cooks, and 4 supervisors. We conducted sensitivity analyses by estimating costs under three different assumptions about the structure of labor. First, we assumed all wages equaled those of the assistants (the lowest price worker). Then, we assumed wages equaled those of the supervisor (the highest price worker). Finally, we set wages equal to a blend of assistant wages and cook wages with the blend equal to the proportion of assistant labor to cook labor given by Pannel-Martin (1999). The results show little variation. Thus, we retain the Pannel-Martin weighting scheme because it is supported by previous research.

We would like to have had a measure of food prices based on wholesale prices. However, those data do not exist. As a substitute, we constructed an index of retail food prices based on ERS's Quarterly Food At-Home Price Database (QFAHPD) and the food-menu plans and purchases of the schools surveyed in the School Nutrition and Dietary Assessment (SNDA-III) (Gordon et al., 2007). The QFAHPD is based on Nielsen Homescan data and gives price indexes for 52 food categories covering 35 market areas across the United States over the 1999-2006 period. SNDA-III is available from FNS and includes the types and volumes of foods used by 300 schools participating in the NSLP.

A food price index based on QFAHPD and SNDA-III offers an advantage over a cost-based measure in that only market prices affect the index. A measure derived from the cost per food item purchased is a cost and not a price because it is unique to an SFA with the purchase cost affected by volume discounts and other SFA choices. Use of a retail food price index offers key advantages over retail market prices. Most importantly, only the correlation between retail prices and wholesale prices matters for an index to accurately reflect differences across wholesale prices. Previous research (Guthrie, 1981) shows a strong correlation between the Consumer Price Index (CPI) and the Producer Price Index (PPI), and Kuhn and Volpe (2014) show a strong association between the PPI and the CPI for food. In support of the use of this index, we find that the food share of costs in this analysis is consistent with findings from the SLBCS-II (Bartlett et al., 2008), which were based on detailed accounting of SFA food costs.

To create the food price index, we first identified the amount of each food consumed by all schools participating nationwide in SNDA-III during the 2004-05 school year. Using prices from the QFAHPD, we multiplied the price of each food item in each marketing area by the number of pounds of each item used by all schools nationwide to obtain a dollar estimation of the cost of each food item in that marketing area. The dollar values of all food items in a given market area are then summed to obtain a dollar value of the nationally representative mix and amount of food consumed in schools in each market. In each of the 35 market areas, price indexes specific to each area are available for the foods used in school meals. Differences in values across market areas are therefore attributed only to these price differences. Using these estimates, we created an index of food prices used by SFAs by dividing the value of food in each marketing area by the average value of food for all SFAs across all market areas.

The dataset does not include the QFAHPD market area but does include a State identifier. Thus, market areas from the QFAHPD were mapped into States and merged into our dataset. The Missouri Economic and Research Information Center (MERIC) food price index is an available alternative to the index constructed using the QFAHPD price data. However, we prefer the index based on the QFAHPD and food menus because the food items are those typically purchased by schools, whereas MERIC measures food items representative of purchases by all consumers. We do use the MERIC data to check the validity of our reported results and find results from the two approaches to be consistent (see Ollinger et al., 2012).

There was no available price or price index for the price of supplies, so we followed Ollinger et al. (2012) in using a State-level, general price index that is based on prices of all products except for food, housing, utilities, health care, and transportation. The data used to construct this index were obtained from MERIC (2009) and can be found at www.missourieconomy.org/indicators/cost_of_living/index.stm

Appendix A.3:
Discussion of Model Selection and Hypotheses Testing

The variable cost function is estimated jointly with three factor-demand equations and the meal-quality equation in a multivariate regression system using weighted iterative three-stage least squares. Because the factor shares add to one, one factor-demand equation (supplies) was dropped to avoid a singular covariance matrix. A number of interaction terms were not included because they had insignificant effects on model fit.

The R-square value was 0.95, but R-square values are typically very high for cost functions. A more reliable way to evaluate the model is to determine if (1) the model meets regularity conditions, (2) likelihood tests justify the model, (3) parameter estimates and elasticities are reasonable, and (4) the model gives reasonable cost estimates.

Results satisfy the regularity conditions suggested by Diewert and Wales (1987) in that (1) all coefficients on factor prices are positive and (2) only about 1 percent of observations had any factor shares in violation of monotonicity (i.e., negative predicted factor shares). For comparison, Ollinger et al. (2005) had 11 percent violations.

