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SCHOOL LUNCH PROGRAM PARTICIPATION IN NEW YORK STATE

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I. INTRODUCTION

A. Summary of the Program

The National School Lunch Program was established in 1946 with the passage of the National School Lunch Act. The intent of the Act was to make subsidized lunches available to all school children, regardless of income. Since inception, the lunch program has grown substantially; for fiscal year 1985 federal expenditures on the school lunch program are estimated at $3.2 billion. In over 85,000 schools across the nation, an average of 24 million children are served a lunch through the program on any given day (Jones, 1985).

The Food and Nutrition Service of the United States Department of Agriculture (USDA) administers the program nationally. At the state level, it is usually the Department of Education that is responsible for operating the program in local school districts. Three different categories of lunches are served: free, reduced price, and full price or paid. Lower income students are determined eligible for the free and reduced price lunches according to family income and size. All students are eligible for a paid lunch. A federal subsidy is provided to the schools, per meal, for all of the lunch categories. The amount of this subsidy is known as the reimbursement rate. Free lunches receive the largest per meal reimbursement, while paid lunches currently receive a minimal reimbursement. Agricultural surplus commodities are provided in legislated amounts for schools to use in the preparation of meals. The schools are subject to a number of regulations concerning the type and amount of food they must serve in order to qualify for the program.

B. The Omnibus Budget Reconciliation Acts of 1980 and 1981

The Omnibus Budget Reconciliation Acts (OBRA) reduced funding for a number of social programs, including the school lunch program. OBRA 1981 reduced school lunch funding substantially more than OBRA 1980. The reductions in funding were accomplished mainly through cutting the federal reimbursement rate paid per meal for the full and reduced price lunches and tightening the eligibility criteria for those families applying for subsidized meals.

The effects of these cuts on schools and children participating in the lunch program have been of continuing concern to hunger groups and legislators. Concerns have centered around both school and student participation in the program. With lower federal reimbursement rates for the paid and reduced price lunches, most schools were forced to raise their prices. The changes in eligibility criteria aroused fears that children who had depended on a free or reduced price lunch for a substantial amount of their daily food requirements would find themselves no longer eligible and faced with yet higher prices (Parker, 1982).

C. Objectives of the Study

The major purpose of this study is to determine the effects of OBRA on school lunch participation in New York State. The difficulties in identifying the effects of OBRA derive from the simultaneous effects of other important factors on participation during the period under study; enrollments declined in New York State and the U.S. economy headed into a deep recession. In addition, it is possible that there was a structural change in participant behavior.

In order to analyze the effects of OBRA on school lunch participation in New York state, three objectives are specified:

1) to identify the factors that significantly affect participation,

2) to determine whether there was a structural change in participation during the years under study,

3) to distinguish program effects from demographic, economic, and behavioral changes.

D. Methods

A complete history of school lunch legislative history, including the OBRA changes, is presented. The literature is reviewed to determine how previous researchers have analyzed the school lunch program. A critique of the previous research suggests the use of a regression model for each lunch category with participation (number of participants) as the dependent variable. The number eligible for lunches appears as a key explanatory variable. Because data defining this variable is not adequate, a logit estimation procedure is used to predict the variable.

Linear equations are specified for each of the lunch categories with explanatory variables suggested by economic theory. The predicted number eligible is included as an explanatory variable. To determine whether structural change has occurred during the period under study, a three-step ordinary least squares (OLS) estimation procedure is used. The application of this procedure indicates the model appropriate for each lunch category. The regression results of the select model are analyzed to determine the factors significantly affecting participation.

The estimated equations are then used to isolate the factors affecting participation. Two different methods are used to accomplish this objective. The equations are used to simulate participation when specific changes are made in relevant variable levels. This allows the identification of effects due to program, economic, and demographic changes. In addition, an approximation to a total differential is applied to the equations to separate behavioral effects from variable level effects.

The next section, "Legislative History," presents a complete description of the National School Lunch Program as it has evolved through legislation over the years. The changes in the program mandated by the Omnibus Budget Reconciliation Acts of 1980 and 1981 (OBRA) are included in detail.

II. LEGISLATIVE HISTORY

Federal aid to school lunches originated in 1935 as a commodity assistance program designed to relieve agricultural surpluses while aiding low income individuals. Concern for the nutrition of school children accompanied the passage of the National School Lunch Act in 1946. The idea that all children were entitled to a federally subsidized nutritious lunch regardless of income was an integral part of the Act. Child nutrition legislation, including the school lunch program, falls under the jurisdiction of the Education and Labor Committee in the House, and the Agriculture, Nutrition and Forestry Committee in the Senate. At the federal level, the lunch program is administered by the Food and Nutrition Service of the USDA. Complete details of the school lunch legislative history are presented below.

A. LEGISLATION

1935 - Section 32 of the Agricultural Adjustment Act authorized 30% of gross custom receipts to be used for the purchase of surplus commodities to increase consumption of farm products. The funds made available through section 32 were to be used for the distribution and donation of surplus commodities to school lunches and other food programs targeted to low income groups.

1946 - The National School Lunch Act of 1946, this legislation permanently authorized the program and appropriations. The features characterizing the legislation include the following:

- States received funds through formula grants based on their proportion of U.S. student enrollment. States were required to match federal funds.
- Subsidized lunches were to be provided for all students regardless of income. In addition, free and reduced price lunches were to be made available to low income children as determined necessary by the local school districts.
- Nutritional standards were to be met by all lunch programs receiving federal funds and they were to operate on a nonprofit basis.
- The USDA was to be appropriated funds for the purchase and distribution of surplus farm commodities. School lunch programs were to use these donated commodities to the fullest extent possible.

1962 - Through Section II of the National School Lunch Act, funds to states were permanently authorized for free and reduced price lunch programs in low income areas. States were to make funds available to those schools with a large proportion of students not able to afford a full price lunch. The formula used to determine state funding was altered, instead of being based on the proportion of enrollments,

funding was to be calculated according to the proportion of U.S. student participation in the lunch program.

1970 - Funds were authorized for all schools serving free and reduced price lunches whether located in a low income area or not through section 11, special assistance. Uniform national criteria were established for eligibility to receive free or reduced price lunches. Eligibility was set at 100% of the official poverty line. Those children determined by the state to be neediest were to receive priority in receiving free meals. The state matching requirement was changed and the National Council on Child Nutrition was established. Funds were authorized for nutritional training and surveys.

1971 - For the first time a guaranteed level of reimbursement to schools was established per lunch served. All lunches were to receive a reimbursement rate of $.06 with an additional $.40 for free and reduced price lunches.

1972 - The reimbursement rate for all lunches was increased to $.08. States were given the option of setting income eligibility at 125% of the poverty line for free lunches and 150% for reduced lunches.

1973 - The reimbursement rate was increased to $.10 for each lunch served. Special assistance rates for free and reduced were established at $.45 and $.35, respectively. The reduced lunch reimbursement rate was to remain $.10 below the free lunch rate. This implied that the reduced lunch student would make up the difference in the reimbursement by paying a price of $.10. All reimbursement rates were to be adjusted semi-annually for inflation using the Consumer Price Index (CPI), Series for Food Away From Home for the most recent six month period available. The income eligibility criteria for reduced price lunches was temporarily raised to 175% of the poverty line.

1974 - The level of commodity assistance was established at $.10 per lunch, adjusted annually for inflation. Section 14 was added to the National School Lunch Act requiring section 32 funds for donation of agricultural commodities to maintain the level of support mandated for child and elderly nutrition programs. Eligibility for reduced price lunches at 175% of the poverty line was made permanent.

1975 - Income eligibility for reduced price lunches was increased to 195% of the poverty line and was made mandatory for all schools participating in the National School Lunch program. States which had phased out their commodity distribution prior to June 30, 1974 were granted the right to receive cash in lieu of commodities.

1977 - Schools were permitted to refuse up to 20% of the commodities offered and to receive other commodities when available. The Secretary of Agriculture was to provide limited amounts of cash in lieu of commodities and a study of cash in lieu of commodities was commissioned.

1978 - The mandated income eligibility for free lunches was raised from 100% to 125% of the official USDA poverty line. The reimbursement rate for reduced price lunches was lowered by $.10, setting it at $.20 less

than the free rate, implying a price to students of $.20. However, if states charged less than the $.20 maximum for a reduced price lunch, they could receive an additional reimbursement. (New York State took advantage of this option setting reduced lunches at a price of $.10 and receiving the additional $.10 reimbursement per lunch.)

1980 - The Omnibus Budget Reconciliation Act of 1980, (OBRA) reduced child nutrition funding by $400 million in fiscal year 1981. Reductions in the lunch program were accomplished mainly through changes in income eligibility criteria and decreases in meal reimbursement rates. Income eligibility levels were effectively lowered by substituting the USDA poverty line with the definition used by the Office of Management and Budget (OMB). Each July 1st the USDA would update the OMB guideline to reflect the increase in the CPI between the average of the previous calendar year and March of the current year. For fiscal year 1981, this March update was eliminated by OBRA 1980 legislation. In addition, a standard deduction of $960 was substituted for the special hardship deductions from income that were previously permitted, (families had been able to deduct unusually high medical, rent or other expenses directly from income). Meal reimbursement rates were decreased by $.045; $.025 for cash and $.02 for commodities. (In those school districts where 60% or more of the lunches were served free or at the reduced price the $.025 cash reduction did not apply.) The extra subsidy for reduced price meals for states charging less than the $.20 maximum was eliminated. (Because New York State could no longer exercise the option of an extra $.10 reimbursement for reduced lunches, the reduced lunch price was increased to $.20. There were some exceptions to this, for example the New York City counties maintained a $.10 price despite the change in the reimbursement rate.) Meal reimbursement rates were to be adjusted for inflation annually rather than semi-annually.