Log-likelihood tests were used to evaluate the effect of independent variables on model fit. In these tests, we compared a full model containing all variables to the basic cost function model that has factor prices and output (number of meals). Then, after showing that the full model is significant, key variables were removed to evaluate the importance of the "restricted" (missing) variables to model fit. We tested more variables than contained in the model but discuss only the variables that were finally used. Results are shown in table A.2.

Log-likelihood tests strongly support the full model relative to the basic model with a chi-square statistic of 704 for 75 restrictions, which easily surpasses a critical value of 110. In subsequent tests, we compared the restricted models against the full model. Results show that the full model easily surpasses a model with no region and urbanicity (location) variables (see table A.1). The chi-square statistic of 264 easily surpasses the critical value. All other variables except the share of elementary schools and use of traditional menus were also significant. We kept variables for the share of elementary schools and use of traditional menus because they are important policy variables.

We also evaluated economies of scope and homotheticity. Model results suggest that economies of scope do exist because both a log likelihood test and the t-statistic on the interaction term between lunches and breakfasts were significant. Homotheticity is a condition in which factor shares do not change as the number of meals served changes. We rejected homotheticity because the full model outperformed a model that excluded interaction terms between the numbers of meals served and factor prices.

We examined a number of other variables, including the availability of a USDA-sponsored after-school snack program, the use of a centralized kitchen for meal preparation, the share of schools in the SFA offering free meals for all students, a dummy variable for whether the SFA had capital costs, and commodity purchases from USDA as a share of all food purchases. All of these variables were dropped because they did not significantly affect model fit, and some had many missing values, which would have caused us to lose observations.

The a la carte, meal quality, and location variables and variables for the health insurance for employees and whether the SFA used a foodservice management company were significant. The variables for use of traditional menus and the type of students served were not significant but were retained in the model.

Table A.3 reports the estimated coefficients for the best-fitting model. Nearly two-thirds of the model variables are significant at the 90-percent-or-higher level. Coefficients for the first-order factor price terms provide estimates of the share of costs devoted to labor (W_{LAB}), food (W_{FOOD}), and supplies (W_{SUPPLY}) at the sample mean. Food and labor inputs each account for about 44.3 percent of meal costs; supplies account for about 11.4 percent of costs. These cost shares apply only to the reference category (urban Southeast SFAs) in which all dummy variables equal 0.

The interactions variables for the number of lunches and breakfasts served and prices with the location variables show that cost shares change relative to the reference region; five of the regional shift terms are negative and significant. These variations in regional costs are consistent with regional differences shown in the results for the translog cost function used in Ollinger et al. (2012) and may reflect cost differences due to variable political and economic conditions across the United States. Other results for offering health insurance, use of a service management company, and use of traditional menus and their interactions with factor prices were also consistent with findings for those same variables shown in Ollinger et al. (2012).

Results for the estimated meal quality equation are consistent with Gertler and Waldman (1992), Antle (2000), and Ollinger et al. (2012) in that the three factor-price variables are significant and negative and five demand variables were significant and positive. The numbers of lunches and breakfasts served were also significant.

There are substantial but reasonable impacts of meal quality and a la carte foods on costs. A 10-percent increase in meal quality raises costs by about 15 percent, and a 10-percent decrease in meal quality results in a 13.1-percent decrease in costs at sample mean values. Similarly, a 10-percent decrease in the share of revenue from a la carte foods ($C_{LACARTE}$) results in an 18.7-percent decrease in meal costs, and a 10-percent increase results in a 10.9-percent rise in meal costs.

Finally, we estimated cost per meal for each SFA and then compared the average estimated cost per meal to the actual cost at each of 21 locations. Table A.4 gives the estimated cost per meal based on our model and data; column three repeats cost per meal data from column three of table 2. As shown, there are no significant differences between predicted and actual costs for any of the 21 locations or overall, indicating a good model fit.

Appendix A.4: Evaluating Factor-Price Elasticities

The own- and cross-price elasticities of input demand and the Allen elasticities of input substitution indicate the degree of responsiveness to changes in input prices. The own-price input-demand elasticity shows how a given change in prices for food or other input affects demand for that input. A cross-price elasticity shows how a change in the price of food or another input affects demand for a different input. A positive sign means that the two inputs are complements, and a negative sign indicates that they are substitutes. Equations A.3 and A.4 (app. A.1) define mathematically own- and cross-price elasticities.

The input-demand elasticity for any inputs i and j is equal to:

(A.1) $$\varepsilon_{jj} = \frac{(\varphi_{jj} + S_j^2 - S_j)}{S_j}$$

The Allen elasticity of input substitution indicates the degree to which a given percentage change in input k—labor—can substitute for a percentage change in input j—food. A higher positive number indicates greater substitutability. The Allen partial cross elasticity of input substitution can be written as:

(A.1) $$\varepsilon_{jk} = \frac{(\varphi_{jk} + S_j S_k)}{S_i} S_j$$

where S represents input shares of jth or kth input and comes from the first-order price coefficients; φjk is the coefficient on the kth input price for the jth input and is also the coefficient on the interaction term between the jth and kth input prices in equation A.1; φjj is the coefficient on the jth input price in the demand equation for that input and is also the coefficient on the squared input in equation A.1.

Elasticities are shown in table A.5. Own-factor-price elasticities are negative and of reasonable values in all cases, as 10-percent price increases in labor, food, and supplies lead to declines in demand of 3.63, 3.75, and 11.2 percent, respectively. The Allen factor-price elasticities indicate that the greatest substitutability is between supplies and labor and the least is between labor and food. Finally, note that price elasticity is highly regular in that all own-factor-price elasticities are negative for all observations except for supplies in seven cases.

Table A.1

Definitions of cost function variables

Variable	Definition
Cost	Total wage and fringe benefit, food, including donated food, and supply costs
W_{LB}	$Mean\_wage = \frac{22}{29} * assistant\_wage + \frac{3}{29} * cook\_wage + \frac{4}{29} * supervisor\_wage$ $W_{LAB} = Mean\_wage + Mean\_benefits, \quad where$ $Mean\_benefits = Mean\_wage * [\frac{(SFA\_fringe\_benefits)}{(SFA\_wages + SFA\_fringe\_benefits)}]$
W_{FOOD}	$W_{FOOD} = \frac{C}{Mean\_C} \text{ and } \quad C = \sum_i W_i * Q_i$, Where W_{FOOD} is a price index of food for a USDA meal; Wi is the price of food “i” used in USDA meals and comes from the QFAHPD; Qi is the total pounds of product “i” purchased nationally by SFAs for the NSLP, as given by menu data from SNDA-III; C is the value of food purchased nationwide using prices in one market area of the QFAHPD; Mean_C is the mean value of all USDA foods purchased nationwide by all SFAs across all market areas of the QFAHPD.
W_{SUPPLY}	An index price for general merchandise purchases for each State, including cleaning material and general merchandise; it excludes food, housing, utilities, health care, and transportation and comes from Missouri Economic Research and Information Center.
$M_{LUNCHES}$	Number of reimbursable lunches served by the SFA.
M_{BFASTS}	Number of reimbursable breakfasts served by the SFA.
$C_{QUALITY}$	Measure of meal quality as determined in the model. It is derived from the cost function and captures the cost of labor and food inputs and SFA student and community demand.
Cost shares	
SH_{LABOR}	Total labor and fringe benefits costs divided by total costs.
SH_{FOOD}	Purchased food plus donated commodities used + State and processor charges related to donated commodities + foodservice management fees divided by total costs.
$SH_{SUPPLIES}$	Supplies and expendable equipment + utilities + other contracted or purchased services + other direct costs + indirect costs charged to SFA account divided by total costs.
Meal characteristics	
$C_{LACARTE}$	One minus a la carte revenues as a share of SFA meal revenues.
$C_{ELEMENTARY\_LO}$[1]	One if the number of high school students enrolled in NSLP as a share of all elementary, middle, and high school students in NSLP is less than 30 percent; zero otherwise.
$C_{ELEMENTARY\_HI}$[1]	One if high school students as a share of students in NSLP is more than 70 percent; zero otherwise.
C_{TRAD_MENU}	One if the SFA uses a traditional menu plan and zero otherwise.
SFA characteristics	
C_{HEALTH}	One if SFA provides workers with health insurance and zero otherwise.
$C_{FOOD\_SERVICE}$	One if service management company provides some or all (1) workers, (2) food or supplies purchasing, or (3) food or supplies purchasing and labor. Zero otherwise.