1981 - The Omnibus Budget Reconciliation Act of 1981 reduced funding for child nutrition programs by approximately $1.4 billion beginning in fiscal year 1982. As in OBRA 1980, the savings in the school lunch program were accomplished through reductions in income eligibility levels and meal reimbursement rates. The USDA March update for inflation was permanently eliminated. Income eligibility for reduced price meals was lowered from 195% to 185% of poverty using the OMB poverty guidelines. Free meal eligibility was established at the gross income standard for food stamps; this was 130% of the OMB poverty guide. The $960 standard deduction from income that was permitted through OBRA 1980 to qualify for free or reduced price meals was eliminated. Reimbursement rates were lowered by $.0725 for all meals and an additional $.1275 for reduced price meals. As a result of the $.20 decrease in the reimbursement rate for reduced price lunches (.0725 + .1275), the maximum allowable charge for the meals was permitted to double from $.20 to $.40. (The price of reduced lunches in New York State increased from $.20 to $.40 because of this change, again there were exceptions such as the New York City counties.) $.0725 was added to the subsidy for free meals to make up for the $.0725 reduction for all meals. (The reimbursement rate remained $.02 higher in those school districts with at least 60% of the meals being served at the free or reduced price.) Additionally, the subsidy for surplus commodities was

reduced by $.0375 per lunch. OBRA 1981 also excluded private schools from participating in the national school lunch program if their tuition was greater than $1500 per year. More stringent income verification procedures were incorporated into the legislation in order to determine eligibility for the free and reduced price categories.

Following OBRA 1980 and 1981 there has been little legislative activity regarding the school lunch program other than appropriations. Both the House and the Senate have sought funding restorations. None of the proposed bills were ever voted on by the full Congress. Tables detailing year to year changes in eligibility criteria, reimbursement rates, and funding are in Appendix I.

B. Code of Federal Regulations[1]

Coincident with OBRA 1981, important changes were made in the Federal Code of Regulations that govern the administration of the school lunch program. Two of the regulations were altered in a way that had the effect of relieving some of the pressures of the OBRA budget cuts. It is not clear that this was the intent of the regulatory changes.

The Code of Federal Regulations changed the school lunch program from a lunches served, to a lunches offered system. Prior to the 1981-82 school year, a school lunch had to be served with five food groups included on the tray: a protein, a grain, milk, and two items from the vegetable/fruit group. This meal pattern is known as a Type A lunch. The regulation change mandated that the five items must be offered, but, a student may refuse up to two of the items. The intent of the change was to try and eliminate some of the waste that occurred when students discarded food items they did not eat. In addition to eliminating waste, this change also generated a cost savings for schools. (e.g., kitchens no longer had to purchase and prepare enough spinach for all students being served a lunch because they knew that a number of students would refuse this item.)

The other significant change in the Code of Regulations involves the amount of reimbursement schools receive per lunch. The lesser of cost or reimbursement method was used prior to the 1981-82 school year. This meant that schools had to document the cost of preparing meals and if the cost per meal fell short of the federal reimbursement rate then the school was only reimbursed for their cost. If a school's per meal cost was greater than the federal reimbursement rate they would not receive more than the legislated amount. In order to reduce the paperwork required of schools to report costs per meal, the lesser of cost or reimbursement method was eliminated. All schools were to be

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[1]The analysis of the regulation changes is based on a discussion with Richard Reed in September, 1985, before he retired from his post as Chief, Bureau of School Food Management, Department of Education, New York State.

reimbursed the full federal rate per meal regardless of their own costs. For those schools whose costs per meal were below the legislated reimbursement rate this represented an additional subsidy that could be used to augment the losses from OBRA.

Studies of the school lunch program have been completed at different times during its' history. The program has come under review because of the service it provides to school children and the magnitude of the program. In the next section the research relevant to school lunch participation is reviewed.

III. LITERATURE REVIEW

Studies of participation in the National School Lunch Program completed in the early 1970's, focused on the effect of price on the number of participants or on a participation rate (Nicholson, West and Hoppe, and Braley and Nelson). In the more recent analysis of participation examined in the National Evaluation of School Nutrition Programs, (United States Department of Agriculture and System Development Corporation, 1980), participation frequency is elaborately modeled as a function of program, school, family, and student characteristics. The methods and results of these studies are reviewed in this chapter.

A. Studies of Participation in the Early 1970's

Nicholson (1973) investigated both demand and cost factors relating to public school food services in North Carolina. Examining demand factors, Nicholson estimated the effect of the price of the lunch and the proportion of students receiving free or reduced price lunches on participation rates of full paying students. A sample of twelve school administrative units were studied, seven county units and five city units. The counties and cities sampled represented geographic regions, urban, rural, and socioeconomic units. The periods of study were the 1970-71 and 1971-72 school years.

First, Nicholson compared and contrasted overall participation rates and percentage of lunches served free or reduced for the county and city sample units and grade levels. Next, a regression analysis was specified with the participation rate of full price students as the dependent variable. Two independent variables were specified, price of the lunch and proportion of students receiving free or reduced lunches. The participation rate of full price students was found by subtracting the number of students receiving lunches free or reduced from the total number of lunches served and from average daily attendance. Then, the number of meals served full paying students was divided by average daily attendance of full paying students to get a participation rate.

There are some problems with the way this participation rate was calculated. The denominator in the participation rate is faulty; only the free and reduced students participating in the program are subtracted from average daily attendance. The set of students eligible for free or reduced lunches is ignored. There are surely students eligible for free or reduced lunches that do not participate during any given time period, these should not be implicitly included in the full paying average daily attendance. This oversight results in an overstatement of the denominator in the paid participation rate, and, hence, an understatement of the rate. An error in the measurement of the dependent variable biases the intercept term of the regression

equation.[1] This is not a serious problem in the analysis because Nicholson does not use the regression equations for prediction.

In the regression equation, price was specified as the amount charged to those students not eligible for the free or reduced lunches. The exact specification of percentage of students receiving free or reduced lunches was not included in the article. The assumption is that the number receiving free or reduced lunches is divided by the total number of lunches received in all categories. This variable was included in the regression analysis because it was believed that a large number of students receiving free or reduced lunches might inhibit or decrease participation among full paying students.

The effects of the independent variables on the participation rate of paid students were estimated for elementary, junior, and senior high separately. The participation rate fell in all three cases as price increased, but, the coefficient was not significant for junior and senior high students. None of the coefficients on the variable, percentage free or reduced lunches were significant.

Nicholson calculated price elasticities for the various prices charged elementary students during the 1970-71 school year. The calculations indicate that the paid participation rate is fairly inelastic with respect to price. Nicholson points out:

> One problem with the sample data is there is a very small range of variation in prices available for analysis because prices charged for school lunches do not vary substantially among North Carolina school units. Data indicates, however, that variation in participation rates is not greatly influenced by price changes within the range of prices observed in North Carolina during the two program years.[2]

Nicholson's elasticities are listed in Table 3.1.

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[1]Pindyck and Rubinfeld, Econometric Models and Economic Forecasts, New York: McGraw Hill Book Company, 1976, pp. 128-9, point out that when the dependent variable is measured incorrectly the mean of the error term is not equal to zero and the bias is captured by the intercept term.

[2]Nicholson, R.H. "Some Economic Aspects of the National School Lunch Program in North Carolina," Economic Information Reports, no. 32, July 1973, p. 16.

TABLE 3.1 - Price Elasticities of Participation.

	PRICE	ELASTICITY
Nicholson[1]	$.30	-.252
	.34	-.295
	.35	-.307
	.40	-.367
West & Hoppe[2]		
Large Districts	.36	-1.18
Small Districts	.31	-.53
Braley & Nelson[3]	.20	-.47
	.35	-1.27
	.47	-2.95
	.20-.35(arc)	-.77
NESNP[4]	.40	-.50
	.60	-.75

1 Nicholson, R.H. "Some Economic Aspects of the National School Lunch Program in North Carolina," Economic Information Reports, no.32, July 1973.

2 Based on the results reported by West and Hoppe (1973).

3 Braley, G.A. and Nelson, P.E. Jr. "Effect of a Controlled Price Increase on School Lunch Participation: Pittsburgh 1973." American Journal of Agricultural Economics (57):90-6, February 1975.

4 United States Department of Agriculture and System Development Corporation. "National Evaluation of the School Nutrition Programs." The American Journal of Clinical Nutrition, vol. 40, no. 2, August 1984.

The relationship between price and participation rate was also investigated by West and Hoppe (1973). This research was one part of a larger research effort undertaken at the University of Washington by Price, et al., (1975). Public school districts were the unit of analysis; 272 school districts were surveyed during the 1970-71 school year. The effect of price on the participation rate was estimated with a linear regression model. Other non-price factors believed to affect the participation rate were discussed in a qualitative manner.

The participation rate of full paying students was again used as the dependent variable; paid price was the independent variable. The average daily participation rates were calculated:

$$R_i = \frac{a_i - b_i}{c_i - d_i} \quad \text{where,}$$

R_i = average daily participation rate in the ith school district.

a_i = average number of lunches prepared per school day, ith school district.

b_i = average number of free and reduced price lunches prepared per school day, ith school district, 1970-71.

c_i = enrollment in the ith school district 1970-71.

d_i = number of children eligible for free and reduced price lunches, ith school district.

Unfortunately, there was no discussion of how the number of free and reduced price eligibles was obtained, other than a note in the Appendix referencing an unpublished state data source.

In order to estimate a linear price-participation rate relationship, the 272 school districts were divided into two groups: districts with enrollments greater than 500 students and districts with enrollments less than 500 students. The regression equation for the large districts was:

$$r = 82.291 - 1.231p$$

The regression equation for the small districts was:

$$r = 92.713 - 1.036p, \text{ where,}$$

r = daily participation rate expressed in percent.

p = average regular price charged for the lunch.

Both of the price coefficients were statistically significant at 1%. The elasticities implied by these price coefficients at average prices and participation rates are calculated and illustrated in Table 3.1.

Nicholson and West and Hoppe each use a participation rate as the dependent variable, but, it is not clear that the specification for either participation rate is correct. The most accurate description of the participation rate is the number participating divided by the number eligible. Nicholson clearly did not use this formulation, and, while West and Hoppe indicate that they have used this formulation, the source of the denominator (number eligible) is not described.

Beyond the question of whether the correct rate has been specified, using a rate obscures the analysis because the rate may change due to two different factors, a change in the number participating or a change in the number of eligibles. If, for example, the participation rate falls it could be due to a drop in the number of students participating or an increase in the number of students eligible, or both. It is even possible that both the number participating and the number eligible drop, but, that the number of participants declined by a larger proportion. The number eligible for a lunch is not a function of price, but of such factors as enrollments, income guidelines for eligibility, and economic conditions. To investigate the effect of price on the number participating, the number eligible must be held constant. To estimate a participation rate in evaluating OBRA effects would be particularly erroneous because a critical part of the analysis involves the reaction of the number participating to the change in the number eligible according to the newly legislated income guidelines.

Braley and Nelson analyzed the number participating rather than a participation rate in their study of Pittsburgh public schools (1975). The schools experienced a large jump in the price of paid lunches on February 5, 1973, due to the decision of Pittsburgh officials to withdraw local, tax-based funding for the lunches. The paid lunch price increased from $.20 to $.47. Braley and Nelson were interested in evaluating the results of the earlier studies by Nicholson and by West and Hoppe. Braley and Nelson point out that these cross sectional studies assume all participating students are on the same demand curve. They assert that:

> ...these regression analyses involve comparisons of behavior patterns of different student populations, a study of the same population before and after a substantial price increase provides a useful check on the results from these earlier regressions.[3]

In order to analyze the effect of the more than doubled price on participation, a linear relationship was computed between prices charged fully paying students and the corresponding number of paid lunches

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[3]Braley, G.A. and Nelson, P.E. Jr. "Effect of a Controlled Price Increase on School Lunch Participation: Pittsburgh 1973." American Journal of Agricultural Economics (57):90-6, February 1975, p. 90.

served daily in both January and February. Price elasticities were then calculated and compared with the earlier studies. In January, price was $.20 and the corresponding number of paid meals was 11,160. In February, price was increased to $.47 and paid participation declined to 4153. These figures represent a 133.4% price increase and a 62.8% reduction in participation. In addition to the price and participation factors, enrollments were 4% higher in February. This fact is mentioned though it does not appear to be accounted for in the analysis.

The price and participation figures were used to compute the slope of their linear relationship (change in the number participating/change in the price), and obtain the equation: $Q = (62.4763-Y)/0.003806$, where Y equals price and Q equals quantity (number of participants). Using this formulation, price elasticities could be calculated for a few different price-quantity combinations. Braley and Nelson computed point elasticities at the prices of $.20, $.47, and $.35, and they also computed an arc price elasticity between $.20 and $.35. Braley and Nelson suggested that the price points of $.20 and $.35, and the arc $.20 to $.35, most closely resembled the range of prices in the earlier studies with which they planned comparison. The calculated price elasticities are listed in Table 3.1.

The authors expressed satisfaction with the comparison of their price elasticities (-.47 to -2.95) to Nicholson's (-.252 to -.367) and West and Hoppe's (-.53 to -1.18) and concluded that the assumption of a common demand curve for cross-sectional school data was a safe one.

Braley and Nelson repeated the calculation of these demand elasticities after more time had elapsed following the price change. A second similar set of elasticities were computed for a January-May relationship of price and the number of participants. The purpose of this repeated exercise was to determine the stability of the change in the number participating in response to the price increase. The resulting elasticities were quite similar and indicated stability.

Braley and Nelson's use of the number of paid lunch participants rather than participation rate is appropriate. The price elasticities computed in all three early studies provide useful reference points. However, the studies are limited in two ways. First, price is the primary or only explanatory variable. Other possible relevant factors, mainly school and student characteristics, were discussed in a qualitative manner, but, they were not measured explicitly. Second, the questions of free or reduced lunch participation were not addressed. All three lunch categories, free, reduced, and paid, must be analyzed in order to evaluate OBRA's effects on participation in the school lunch program.

B. The NESNP Study of Participation, 1980

The "National Evaluation of School Nutrition Programs" was an extensive study carried out by the United States Department of Agriculture (USDA) and System Development Corporation of Santa Monica, California (1984). This comprehensive study addressed many aspects of

the school lunch and school breakfast programs. In addition to their examination of factors affecting participation in the program, the topics studied included program impact on dietary intake, anthropometric measures for determining longer term effects on growth, and family food expenditures.

The NESNP used nationally representative data on individual students, their family characteristics, characteristics of their schools, and their participation in the program. Though there are some problems in their specification, the study provides the most detailed and complete model of lunch participation from which to make comparisons. Therefore, considerable space will be devoted to reviewing their methods and results.

C. The NESNP Model

Multiple regression analysis was used to estimate the effects of different factors on the frequency of participation. The results were then used to predict the effects of hypothesized changes in the eligibility criteria for free and reduced meals. Data was collected in the Fall of 1980. Personal interviews were conducted with students and parents, mail surveys were completed by principals, district superintendents, and school and district food service directors. The sample consisted of 6556 students.

The dependent variable was the frequency of participation. Independent variables included: characteristics of students and their families, and characteristics of schools and their meal programs. Rather than using aggregate data, the variable corresponding to the particular student or their school was used.

The dependent variable, participation frequency, was specified as the number of times a student participated during the week before the interview. Because the dependent variable had a limited range, 0 to 5, it was converted to a logit ($L = \log(f/(5-f))$, where, f is the number of days per week a student participated. The regression analysis was weighted to compensate for the limited range of the dependent variable and heteroscedasticity. Participation models were analyzed in total and for various subgroups. These subgroups included: high and low income, elementary and secondary, free lunch and the combination full/reduced price lunch.

Twenty-seven independent variables were specified; including such items as sex, age, race, meal price, meal price status (whether a student is approved for a free or reduced meal), available lunch alternatives, parental attitudes, geographic region etc.

The participation model suffers from some specification problems, particularly in the model of all students. Functional relationships that exist between explanatory variables will cause unwanted correlations. If multicollinearity is the result of these correlations, the estimates are not precise.

In the total model, free, reduced, and paid lunch participation frequency are specified in the same equation. As a result, the variables "price status-- free" and "price status--reduced" are included as dummy variables that indicate whether a student has been approved for free or reduced meals. However, meal price status is a function of income and family size, and these are also included as explanatory variables indicating free and reduced eligibility. There is another troublesome interrelationship, price is included as an explanatory variable, and the price paid by a student is a function of meal price status.

An additional problem is associated with this specification. By including all three meal categories in the same equation, the model forces a common slope on the different categories, only allowing the intercepts to vary via the dummy variables specified for free and reduced meal price status. The assumption of a common slope implies that students in the free, reduced, and paid categories share participation behavior with respect to the explanatory variables. This may not be an appropriate assumption given the differences in the socio-economic backgrounds of students in different meal categories.

By combining full and reduced price students in the subgroup, full/reduced, the same problems are repeated in the subgroup model. Meal price status is a function of income, family size, and price. Forcing the full and reduced price students to share a common slope assumes their behavior with regard to the explanatory variables is identical. The free lunch subgroup does not share these specification errors.

D. NESNP Results

The regression results are reported in Appendix II. In the total model including all students, fourteen of the coefficients were significant at the 1% level, and five more were significant at the 5% level. Similar results were obtained for the full/reduced subgroup. But, the free subgroup had only six coefficients significant at 1%, and another two at 5%. In addition, the signs of the coefficients in the free subgroup often differ from the total and full/reduced models. This supports the belief that the meal categories should be modeled separately. It is uncertain what differences would have been evident had the full and reduced categories been modeled separately.

Despite the specification errors, the NESNP regression results provide some basis for comparisons. The NESNP found price to be, "the single most important variable, accounting for approximately 52% of the explained variation in participation."[4] The NESNP specified price as

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[4]United States Department of Agriculture and System Development Corporation. "National Evaluation of the School Nutrition Programs." The American Journal of Clinical Nutrition, vol. 40, no. 2, August 1984, p. 430.

log of meal price, the coefficients were negative and significant at 1% in both the total model and the full/reduced subgroup. Price elasticities were computed for two price points and are not unlike those found in the earlier studies, -.5 and -.75. The prices and corresponding elasticities are listed in Table 3.1.

Because parents were interviewed directly, their perceptions were included as explanatory variables in the study. The NESNP measured parents perceptions regarding the cost of the school lunch, the convenience of the school lunch, the nutrition of the lunch, and if nutrition is the most important determinant of the lunch the student eats. Cost of the school lunch was negatively related to participation frequency; as parents perceptions of cost increase participation decreases. The coefficients were significant at 1% in the total model and the full/reduced subgroup. In the free subgroup, the coefficient was not significant; this is an intuitive result because there is no cost to the parent for the lunch. Parents perceptions of the school lunch as convenient positively affected participation; the coefficients were significant at 1% for the total model and both subgroups. Perceptions of the school lunch as nutritious also affected participation positively; significant at 1% for the total model and the full/reduced subgroup, the coefficient was not significant for the free subgroup. It could be that parents consider nutrition more carefully when they must pay some price for the lunch. When nutrition is the most important factor in determining the lunch a student eats, school lunch participation is negatively affected in the total model (coefficient significant at 5%) and the full/reduced subgroup (coefficient significant at 1%). This finding indicates that parents do not have a positive perception of the nutrition provided by school lunches. It may be that parents concerned about nutrition feel they can do a better job of providing a nutritious lunch. Though the coefficient is positive in the free subgroup, it is not significant.

The NESNP results indicate that the more educated the parents, the lower the frequency of participation. The coefficients on the variable, "parental education," are negative in the total model and both subgroups. The coefficients are significant at 1% in the total model, 5% in the full/reduced subgroup, and not significant in the free subgroup. The sex and age of the child also appear to affect participation, with male and younger students having higher participation frequencies. The coefficients on the variable "male" are positive and significant at 1% for the total model and both subgroups. The coefficients on "age of the child" are all negative; they are significant at 1% in the total model and the free subgroup, but not significant in the full/reduced subgroup.

The results of the NESNP indicate that the more freedom students have to choose lunch and the more choices available, the less students participate in the program. The variables "can eat lunch at home" and "child decides where to eat" are all negatively related to participation frequency. The coefficients on these variables are significant at 1% in the total model and both subgroups with one exception: in the free lunch subgroup the coefficient for "can eat lunch at home" is not

significant. This is reasonable, considering that the child receives a free lunch if they stay at school.