Table A.1
Definitions of cost function variables (continued)

Variable	Definition
Location	Includes region and urbanicity variables
C_{SUBURB}	One if Common Core data indicate that SFA is a suburban area. Zero otherwise.
C_{RUR}	One if Common Core data indicate that SFA is a rural area. Zero otherwise.
$C_{ATLANTIC}$	One if SFA located in FNS "Mid-Atlantic" region and zero otherwise.
$C_{MIDWEST}$	One if SFA located in FNS "Midwest" region and zero otherwise.
C_{MOUNT}	One if SFA located in FNS "Mountain" region and zero otherwise.
$C_{NORTHEAST}$	One if SFA located in FNS "Northeast" region and zero otherwise.
$C_{SOUTHWEST}$	One if SFA located in FNS "Southwest" region and zero otherwise.
C_{WEST}	One if SFA located in FNS "Western" region and zero otherwise.

[1]Continuous variables cannot be used because some SFAs only have elementary or high school students. Because we use the log of continuous variables, we would have a missing value. QFAHPD = Quarterly Food At-Home Price Database. SFA = school food authority. NSLP = National School Lunch Program. SNDA = School Nutrition Dietary Assessment Study.
Source: USDA, Economic Research Service using data from School Food Authority Characteristics Survey, Mathematica Policy Research, Inc. (2004), and analysis by authors.

Table A.2
Model selection hypotheses tests for school meal cost functions

					Test statistics[1]		
Model	Description	Log-likelihood statistic	Parameters estimated	Test	Restrictions	Critical chi-square at 0.01 level	Model chi-square
I	Translog factor prices and output	3432	14	-	-	-	-
II	Full, Reference Model[2]	3784	89	II vs. I	75	110	704***
III	Removes urbanicities and regions from II	3652	49	III vs. II	40	67	264**
IV	Removes a la carte revenues from II	3752	83	IV vs. II	6	19	64***
V	Removes quality from II	3696	85	V vs. II	4	15	176***
VI	Removes shares of high school students from II	3776	79	VI vs. II	10	25	16
VII	Removes menu from II	3780	84	VII vs. II	5	17	8
VIII	Removes health care for workers from II	3761	84	VIII vs. II	5	17	46***
IX	Removes foodservice companies from II	3751	84	IX vs. II	5	17	66***
X	Removes interaction of lunches and breakfasts (economies of scope)	3724	88	X vs. II	1	8	120***
XI	Imposes homotheticity on II[3]	3771	85	XI vs. II	4	15	26***

* = .10 level (10 percent); ** =.05 level (5 percent); *** =.01 level (1 percent). SFA = school food authority.
[1]Chi square = 2 times the difference between the log likelihood statistics. [2]The full model includes factor prices, number of lunches, number of breakfasts, meal quality, variable accounting for a la carte foods, dummy variables for SFAs with a high share of high school students and SFAs with a low share of high school students, SFAs that use a traditional menu, SFAs that provide health care, SFAs that use foodservice companies, and urbanicities and regions. [3]The homothetic model has no interactions between factor prices and either the number of breakfasts or the number of lunches.
Source: USDA, Economic Research Service using data from School Food Authority Characteristics Survey, Mathematica Policy Research, Inc. (2004), and analysis by authors.

Table A.3

Translog multiproduct variable cost function estimates of school meals for the 2002-03 school year