Variables measuring urbanization may also be associated with the availability of more lunch choices; in urban areas students may be able to eat lunch at establishments other than the school. The "suburban" variable has a negative relationship with participation frequency. The coefficients are significant at 1% in the total model and the full/reduced subgroup, the free subgroup coefficient is not significant. This same result is true for the variable "central city," except that the coefficient for the free subgroup is positive and not significant.

It is puzzling that the coefficients for the variable "log of per capita income" were not significant for the total model or either of the subgroups. This could be due to the correlation that exists between the price status variables and the income variable. In addition, the race variables, "black" and "hispanic," did not have statistically significant coefficients.

E. NESNP Eligibility Analysis

Using the regression results, the effects of different eligibility criteria for free and reduced price lunches were analyzed. Nine eligibility criteria were hypothesized. The first one corresponded to the guidelines in place prior to the passage of OBRA, the second corresponded to eligibility criteria legislated by OBRA 1980, and the third to OBRA 1981 criteria. The other six were purely hypothetical situations. Though the NESNP had collected their data prior to OBRA legislation, the analysis was still in process when debates arose regarding OBRA. The NESNP took advantage of their wealth of data to produce the eligibility analysis.

Participation frequencies were estimated for each of the nine eligibility scenarios. While the results of this analysis suggested that the overall effects of the eligibility changes were small, there was a considerably larger impact on students with family incomes falling between the most and least restrictive hypothesized guidelines. These are students within 100% to 300% of poverty; their participation frequency would be reduced by 2.5 to 3 times as much as the overall population.

The NESNP provides a comprehensive model of lunch participation and suggests a number of explanatory variables though there are some specification problems. The free, reduced, and full price categories should have been modeled individually. The participants in these categories may be sufficiently different to warrant this treatment and econometric difficulties could have been avoided had they done so. Though the eligibility exercise simulates OBRA changes, the study was initiated before OBRA legislation and their data reflects pre-OBRA participation.

The studies presented in this literature review provide insights and results for comparisons. However, examination of these studies

indicated that alternative methods should be used to study the effects of OBRA legislation on lunch participation: (1) the number of participants, not the participation rate, is the appropriate measure of lunch participation, (2) free, reduced, and paid student behavior should be modeled individually, (3) the effect of OBRA on the number eligible in each of the lunch categories is critical in determining the impact of OBRA because the number eligible will affect the number of participants.

The number participating in the lunch program is the appropriate dependent variable for study and the number eligible is a key explanatory variable. Data defining the number participating in the program were obtained, but, for one of the study years, an estimation procedure was necessary to predict the number eligible in each of the lunch categories. In the next chapter the participation data are described and the estimation of the number eligible is outlined.

IV. DESCRIPTION OF THE DATA AND PREDICTION OF ELIGIBLES

A. Participation Data

Information on the number of participants in the school lunch program in New York State was obtained from the state education offices.[1] Data regarding the number of participants in each of the three lunch categories by county provided the basis for the analysis. The county was chosen as the unit of analysis for two reasons: it would allow an adequate number of observations for statistical testing and many of the other types of data needed for the analysis could be obtained for counties.

The five New York City counties (Brooklyn, Bronx, New York, Queens, and Richmond) are omitted from the study. This left a total of 57 counties in the analysis. The size and uniqueness of New York City would bias the results for the state and make the analysis of questionable value. A completely separate analysis would be necessary to specifically examine New York City.

The state education department did not have a complete breakdown of the number of participants by county for entire school years or every month of the school year. However, in selected months, information on the number of participants had been compiled by county for internal administrative purposes.

In order to examine the changes in participation and attribute them to OBRA legislation, data is needed to represent a time period before and after OBRA. The Fall of 1979 was chosen for the pre-OBRA period and the Fall of 1981 as the post-OBRA period. By keeping the pre and post policy periods as close in time as possible, any elusive changes in the program that might occur over time may be minimized. By using Fall 1981 as the post-OBRA time period (the first semester the legislation was operating), the immediate effects of the change before schools began to engage in compensating behavior may be captured. Though participation data could not be obtained for the entire Fall semesters of 1979 and 1981, the month of October had been selected for the education department's own analysis in both 1979 and 1981 and so serves as a suitably representative month for Fall participation. October participation is a particularly acceptable month for examination because it is beyond the introductory month of September when students may be applying for free and reduced price lunches; it also avoids the possible holiday complications that could arise in a month such as December.

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[1]Participation data was obtained with the help of Richard Reed, now retired Chief of the Bureau of School Food Management, Department of Education, New York State. The actual figures were kept on file by the Reimbursement Unit in order to report and receive subsidies from the federal government.

The reports contain the number of participants listed by each school district in a county and then the county total. Included in the listings are handicapped, children, and group homes; the residents of these homes are eligible for lunches and do participate, mainly in the free category. The homes could easily be identified by their code numbers and were subtracted from the county totals. Thus, participation is only representing public and private, elementary and secondary schools.

The reports separate participation into the three categories of free, reduced, and regular (paid or full price). Within each category the relevant figure is Average Daily Participation (ADP) in the program. Descriptive statistics for each of the categories are presented in Table 4.1, from 1979 to 1981, the number of participants declined in all three lunch categories.

TABLE 4.1 - Descriptive Statistics of the Average Daily County Participation (ADP) Data: Free, Reduced, Paid.

VARIABLE	YR.	MEAN	STAND. DEV.	MIN	MAX
ADP, Free	'79	4571	7142	250	41909
	'81	4282	6372	165	36794
ADP, Reduced	'79	1120	1398	94	8301
	'81	882	1141	106	6863
ADP, Paid	'79	9912	13209	458	71627
	'81	7585	10307	439	59627

B. Approved Applications versus Number Eligible

The number of approved applications for free and reduced price lunches is collected along with the participation data by school district and county. These might have been considered as a possible measure of the number eligible for free and reduced lunches. However, the number of students eligible for the free and reduced price categories will differ from the number of approved applications. Students who are eligible may choose not to apply for meals due to the stigma they or their families might attach to receiving government assistance. Through errors in the application process, students who are eligible may be deemed ineligible, or some families may be intimidated by the application itself. OBRA 1981 required all adults in a household to list their social security numbers on the application. There was some evidence that families found this requirement intimidating and that it discouraged some families from applying (Parker, 1982).

Because of the difference between the number eligible and approved applications, approved applications are not used as a data source. The number of students eligible for free and reduced price lunches is the correct specification for the variable and had to be estimated. The estimation procedure is the topic of the next section.

C. Predicting Eligibles

The number of eligibles is an important explanatory variable in the lunch participation models. Significant changes were enacted through OBRA with regard to meal price eligibility. A critical impact of the legislation could be overlooked if the effects of a change in the number eligible on the number participating are not examined.

In addition to legislative changes, the number eligible for lunches is influenced by economic and demographic forces. In periods of recession one would expect that there would be more children eligible for free or reduced price lunches. Demographic changes in the population of school-age children will impact the number of students eligible for lunches. In 1981, the U.S. economy was headed into a deep recession and school enrollments in New York State were declining. These economic and demographic changes will affect the number of eligibles and, therefore, participation.

Determining eligibles in the paid category is straightforward because all students not eligible for a free or reduced lunch may purchase a full price meal. When the free and reduced eligible sets have been defined, their sum can be subtracted from total enrollments to yield the number eligible for paid lunches. Unfortunately, data that appropriately defines the free and reduced eligible sets is difficult to obtain. Detailed income information is only collected on a large scale every ten years by the census; the 1980 census reports 1979 income information. As detailed as these data may be, they still do not define the specific income categories that are necessary to identify the number of school-age children that would be eligible for free or reduced lunches. In addition, 1979 income information must be updated in order to calculate the number of eligibles in 1981. As a result, obtaining figures that adequately represent the number of eligible students requires an estimation procedure.

D. Data Requirements

The number eligible for free and reduced lunches in 1979 and 1981 are needed in order to complete the analysis of participation. Specifically the requirements are as follows:

1) 1979, free lunch eligibles -- number of school-age children below 125% of the poverty line.

2) 1979, reduced lunch eligibles -- number of school-age children 125-195% of the poverty line.

3) 1981, free lunch eligibles -- number of school-age children below 130% of the poverty line.

4) 1981, reduced lunch eligibles -- number of school-age children 130-185% of the poverty line.

After examining the data requirements and the census reports, it was evident that only one of the requirements, number of school-age children below 125% of the poverty line in 1979, was directly obtainable at the county level. The 1980 census lists the number of children between ages 5-17 below 125% of the poverty line and the number of children between ages 5-17 in all income categories.[2] The number of children between ages 5-17 below 125% of the poverty line is divided by the number of children between ages 5-17 in all income categories. The result is a rate that represents the proportion of total children in a county, ages 5-17, below 125% of the poverty line. This rate is then multiplied by county enrollments in 1979 to obtain a good approximation of the number of free lunch eligibles:[3]

$$\frac{\text{\# of children 5-17 below 125\% of poverty}}{\text{\# of children 5-17, all income categories}} \times \text{county enrollments} =$$

1979 free lunch eligibles.

Obtaining approximations for the other three lunch categories is more complicated due to the lack of detailed information at the county level. Because so much more information on the income distribution of children is available for Standard Metropolitan Statistical Areas (SMSA) or Rural census designations, individual counties are assigned into these categories and combinations of these categories. The assignment of the counties is an important link in the procedure because this process will determine the income distribution a county matches. For details outlining the assignment of counties see Appendix III.

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[2]The data are from the 1980 Census of Population, Characteristics of New York State, United States Department of Commece, Bureau of the Census, Section C, Section 2, Table 181, Poverty Status in 1979 of Families and Persons for Counties, pp.34-985-990, under the subheadings "income in 1979 below 125 percent of poverty," and "all income levels in 1979," are the categories "related children 5 to 17 years."

[3]Public school enrollment data for Fall 1979 and Fall 1981 are listed by county in the Annual Educational Summary of New York State, 1982 and 1984, the State Education Department, Information Center on Education, Tables 55 and 54, pp. 62-3 and pp. 60-1, respectively. Private school enrollments for 1979 and 1981 by county are from the New York State Statistical Yearbook, 1986, Table D-6, p.109.

Once counties are assigned, linear interpolation is used to calculate the poverty rates of school-age children within the specific income guidelines for the three remaining lunch categories. This procedure is detailed in Appendix IV. Reduced price lunch eligibles in 1979 are then computed in the same way as that outlined above for 1979 free lunch eligibles. Multiplying the computed poverty rate by 1979 county enrollments, an approximation of reduced price county eligibles is obtained:

$$\frac{\text{\# of children 5-17 125-195\% of poverty}}{\text{\# of children 5-17, all income categories}} \times \text{county enrollments} =$$

1979 reduced lunch eligibles.

E. Updating 1979 Poverty Rates: The Model

In order to compute the 1981 eligible sets, the two poverty rates defining 1981 guidelines, (proportion of school age children below 130% and between 130-185% of poverty), are updated to reflect economic conditions in 1981. All of the census data used this far have been based on income information from 1979. A regression model is used to predict the free and reduced poverty rates in 1981. The predicted rates are then multiplied by 1981 enrollments to obtain the number of eligibles.

Two equations are estimated, one with the 1981 free lunch poverty rate as the dependent variable and the other with the 1981 reduced lunch poverty rate as the dependent variable. The independent variables include the following: deflated income per capita, unemployment rate, and rural vs. urban. The equations are estimated with 1979 county level data. Once the parameters are obtained, 1981 values for the explanatory variables are multiplied by the regression parameters to predict poverty rates for 1981.

Three explanatory variables are chosen and evaluated according to economic theory. Deflated income per capita is selected because incomes in a county are an important determinant of the incidence of poverty. As per capita income increases one would expect that the rate of children in poverty will decline. The income per capita variable is deflated to reflect real income.[4] The unemployment rate is another measure of the economic well-being of a county. If unemployment

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[4]County income per capita is reported in the New York State Statistical Yearbook, 1986, Table E-27, p. 164. The source of the data is listed as the United States Department of Commerce, Bureau of Economic Analysis. Income per capita is deflated by the Consumer Price Index (CPI) for all items in the Northeast region by population size class. The CPIs for 1979 and 1981 are from the CPI Detailed Report, December 1979 and 1981, United States Department of Labor, Bureau of Labor Statistics, p. 84 and p. 86, respectively.

increases, the loss of family income will positively affect the rate of children in poverty. Average yearly unemployment rates per county in 1979 and 1981 are used in the analysis.[5] The amount of urban settlement in a county affects the rate of poverty due to the placement of industries and well-paying jobs, which are associated with denser population centers. To capture this relationship, the rural vs. urban variable is set-up as a dummy, with rural counties equalling one and urban counties equalling zero.[6]

F. Estimating a Rate with Logit

The ordinary least squares (OLS) regression technique cannot be used when the dependent variable is a rate. The OLS method cannot guarantee predicted rates that fall within the required one-zero range. The logit procedure, however, does meet this requirement and is used for estimation.

A simple linear model is specified for deriving the logit estimator of poverty rates:

(1) $P_i = a + BX_i$,

where P_i will equal the poverty rate. The logit model is based on the cumulative logistic probability function:

(2) $$Pi = F(Zi) = \frac{1}{1 + e^{-Z_i}} = \frac{1}{1 + e^{-(a + BX_i)}},$$

Transforming equation (1) logrithmically according to equation (2) yields:

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[5]Average yearly unemployment rates per county are available for 1979 and 1981 from the "Resident Employment Status of the Civilian Labor Force," published by the New York State Department of Labor, Division of Research and Statistics, 1984.

[6]In order to code the counties rural or urban, the population density illustrated in the New York State Statistical Yearbook, 1986, Figure A-2 is used. The source of the population densities is the Bureau of Census, 1980. If a county has population per square mile of 1-100, it is considered rural. Any higher density is treated as urban. This is not a census definition, but one that is useful for defining those most rural counties that apparently have different economic dynamics. As the density categories of counties do not change from 1979 to 1981, this variable is the same in the 1979 regression equation and the 1981 prediction.

$$(3)\quad \log\left(\frac{P_i}{(1-P_i)}\right) = a + BX_i$$

The predictions resulting from equation (3) will be restricted to the desired range of zero to one.

Pindyck and Rubinfeld (1976) point out that this specification is heteroscedastic because the error variance is not constant. Judge et al (1980) demonstrate that the logit model has a nonconstant error variance:

$$(4)\quad \sigma^2 = \frac{1}{N_i \hat{P}_i (1-\hat{P}_i)},$$

where, N_i is the total population from which the rate is drawn. In this case, N_i is the total number of school-age children. If the model is not corrected for heteroscedasticity, the parameters will be unbiased and consistent, but, they will not be efficient.[7]

Pindyck and Rubinfeld suggest a correction for heteroscedasticity.[8] A weighted least squares approach is used, a particular form of generalized least squares. Specifically, all variables are weighted by the inverse of the square root of the variance, equation (4). In order to use this method of weighting, the error variance must be known. If the value of $\hat{P}_i$ is known, then the error variance can be calculated from equation (4). An approximation of $\hat{P}_i$ is found by estimating the uncorrected model, equation (3). 1979 data values are multiplied by the estimated parameters to obtain $\hat{P}_i$.

Once the error variance is computed, the logit model is estimated with the correction for heteroscedasticity:

$$(5)\quad \log\left(\frac{P_i}{(1-P_i)}\right)\frac{1}{\sigma_i} = a\frac{1}{\sigma_i} + B_1\frac{X_1 i}{\sigma_i} + B_2\frac{X_2 i}{\sigma_i} + B_3\frac{X_3 i}{\sigma_i} + \frac{E_i}{\sigma_i}.$$

This is a form of generalized least squares (GLS).

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[7]For a complete discussion of the nonconstant error variance and the inefficiency associated, see Pindyck and Rubinfeld's Econometric Models and Economic Forecasts. New York: McGraw Hill Book Company, 1976, p. 96.

[8]Pindyck, R.S. and Rubinfeld, D.L.. Econometric Models and Economic Forecasts. New York: Mcgraw-Hill Book Company, 1976, pp. 97-8.

G. Logit Results

The results of the logit procedures outlined above are listed in Table 4.2. Equation (5) illustrates the estimating model.

TABLE 4.2 -- Poverty Rate Estimates.

EXPLANATORY VARIABLE	DEPENDENT VARIABLE Free Poverty Rate	 Reduced Poverty Rate
Intercept	-1.18 (-6.51)	-1.55 (-8.51)
Income per capita	-.000104 (-7.01)*	-.00009 (-6.02)*
Unemployment rate	.0429 (2.38)+	.0268 (1.48)
Rural vs. urban	.237 (3.56)*	.288 (4.32)*

*Indicates a t-statistic significant at 1%.
+Indicates a t-statistic significant at 5%.

In both of the estimations, all of the coefficients have the expected signs, and, deflated income per capita and rural vs. urban are significant at the 1% level. Unemployment rate is significant at 5% in the free lunch estimation and 20% in the reduced. To test the validity of the predicting models, actual 1979 poverty rates are correlated with the 1979 poverty rates predicted by the models. The correlation is .833 and .845, respectively, in the free and reduced estimations.

To predict poverty rates in 1981, the 1981 values for deflated income per capita, unemployment rate, and rural vs. urban are multiplied by the parameters of the estimated equations. In the final step, the predicted poverty rates are multiplied by 1981 county enrollments to define the free and reduced eligibles:

predicted poverty rate (free or reduced) x enrollments = number of eligibles.

Obtaining the number eligible for paid lunches is straightforward: (1 - (poverty rate free + poverty rate reduced)) x enrollments. This insures that the total number of eligibles will equal enrollments. Table 4.3 provides descriptive statistics on enrollments, poverty rates, and eligibles.

TABLE 4.3 -- Descriptive Statistics on County Enrollments, Poverty Rates, and Eligibles.

Variable	Yr.	Mean	Stand. Dev.	Min.	Max.
Enrollments	'79	37716	60071	937	301030
Enrollments	'81	35212	55792	831	281205
Free Lunches:					
Poverty rate	'79	.1808	.0487	.0507	.2817
Poverty rate	'81	.2068	.0448	.1038	.2856
Eligibles	'79	5491	7194	249	34456
Eligibles	'81	5806	7613	233	41099
Reduced Lunches:					
Poverty rate	'79	.1883	.0485	.0897	.2569
Poverty rate	'81	.1505	.0330	.0799	.2037
Eligibles	'79	5771	7732	241	42806
Eligibles	'81	4230	5550	165	30099
Paid Lunches:					
Rate	'79	.6309	.0957	.4614	.8596
Rate	'81	.6427	.0776	.8163	.5107
Eligibles	'79	26454	45656	447	224089
Eligibles	'81	25176	43079	433	210007

H. Participation Rates

Though participation rates will not be used as dependent variables in the participation analysis, examination of participation rates before and after OBRA is instructive. Participation data was presented at the beginning of this section, and, having estimated the eligible sets it is now possible to examine participation rates in 1979 and 1981. The participation rate is defined as:

$$\frac{\text{number participating}}{\text{number eligible}}.$$

The number participating is average daily participation and the number eligible is the number of children between ages 5-17 within the income criteria for eligibility.

Analysis of the two components of the participation rate illustrates the point that a specification using participation rate as the dependent variable is incorrect. Table 4.4 presents an analysis of average participation rates for all lunch categories in 1979 and 1981. Included in the table are the directional changes of the number of participants and the number of eligibles from 1979 to 1981. Though the denominators of the free and paid participation rates behaved differently, their average rates both declined after OBRA. The average reduced participation rate appears stationary.

Reduced lunch participation rates are approximately one third the free rate and one half the paid rate. The fact that reduced lunch participation rates are quite low may be due to a variety of reasons. Students in the reduced price category pay a legislated amount for their lunches and, being at the lower end of the income distribution they may not always be able to afford to purchase the school lunch even at a reduced charge. In addition, students in this category are not as poor as those in the free category, yet they must still apply for reduced price status and possibly experience welfare stigma.

The effort required to apply for meals and the possible stigma experienced are transaction costs for both free and reduced lunch categories. However, the benefit of receiving a lunch free of charge is greater than the benefit derived from a reduced price meal. Additionally, it appears that the benefits of receiving a reduced price meal do not sufficiently outweigh the transaction costs to encourage a reduced participation rate comparable to the paid rate.