Variable	Coefficient	s.e.	Variable	Coefficient	s.e.
Intercept	-0.138*	0.073	W_{FOOD} * $C_{QUALITY}$	0.008	0.020
W_{LAB}	0.443***	0.014	W_{FOOD}*C_{SUBURB}	0.005	0.008
W_{FOOD}	0.443***	0.015	W_{FOOD} *C_{RUR}	-0.007	0.009
W_{SUPPLY}	0.114***	0.010	W_{FOOD} *$C_{ATLANTIC}$	0.015*	0.009
$M_{LUNCHES}$	0.464***	0.059	W_{FOOD} *$C_{MIDWEST}$	0.027***	.009
M_{BFASTS}	0.409***	0.058	W_{FOOD} *C_{MOUNT}	0.023***	0.009
$C_{LACARTE}$	-0.340***	0.044	W_{FOOD} *$C_{NORTHEAST}$	0.012	0.010
$C_{ELEMENTARY\_LO}$	0.071***	0.025	W_{FOOD}*$C_{SOUTHWEST}$	-0.0005	0.008
$C_{ELEMENTARY\_HI}$	0.248**	0.121	W_{FOOD} *C_{WEST}	0.008	0.009
C_{TRAD_MENU}	0.035	0.023	W_{SUPPLY}*$M_{LUNCHES}$	0.011***	0.003
C_{HEALTH}	0.274***	0.064	W_{SUPPLY}* M_{BFASTS}	-0.003	0.003
$C_{SERVICE}$	-0.023	0.025	W_{SUPPLY}* $C_{LACARTE}$	-0.004	0.004
$C_{QUALITY}$	1.397***	0.090	W_{SUPPLY}*$C_{ELEMENTARY\_LO}$	-0.004	0.013
C_{SUBURB}	-0.015	0.024	W_{SUPPLY} *$C_{ELEMENTARY\_HI}$	0.002	0.020
C_{RUR}	-0.064**	0.033	W_{SUPPLY}*C_{TRAD_MEN}	-0.009**	0.003
$C_{ATLANTIC}$	-0.122***	0.035	W_{SUPPLY} *C_{HEALTH}	0.0009	0.007
$C_{MIDWEST}$	-0.156***	0.038	W_{SUPPLY}*$C_{SERVICE}$	0.010**	0.005
C_{MOUNT}	-0.176***	0.038	W_{SUPPLY}*$C_{QUALITY}$	-0.078***	0.016
$C_{NORTHEAST}$	-0.190***	0.045	W_{SUPPLY}*C_{SUBURB}	0.003	0.005
$C_{SOUTHWEST}$	-0.029	0.028	W_{SUPPLY}*C_{RUR}	-0.004	0.006
C_{WEST}	-0.237***	0.031	W_{SUPPLY}*$C_{ATLANTIC}$	-0.033***	0.007
W_{LAB} * W_{LAB}	0.069***	0.012	W_{SUPPLY}*$C_{MIDWEST}$	-0.018***	0.006
W_{FOOD} * W_{FOOD}	0.071**	0.026	W_{SUPPLY}*C_{MOUNT}	-0.021***	0.006
W_{SUPPLY}*W_{SUPPLY}	-0.008	0.026	W_{SUPPLY}*$C_{NORTHEAST}$	-0.032***	0.007
$M_{LUNCHES}$*$M_{LUNCHES}$	0.131***	0.014	W_{SUPPLY}*$C_{SOUTHWEST}$	-0.021***	0.006
M_{BFASTS}*M_{BFASTS}	0.087***	0.011	W_{SUPPLY}*C_{WEST}	-0.007	0.007
$C_{LACARTE}$ *$C_{LACARTE}$	-0.169***	0.020	$M_{LUNCHES}$*M_{BFASTS}	-0.107***	0.010
$C_{QUALITY}$ *$C_{QUALITY}$	0.552	0.452	$M_{LUNCHES}$ * $C_{LACARTE}$	-0.003	0.021
W_{LAB} * W_{FOOD}	-0.073***	0.012	$M_{LUNCHES}$ *$C_{ELEMENTARY\_LO}$	0.003	0.017
W_{LAB} * W_{SUPPLY}	0.005	0.008	$M_{LUNCHES}$ *$C_{ELEMENTARY\_HI}$	0.045	0.089
W_{LAB} * $M_{LUNCHES}$	-0.011***	0.003	$M_{LUNCHES}$*C_{TRAD_MEN}	-0.0016	0.017
W_{LAB} *M_{BFASTS}	0.007*	0.004	$M_{LUNCHES}$ *C_{HEALTH}	0.092***	0.033
W_{LAB} * $C_{LACARTE}$	0.003	0.006	$M_{LUNCHES}$ *$C_{SERVICE}$	0.029	0.024
W_{LAB} *$C_{ELEMENTARY\_LO}$	0.001	0.005	$M_{LUNCHES}$ *C_{SUBURB}	0.014	0.035
W_{LAB} *$C_{ELEMENTARY\_HI}$	-0.010	0.020	$M_{LUNCHES}$ *C_{RURAL}	0.008	0.041
W_{LAB} * C_{TRAD_MEN}	-0.004	0.005	$M_{LUNCHES}$ *$C_{ATLANTIC}$	0.139***	0.042