Changes in the denominators of the rates (number eligible) are a function of the variables presented in this section: legislative changes in the income criteria, economic conditions, and enrollments. Changes in the numerators of the rates (number participating) are a function of the number eligible, lunch prices, student characteristics, family incomes and characteristics, and food preferences. A complete discussion of the variables explaining lunch participation is presented in the next section.

TABLE 4.4 -- Participation Rates in 1979 and 1981 for Free, Reduced and Paid Lunches.

Number of participants (Numerator)	Number of eligibles (Denominator)	Average rate '79	Average rate '81	Rate change
Free Lunch:				
decreased	increased	77.9%	69.3%	-8.6%
Reduced Lunch:				
decreased	decreased	22.7%	23.5%	+.8%
Paid Lunch:				
decreased	decreased	53.2%	42.5%	-10.7%

V. PARTICIPATION EQUATIONS

To analyze the effects of OBRA legislation on lunch participation, three objectives are specified for the empirical model: 1) identifying the factors that significantly affect participation, 2) determining whether there was a structural change in participation between the years 1979 and 1981 (this would indicate a change in the behavior of participants), and 3) distinguishing program effects from economic, demographic, and behavioral effects. The first two objectives are addressed in this section, which outlines the participation model and results. The third objective is reserved for the next section.

A. The Participation Model

Three different equations are estimated, one for each of the three lunch categories: free, reduced, and paid. Ordinary least squares is used as the estimating procedure. Because there is no reason to believe that the relationship of participation to the explanatory variables is not linear in nature, a linear form is specified, $Y_i = a + BX_i$. The county is the unit of analysis.

As noted in Section Four, the dependent variable is average daily participation (free, reduced, and paid) per county, in the month of October, 1979 and 1981. Though the equations are estimated independently, explanatory variables for the three lunch categories include the following: number eligible, income, employment, urbanization, female head of household, race, and education. A price variable is also included in the paid participation model. A price variable in the reduced specification would have been appropriate for capturing the effect of the large jump in price from $.10 in 1979 to $.40 in 1981. However, a price variable could not be included due to the lack of variation in the reduced price across counties.

The explanatory variables are measured by county. In most cases the method of measurement is dictated by the data available, with the exception of the number eligible which is predicted (as outlined in Section Four). The income variable is deflated income per capita per county and employment is the average yearly unemployment rate per county.[1]

Urbanization is measured by the percent of a county's population in urban areas. The percent of female headed households and the percent of the population that is black are measures for the female head of household and race variables. Education is measured as the percent of population 25 and over that has completed at least four years of

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[1]The precise sources of the deflated income per capita and unemployment data are detailed in footnotes four and five, respectively, of Section Four.

college. (The completion of college was chosen rather than high school because there is more variation across counties.) Percents, rather than raw figures are used for these variables to avoid any size bias that could occur due to the large differences in the population of New York counties.

Percent urban, percent female head of household, percent black, and percent college are all obtained from census reports.[2] Because the census only collects data for 1980, 1980 data values are used for 1979 and for 1981. With the exception of percent female householder, the data values are not expected to differ significantly during the period 1979 to 1981.[3] Though an enumeration of female heads of households for both years would have been preferred, 1980 data are used for lack of a better alternative.

The price variable in the paid participation equation is an average price per county. The average price is then deflated by the regional CPI for Food Away From Home. The average price per county had to be calculated, the calculations are detailed in Appendix V.

With respect to the variables specified, the behavior of the free and reduced participants is expected to be similar. The signs on the coefficients are hypothesized to be the same for the explanatory variables in the two equations, though the magnitudes of the coefficients are expected to differ. Free and reduced participants have two important similarities. They must apply to obtain subsidized meals and they are located at the lower end of the income distribution. For

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[2]The variables are defined with the use of 1980 census data, some of which is reported in the New York State Statistical Yearbook. The percent in urban areas is listed by county in the 1980 Census of Population, Characteristics of New York State, Section A, Table 3, Population of Counties by Urban and Rural Residence: 1980 and 1970, p. 34-9. The education variable is detailed in the 1980 Census of Population, Characteristics of New York State, Section C, Section 2, Table 175, Educational Characteristics for Counties: 1980, pp. 34-949 - 34-954. The percent of female headed households is from the New York State Statistical Yearbook, 1985-86, Table A-10, Households, Families and Persons in Group Quarters New York State by County - 1980, p. 16. The percent black is also from the New York State Statistical Yearbook, 1985-86, Table A-7, Population by Race and Spanish Origin New York State by County - 1980, p. 13.

[3]During these years, the number of female headed households in the U.S. increased. According to the Statistical Abstract of the United States 1986, Bureau of the Census, Table 56, Households, by Selected Characteristics of Householder: 1970 to 1984, p. 40, 25.4% of households were female headed in 1979 and 28.8% in 1981. These percents translate to 19,943,400 female headed households in 1979 and 23,731,200 in 1981.

these reasons the direction of the relationship between the dependent and independent variables is expected to be the same in the two equations. The magnitudes of the coefficients in the free equation are expected to be greater for variables such as number eligible, income, unemployment rate, percent female head of household, and percent black. Free lunch participants comprise the lowest part of the income distribution and their response to these socio-economic variables is expected to be greater.

Different behavior is hypothesized with respect to the explanatory variables in the paid lunch category. Paid students are expected to react differently for the same reasons the free and reduced participants react similarly; paid students are in the mid to upper portion of the income distribution and they do not need to apply for meals.

Because of their similarities, the hypothesized relationships between the dependent and independent variables in the model for the free and reduced equations are discussed together. Following this discussion, a thorough treatment of the hypothesized relationships in the paid equation will highlight the expected behavioral differences.

B. The Free and Reduced Participation Equations

The expected signs of the coefficients in the free and reduced equations are illustrated in Table 5.1.

TABLE 5.1 -- The Explanatory Variables in the Free and Reduced Equations and the Expected Signs of their Coefficients.

Explanatory Variable	Expected Sign of the Coefficient
Number eligible	+
Deflated income per capita	-
Percent urban	-
Unemployment rate	+
Percent female householder	+
Percent black	+
Percent college	-

The number eligible will have a positive effect on the number of participants. This relationship is expected to be almost one-to-one in the free equation. The coefficient on the number eligible will represent the change in the number participating with respect to a change in the number eligible. Possible reasons not to participate for free and reduced eligibles include: the stigma of government assistance, ignorance regarding program characteristics or eligibility requirements, intimidation by the application procedure, or displeasure with the lunch provided. The magnitude of the coefficient on number eligible should be larger in the free than the reduced equation. As

pointed out in Section Four, the transaction costs are the same for free and reduced participants, but, the benefits are greater in the free category.

Income will not only affect student eligibility, it will also play a role in the decision of the individual to have a meal, or choose another alternative. An increase in income that does not affect the student's eligibility may allow the student some discretion in choosing the meal. A decrease in income may have the opposite effect, precluding a student from choosing between a school lunch and some other option. Therefore, a negative coefficient is expected on income in the free and reduced equations, and the coefficient should be larger in the free participation equation due to the lower income status of the participants.

In urban areas there are more lunch options available to students such as eating out or going home for lunch. As a result, a negative relationship between percent urban and lunch participation is hypothesized.

Unemployment rate, percent female householder, and percent black will each have a unique relationship with participation. However, all three of these variables will reflect differences in a county's income distribution that are not specifically captured by the income per capita variable. The unemployment rate is one measure of the economic health of a county. In addition, because female headed and black households tend to be at the very lowest end of the income distribution, a high percentage of female headed households or blacks in a county will indicate a more serious degree of poverty. A positive relationship with free and reduced lunch participation is hypothesized for each of these variables and the magnitudes of the coefficients should be greater in the free equation because free participants comprise the lowest portion of the income distribution.

There are other sociological aspects to consider when analyzing the relationship of participation to the employment, female householder, and race variables. The unemployment rate may reflect welfare stigma. Families in an environment with a high unemployment rate may feel less stigmatized when receiving government assistance. Female heads of households may be working mothers, with less time to engage in activities such as preparing a lunch from home. If blacks reside in urban, racially-segregated neighborhoods, they may face higher prices for food and other goods which would make participation in the lunch program more attractive.

A negative relationship is expected between the percent completed college and free and reduced lunch participation. Life-cycle theories of consumption indicate individuals consume according to what would be considered "permanent income." Individuals with college degrees, on average, have a higher earning potential than those without college degrees. A family with at least one college-educated wage earner may be eligible to receive free or reduced lunches, but, they may be more likely to view their current financial situation as temporary and so, may be hesitant to apply for free and reduced meals. Additionally, more

highly educated parents may believe they are more capable of providing a nutritious meal than available from the school lunch program.

C. The Paid Participation Equation

Table 5.2 presents the explanatory variables and the expected signs of their coefficients for the paid equation. Included are the free and reduced hypothesized relationships for purposes of comparison.

TABLE 5.2 -- Explanatory Variables in the Paid Equation and the Expected Signs of their Coefficients.

Explanatory Variable	Expected Sign of the Coefficient	
	Paid	Free and Reduced
Number Eligible	+	+
Deflated income per capita	?	-
Percent urban	-	-
Unemployment rate	-	+
Percent female householder	-	+
Percent black	-	+
Percent college	-	-
Deflated price	-	NA

The signs on the coefficients of the variables, number eligible, percent urban, and percent college, should be the same in the paid equation as in the free and reduced equations. Their expected signs do not depend on aspects of the income distribution. Where positive coefficients are hypothesized in the free and reduced equations for those variables describing the income distribution of a county, unemployment rate, percent female householder, and percent black, negative relationships are hypothesized in the paid equation.

The expected sign on the income coefficient in the paid equation is not completely clear. An increase in income may allow a student to afford a full price school lunch when they could not previously. Conversely, an increase in income may give the student the option of purchasing some other more attractive lunch. Price is expected to have a negative relationship with paid participation.

The magnitude of the coefficient on number eligible is expected to be smaller in the paid equation than in the free equation. Comparing reduced and paid participation models, it is not clear which equation will have a larger coefficient on the number eligible variable. Though reduced lunch participants pay a lower price for their meals, the transaction costs involved in obtaining a reduced meal make it less attractive.

D. DESCRIPTIVE STATISTICS OF THE VARIABLES

Table 5.3 lists the descriptive statistics for the variables.

TABLE 5.3 -- Descriptive Statistics of the Variables.

VARIABLE	YR	MEAN	STD. DEV.	MIN	MAX
ADP, Free	'79	4571	7142	250	41909
	'81	4282	6372	165	36794
ADP, Reduced	'79	1120	1398	94	8301
	'81	882	1141	106	6863
ADP, Paid	'79	9912	13209	458	71627
	'81	7585	10307	439	59627
Free eligibles	'79	5491	7194	249	34456
	'81	5806	7613	233	41099
Reduced eligibles	'79	5771	7732	241	42806
	'81	4230	5550	165	30099
Paid eligibles	'79	26454	45656	447	224089
	'81	25176	43079	433	210007
Deflated income per capita	'79	6202	1275	4691	11003
	'81	6174	1393	4611	11508
Percent urban	'80	45.07%	26.14%	0.0%	99.7%
Unemployment rate	'79	6.96%	1.80%	4.4%	12.8%
	'81	7.96%	1.94%	4.7%	13.2%
Percent female householder	'80	.119	.019	.073	.167
Percent black	'80	.027	.029	0.0	.121
Percent college	'80	14.6%	5.11%	8.4%	36.3%
Deflated lunch price	'79	$.449	$.063	$.255	$.608
	'81	$.535	$.065	$.304	$.671

E. Tests of Structural Change

The factors believed to be important determinants of lunch participation have been identified and discussed. The second objective outlined at the beginning of this section will now be addressed, did structural change occur between the years under study, 1979 to 1981? Evidence of structural change will indicate that the way in which participants respond to the independent variables has changed between the two time periods. The issue of structural change must be addressed at this point because the result will influence the statistical model used for the final regression analysis of the participation equations.

The data under study is a pooled time-series, cross-section. The time-series is 1979 and 1981, the cross-section is across counties. There are different matrix models for pooled time-series, cross-section data that will be appropriate for the regression analysis depending on whether structural change has occurred. Johnston (1984) outlines three possible models for pooled time-series, cross-section data and details the tests of structural change that will determine the correct model for analysis. The three models are illustrated below:

MODEL I:

$$\begin{bmatrix} Y_1 \\ \\ Y_2 \end{bmatrix} = \begin{bmatrix} i_1 & X_1 \\ \\ i_2 & X_2 \end{bmatrix} \begin{bmatrix} a \\ \\ B \end{bmatrix} + u$$

common regression for both periods

MODEL II:

$$\begin{bmatrix} Y_1 \\ \\ Y_2 \end{bmatrix} = \begin{bmatrix} i_1 & 0 & X_1 \\ \\ 0 & i_2 & X_2 \end{bmatrix} \begin{bmatrix} a_1 \\ a_2 \\ B \end{bmatrix} + u$$

differential intercepts, common slope

MODEL III

$$\begin{bmatrix} Y_1 \\ \\ Y_2 \end{bmatrix} = \begin{bmatrix} i_1 & X_1 & 0 & 0 \\ \\ 0 & 0 & i_2 & X_2 \end{bmatrix} \begin{bmatrix} a_1 \\ B_1 \\ a_2 \\ B_2 \end{bmatrix} + u$$

differential intercepts, differential slopes

The matrix notation:

Y_1 = The dependent variable in 1979
Y_2 = The dependent variable in 1981

i_1 = The intercept term in 1979
i_2 = The intercept term in 1981

X_1 = The explanatory variables in 1979
X_2 = The explanatory variables in 1981

a = The coefficient on the intercept term
a_1 = The coefficient on the intercept term in 1979
a_2 = The coefficient on the intercept term in 1981

B = The coefficients on the explanatory variables
B_1 = The coefficients on the explanatory variables in 1979
B_2 = The coefficients on the explanatory variables in 1981

u = The error term

To determine if structural change has occurred, the three models are estimated and then statistically tested against each other. The lunch categories, free, reduced, and paid, are estimated using the three different models. The models are then tested to determine if, in fact, there has been structural change. The tests performed are listed below:

1) Model I against Model II tests for differential intercepts in the two years. The test statistic is:

$$F = \frac{RSS1 - RSS2}{RSS2/(n - k - 1)} \sim F(1, n - k - 1)$$

2) Model II against Model III tests for differential slope coefficients in the two years. The test statistic is:

$$F = \frac{(RSS2 - RSS3)/(k - 1)}{RSS3/(n - 2k)} \sim F(k - 1, n - 2k)$$

3) Model I against Model III tests for differential regressions, slopes and intercepts. The test statistic is:

$$F = \frac{(RSS1 - RSS3)/k}{RSS3/(n - 2k)} \sim F(k, n - 2k)$$

Notation:

RSS1 = Residual sum of squares, Model I
RSS2 = Residual sum of squares, Model II
RSS3 = Residual sum of squares, Model III

n = The number of observations

k = The number of explanatory variables

As a result of the tests, Model III was selected for final analysis. The actual tests for the free, reduced, and paid equations are calculated in Appendix VI. There is evidence of structural change for all three of the lunch categories. Model III is the most

unrestricted of the possible models, allowing both intercepts and slopes to vary with the different years.[4]

F. RESULTS

The regression results reported for the participation equations in this section are from estimations using Model III. The results vary for each of the three lunch categories. The free, reduced and paid equations are presented in tabular form; coefficients are discussed and compared.

The regression results for the participation equations are listed in Table 5.4 on the following page. Six of the coefficients in the free equation are significant at better than the 5% level, these are number eligible, income per capita, and percent black in the years 1979 and 1981. All of the coefficients, except percent college in 1981, have the expected sign. The percent college coefficient is positive in 1981 and a negative sign was anticipated.

In the reduced equation, five of the coefficients are statistically significant at the 5% level: number eligible and deflated income per capita in both years, and percent black in 1979. Percent urban and percent college are significant at the 10% level in 1979. Three of the coefficients do not have the expected sign, percent urban in both years and unemployment rate in 1979. The percent urban coefficients are positive; negative coefficients were hypothesized. The coefficient on the unemployment variable in 1979 is negative when a positive sign was anticipated.

Six of the coefficients in the paid equation are significant at 5%, these include: number eligible and income per capita in both years, unemployment rate in 1979, and percent urban in 1981. Another five of the coefficients are significant at 10%: percent urban, percent black and percent college in 1979, unemployment rate and percent female head of household in 1981.

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[4]For a more complete discussion of pooled time-series, cross-section data, the models, and the subsequent testing see Johnston, J. Econometric Methods, 3rd ed. New York: McGraw Hill Book Company, 1984, pp. 207-225.

Table 5.4 - Regression Results for Free, Reduced, and Paid Lunch Participation Equations

EXPLANATORY VARIABLE	FREE	REDUCED	PAID
Constant, 1979	4,948.00	3,189.00	26,904.00
	(1.62)	(3.63)	(5.06)
Number eligible, 1979	1.02	0.18	0.31
	(22.61)*	(15.37)*	(25.20)*
Income per capita, 1979	-1.14	-0.54	-3.07
	(-3.40)*	(-5.57)*	(-5.08)*
Unemployment rate, 1979	49.57	-25.20	-673.00
	(0.36)	(-0.64)	(-2.90)*
Percent urban, 1979	-3.08	10.25	56.03
	-(0.17)	(1.94)+	(1.90)+
Percent female household, 1979	1,654.00	1,043.00	6,809.00
	(0.09)	(0.21)	(0.23)
Percent black, 1979	29,517.00	9,022.00	35,534.00
	(2.13)*	(2.35)*	(1.66)+
Percent college, 1979	-6.17	-27.90	-150.00
	(-0.12)	(-1.83)+	(-1.77)+
Paid lunch price, 1979			-8,042.00
			(-1.15)
Constant, 1981	-344.00	1,211.00	25,794.00
	(-0.11)	(1.30)	(4.15)
Number eligible, 1981	.81	0.21	0.25
	(20.37)*	(13.35)*	(19.65)*
Income per capita, 1981	-0.86	-0.30	-2.22
	(-2.76)*	(-3.34)*	(-4.30)*
Unemployment rate, 1981	128.40	20.89	-442.00
	(0.90)	(0.51)	(-1.84)+
Percent urban, 1981	-10.00	3.37	70.82
	(-0.53)	(0.63)	(2.44)*
Percent female household, 1981	29,344.00	2,350.00	-58,390.00
	(1.56)	(0.43)	(-1.93)+
Percent black, 1981	33,081.00	4,811.00	28,007.00
	(2.43)*	(1.23)	(1.32)
Percent college, 1981	15.49	-7.71	-105.00
	(0.79)	(-0.47)	(-1.14)
Paid lunch price, 1981			-5,266.00
			(-0.94)

* Indicates a t-statistic significant at 5%.
+ Indicates a t-statistic significant at 10%.
Adjusted R-squared: Free=.952, Reduced=.89, Paid=.96

There are some interesting results in the signs of the coefficients in the paid equation. Income per capita is negative in both 1979 and 1981, it was not clear previously that income would have a negative relationship with paid participation. This result is especially important because it indicates that school lunches are considered an inferior good by paid participants.

Similar to the reduced equation, percent urban has positive coefficients in the paid equation. It was only in the free equation that percent urban displayed the hypothesized negative relationship with participation. It was hypothesized that with more choices available in urban areas, participation would be negatively affected. The explanation for the positive relationships in the reduced and paid equations is not immediately obvious. One possibility is that in highly urban, central city areas, schools may be more likely to have a closed campus policy which would limit the choices available to students purchasing lunch in the reduced and paid categories.

As expected, the coefficients on unemployment rate and percent female head of household were negative in the paid equation, changing signs from the positive coefficients found in the free and reduced equations. However, the expected change in the coefficient on percent black from positive in free and reduced to negative in the paid equation, did not occur. This indicates that blacks may reside in urban, racially-segregated neighborhoods and face higher prices for food and other goods, making school lunches a more attractive alternative.