$W_{LAB} * C_{HEALTH}$	0.035^{***}	0.010	$M_{LUNCHES} * C_{MIDWEST}$	0.067^{*}	0.038
$W_{LAB} * C_{FOOD\_SERVICE}$	-0.046^{***}	0.007	$M_{LUNCHES} * C_{MOUNT}$	0.073^{**}	0.036
$W_{LAB} * C_{QUALITY}$	0.070^{***}	0.023	$M_{LUNCHES} * C_{NORTHEAST}$	-0.003	0.040
$W_{LAB} * C_{SUBURB}$	-0.008	0.008	$M_{LUNCHES} * C_{SOUTHWEST}$	0.135^{***}	0.036
$W_{LAB} * C_{RUR}$	0.010	0.009	$M_{LUNCHES} * C_{WEST}$	0.009	0.040
$W_{LAB} * C_{ATLANTIC}$	0.018^{*}	0.009	$M_{BFASTS} * C_{LACARTE}$	0.017	0.016
$W_{LAB} * C_{MIDWEST}$	-0.009	0.009	$M_{BFASTS} * C_{ELEMENTARY\_LO}$	0.008	0.015
$W_{LAB} * C_{MOUNT}$	-0.002	0.009	$M_{BFASTS} * C_{ELEMENTARY\_HI}$	0.001	0.076
$W_{LAB} * C_{NORTHEAST}$	0.020^{**}	0.010	$M_{BFASTS} * C_{TRAD\_MEN}$	0.010	0.014
$W_{LAB} * C_{SOUTHWEST}$	0.021^{***}	0.008	$M_{BFAST\ S} * C_{HEALTH}$	-0.019	0.038
$W_{LAB} * C_{WEST}$	-0.001	0.009	$M_{BFAST\ S} * C_{SERVICE}$	-0.040^{**}	0.020
$W_{FOOD} * W_{SUPPLY}$	0.003	0.025	$M_{BFASTS} * C_{SUBURB}$	-0.028	0.029
$W_{FOOD} * M_{LUNCHES}$	0.0002	0.004	$M_{BFASTS} * C_{RURAL}$	-0.051	0.034
$W_{FOOD} * M_{BFASTS}$	-0.004	0.004	$M_{BFASTS} * C_{ATLANTIC}$	-0.135^{***}	0.038
$W_{FOOD} * C_{LACARTE}$	0.0003	0.006	$M_{BFASTS} * C_{MIDWEST}$	-0.058^{*}	0.034
$W_{FOOD} * C_{ELEMENTARY\_LO}$	0.003	0.005	$M_{BFASTS} * C_{MOUNT}$	-0.096^{***}	0.036
$W_{FOOD} * C_{ELEMENTARY\_HI}$	0.015	0.019	$M_{BFASTS} * C_{NORTHEAST}$	-0.011	0.036
$W_{FOOD} * C_{TRAD\_MEN}$	0.013^{***}	0.005	$M_{BFASTS} * C_{SOUTHWEST}$	-0.144^{***}	0.036
$W_{FOOD} * C_{HEALTH}$	-0.036^{***}	0.010	$M_{BFASTS} * C_{WEST}$	-0.020	0.040
$W_{FOOD} * C_{FOOD\_SERVICE}$	0.036^{***}	0.025			
Quality function					
Intercept	0.00				
$C_{ELEMENTARY\_LO}$	-0.035^{***}	0.009			
$C_{ELEMENTARY\_HI}$	0.034	0.044			
C_{TRAD_MENU}	-0.017^{*}	0.010			
$C_{ENROLLMENT}$	0.150^{***}	0.010			
C_{INCOME}	0.080^{***}	0.031			
$C_{EDUCATION}$	0.108^{***}	0.108			
$C_{STUDENT\_TEACHER}$	0.0822^{***}	0.024			
C_{HOUSE}	0.062^{***}	0.018			
W_{LAB}	-0.076^{***}	0.019			
W_{FOOD}	-0.149^{**}	0.062			
W_{SUPPLY}	-0.203^{**}	0.090			
$M_{LUNCHES}$	-0.045^{***}	0.013			
M_{BFASTS}	-0.097^{***}	0.007			

* = .10 level (10 percent); ** =.05 level (5 percent); *** =.01 level (1 percent).

--All variables are standardized at their means, so first-order coefficients can be interpreted as elasticities at the sample means. Dummy variable captures shifts in costs.

--There were 1,221 observations taken from the SFA Characteristics Survey of 2002-03 on the costs of producing school meals at the school food authority level. The model R2 was 0.9530.

Source: USDA, Economic Research Service using data from School Food Authority Characteristics Survey, Mathematica Policy Research, Inc. (2004), and analysis by authors.

Table A.4

Actual versus estimated cost per meal at location mean values for 21 locations spanning the United States

Region	Urbanicity	Unweighted cost per meal	Estimated cost per meal	Difference
			Dollars	
Mid-Atlantic	Rural	2.54	2.38***	0.16
	Suburban	3.14	3.15***	0.01
	Urban	2.58	2.26***	-0.32
Midwest	Rural	2.55	2.56***	0.01
	Suburban	3.17	3.26***	0.09
	Urban	2.37	2.43***	0.06
Mountain	Rural	2.48	2.44***	-0.04
	Suburban	2.72	2.60***	-0.12
	Urban	2.45	2.20***	-0.25
Northeast	Rural	2.77	2.97***	0.22
	Suburban	3.08	2.74***	-0.34
	Urban	2.42	2.32***	-0.10
Southeast	Rural	2.39	2.25***	-0.14
	Suburban	2.65	2.54***	-0.11
	Urban	2.67	2.42***	-0.25
Southwest	Rural	2.28	2.25***	-0.03
	Suburban	2.62	2.61***	-0.01
	Urban	2.14	2.24***	0.10
West	Rural	2.89	2.93***	0.04
	Suburban	2.82	3.16***	0.34
	Urban	2.54	2.63***	0.09
Mean		2.63***	2.59***	-0.04

* = .10 level (10 percent); **=.05 level (5 percent); ***=.01 level (1 percent).

Source: USDA, Economic Research Service using data from School Food Authority Characteristics Survey, Mathematica Policy Research, Inc. (2004), and analysis by authors.

Table A.5
Mean factor shares and elasticities

	Factor-price variables		
	W_{LAB}	W_{FOOD}	W_{SUPPLY}
Mean factor shares	0.474	0.443	0.083
ε_{ii} (own factor price)	-0.364***	-0.375***	-1.122***
A_{ij} (Allen elasticities of substitution)			
W_{LAB}	-0.829***	0.419***	1.299***
W_{FOOD}	-	-0.916***	1.174***
W_{SUPPLY}	-	-	-15.14***

*= .10 level (10 percent); **=.05 level (5 percent); ***=.01 level (1 percent).
Source: USDA, Economic Research Service using data from School Food Authority Characteristics Survey, Mathematica Policy Research, Inc. (2004), and analysis by authors.

Table B.1

Mean weighted cost per meal for the full sample, SFAs with typical breakfast service, and SFAs with typical breakfast service and no a la carte costs across seven regions and three urbanicities[1]

Region	Urbanicity	Number of SFAs	Share breakfasts	Weighted cost per meal full sample	Weighted cost per meal (15-30 percent breakfasts)	Weighted cost per meal (15-30 percent breakfasts; no a la carte foods)
		Number	*Fraction*	*Dollars*		
Mid-Atlantic	Rural	17	0.216	2.50	2.65	2.06
	Suburban	34	0.202	3.06	2.62	2.14
	Urban	8	0.257	2.57	2.49	2.24
Midwest	Rural	39	0.211	2.52	2.50	2.10
	Suburban	34	0.217	3.08	2.71	2.14
	Urban	11	0.228	1.86	2.54	2.08
Mountain	Rural	57	0.222	2.44	2.41	2.21
	Suburban	21	0.220	2.40	2.17	1.90
	Urban	11	0.206	2.44	2.49	2.08
Northeast	Rural	11	0.224	2.72	2.63	2.02
	Suburban	20	0.216	3.00	2.87	1.95
	Urban	9	0.222	2.58	2.71	1.77
Southeast	Rural	50	0.228	2.36	2.51	2.09
	Suburban	53	0.232	2.55	2.49	2.01
	Urban	13	0.228	2.66	2.71	2.16
Southwest	Rural	38	0.251	2.28	2.67	2.41
	Suburban	42	0.243	2.45	2.46	2.20
	Urban	16	0.248	2.22	2.57	2.10
West	Rural	25	0.241	3.02	2.75	2.36
	Suburban	52	0.233	2.84	2.59	2.26
	Urban	27	0.231	2.20	2.48	2.07

[1]Sample and location mean values based on adjusted sample weights. SFA = school food authority.

Source: USDA, Economic Research Service using data from School Food Authority Characteristics Survey, Mathematica Policy Research, Inc. (2004), and analysis by authors.