Price does have the expected negative sign in both years for paid lunches, but the coefficients are not significant in either year. However, the price effect is composed of both the substitution and the income effect. For a normal good, the direction of these effects reinforce each other, but, for inferior goods, the income effect moderates the substitution effect. School lunches are an inferior good. Using Slutsky's equation it is possible to separate the income from the substitution effect and define the compensated price effect. The calculations and t-statistics for the compensated price effects are outlined in Appendix VII. The compensated price coefficients are significant at 1% in 1979 and 1981.

G. Elasticities

The price elasticity of participation was computed for paid prices in 1979 and 1981. The elasticities calculated are comparable to those found in previous studies discussed in the literature review in Section Three. In 1979, at an average deflated price of $.449 and average participation of 9912, the elasticity is -.364. In 1981, at an average deflated price of $.535 and average participation of 7585, the elasticity is -.37. It is interesting that though price and participation changed from 1979 to 1981, the elasticities are almost identical.

To further examine this result, the calculation of the elasticities are broken down into two major components:

(price)/(participation) X (change in participation)/(change in price). The ratio of price to participation changed from $.449/9912 = .000045299 in 1979 to $.535/7585 = .000070534 in 1981. The ratio of change in participation to change in price must then have changed in a manner which would allow the multiplication of the two ratios to have the same result in both years. The ratio of change is the coefficient on the price variable and represents the response of participants to a price change or the slope of the line which measures the relationship. The response of participants changed by just the right amount to keep the price elasticity of participation in the -.36-.37 range. The coefficient on the price variable adjusted from -8042 in 1979, to -5266 in 1981.

Income elasticities were also computed for each of the lunch categories in 1979 and 1981. Table 5.5 lists these elasticities.

TABLE 5.5 -- Income Elasticities for Free, Reduced and Paid Lunches in 1979 and 1981.

	YR	AVE PARTICIPATION	ELASTICITY
Free Lunches	'79	4572	-1.55
	'81	4282	-1.24
Reduced Lunches	'79	1120	-2.98
	'81	882	-2.09
Paid Lunches	'79	9912	-1.92
	'81	7585	-1.81

(Average deflated income per capita was 6202 in 1979 and 6174 in 1981.)

The negative signs on the elasticities indicate that school lunches are an inferior good; as income goes up, consumption goes down. All of the elasticities are greater than one, this means that an increase in income will cause a proportionately larger decline in participation. The most elastic responses are in the reduced category. This is a reasonable result considering these students are not as needy as free lunch recipients and yet they must apply for reduced status. With an increase in income these individuals may choose not to become involved in the application procedure at all.

H. Testing Number Eligible Coefficient Vs. One

In all of the equations, the t-statistics on number eligible indicate coefficients significantly different from zero. If every student eligible for a lunch participated, the coefficient on number eligible would be one. Therefore, the coefficients on number eligible in each of the equations are tested to determine if they are

significantly different from one. This is a simple procedure, the test statistic is:

$$t = \frac{\text{coefficient} - 1}{\text{standard error of the coefficient}}.$$

The only number eligible coefficient not significantly different from one at 5% is the 1979 coefficient in the free participation equation. These tests are calculated in Appendix VIII.

I. Testing Differences in Magnitudes of Coefficients

The coefficients on the variables, number eligible, income per capita, unemployment rate, percent female householder, and percent black were expected to be larger in magnitude in the free equation than the reduced equation. The results verify this hypothesis, the coefficients on the variables are larger in magnitude in the free equation.

To test the difference in the magnitudes of the coefficients statistically, a procedure outlined for comparing regression coefficients from different populations in James (1951) is used. The hypothesis is stated:

(1) H_o: $b^1 = b^2$.

The test statistic is:

(2) $h = \Sigma w_i (b^i)^2 - (\Sigma w_i b^i)^2 / w$,

distributed Chi Square with n-1 degrees of freedom, where n equals the number of coefficients being compared. If h is greater than the critical value, H_o is rejected. The following are defined:

(3) $w_i = \frac{1}{\text{var}(b^i)}$

(4) $w = \Sigma w_i$.

According to these tests, the 1979 and 1981 coefficients on number eligible, income per capita, and percent black are significantly different at 5% in the free and reduced equations. The null hypothesis that the coefficients are equal is not rejected for unemployment rate and percent female householder. This is not surprising given that these coefficients are not significantly different from zero in their respective equations. The actual calculations for the tests are presented in Appendix IX.

In addition to comparing free and reduced coefficients, the paid coefficients on number eligible are compared with free and reduced coefficients. The magnitudes of the coefficients for number eligible

are smaller in the paid equation than in the free equation, as anticipated. Prior to estimation, it was not obvious whether the number eligible coefficients would be larger in the paid or reduced equations. They are larger in the paid equation. This highlights the fact that many of the students eligible for reduced lunches do not apply for lunches, or apply, but do not participate in the program.

Number eligible coefficients are tested for significant differences in the free versus paid, and reduced versus paid equations. The coefficients are found significantly different at 5% in 1979 and 1981, when comparing the free and paid, and the reduced and paid coefficients. The tests are detailed in Appendix XI, following the tests performed comparing the free and reduced equations.

In Section Six, changes in program effects are isolated to identify the impact of OBRA on participation.

VI. ANALYSIS OF RESULTS

The equations estimated in Section Five indicate the factors significantly affecting lunch participation. The equations, by themselves, do not address the major purpose of this study, to determine the impact of the 1980 and 1981 Omnibus Budget Reconciliation Acts on lunch participation in New York State. Participation in all three lunch categories declined in New York State between 1979 and 1981. Did OBRA make a difference and, if so, how much? In this section the estimated participation equations are used as tools to define and measure the effects of OBRA.

School lunch participation is affected by a number of different factors: economic conditions, demographics, participant behavior, and OBRA legislation. In order to measure the effects due to OBRA, all of these factors must be isolated in the equations. This objective is accomplished in two different ways. First, the regression equations are used to simulate participation when controlled changes are made in variables. This method allows the identification of program (OBRA), demographic, and economic effects, but, not behavioral changes. To identify these behavioral effects, an approximation to the total differential of the equations is computed. This approach separates changes that occurred in the behavior of participants (the coefficients of the equations) from changes in variables.

A. Simulations

In the first method, the regression equations simulate school lunch participation using hypothetical "what if" situations. For example: what if enrollments in 1981 had been at the 1979 level, or, what if 1979 income criteria had been in place in 1981? These simulations identify the individual effect of changes in specific variables from 1979 to 1981.

In order to isolate the effects of OBRA from demographic and economic factors, four relevant questions are posed: 1) what is the effect on participation of the decline in enrollments from 1979 to 1981? 2) what is the effect on participation of the OBRA change in income criteria from 1979 to 1981? 3) what is the effect on participation of the change in economic conditions from 1979 to 1981? and, for the paid equation, 4) what is the effect on participation of the change in lunch prices from 1979 to 1981?

Using 1981 as the base year, 1979 variable levels for enrollments, income criteria, economic conditions, and paid price are substituted into the equations. Subtracting the hypothetical equation from the original equation identifies the impact on participation of the specific variable change:

$$(1) \quad (Y_o - Y_h) = (a + BX_o) - (a + BX_h).$$

Y_o = actual participation
Y_h = hypothetical participation

$a + BX_o$ = equation with original variable
$a + BX_h$ = equation with hypothetical variable.

Due to the definition of some of the variables, prior calculation and estimation is required for the simulation of 1979 enrollments, income criteria, and economic conditions.

Recall that enrollments do not appear as a direct variable in the participation equations but, are incorporated into the number eligible variable. In order to determine the number eligible in a lunch category, the poverty rate is multiplied by enrollments. In the hypothetical model, 1979 enrollments are multiplied by 1981 poverty rates to simulate no drop in enrollments in 1981.

As with enrollments, income criteria are not separate variables in the model, but, are part of the calculation of the number eligible. The income criteria in 1981 are defined by the poverty rates predicted in the logit procedure, they are then multiplied by enrollments to yield the number eligible. To examine participation in 1981 with 1979 income criteria, the poverty rates for 1981 have to be re-estimated with logit using 1979 income guidelines. To estimate using 1979 income criteria, a different poverty rate is specified as the dependent variable. In the free poverty rate estimation, the dependent variable is 125% of the official poverty line rather than 130%. The dependent variable in the reduced estimation is 125-195% of the official poverty line rather than 130-185%. The independent variables and the logit procedures used for estimation and prediction are identical to those outlined in Section Four. The paid poverty rate is then determined by totalling the free and reduced poverty rates and subtracting them from one. Once the new poverty rates are obtained, they are multiplied by 1981 enrollments and inserted into the hypothetical participation equation.

Economic conditions are reflected in the participation equations in two ways. The variables, deflated income per capita and unemployment rate are indicators of economic conditions. In addition, the number eligible is a function of these same economic indicators. The poverty rates that define the number eligible are estimated in the logit procedure as a function of deflated income per capita, unemployment rate, and rural versus urban. Because of the relationship between the number eligible and economic conditions, the poverty rates in 1981 are calculated using 1979 economic conditions. The equations do not need to be re-estimated, the existing equation parameters are used to predict 1981 poverty rates with 1979 variables for deflated income per capita and unemployment rate. In the hypothetical equations, the new poverty rates are multiplied by 1981 enrollments and 1979 values for deflated income per capita and unemployment rate are substituted for 1981 values.

Questions (1), (2), and (3) are evaluated for each of the lunch categories, and question (4) is evaluated for the paid category using the coefficients from the estimations reported in Section Five and the mean value of the variables. The results of these calculations are

illustrated in Table 6.1. The numbers represent the change in 1981 daily participation on average for a county. The percentage of 1981 mean participation is included to describe the magnitude of the effects.

The results are not surprising, +'s indicate that participation is higher, -'s indicate that participation is lower. All of the lunch categories have the same reaction to the drop in enrollments from 1979 to 1981, the effect of fewer enrollments decreases participation in 1981. As a percentage of mean participation, the average effects are larger in the free and reduced categories at -10% and -9%, respectively, with paid at -5.4%.

The change in income criteria affected the lunch categories differently. Because OBRA expanded the free lunch income guideline from 125% of the poverty line to 130%, the change increases free lunch participation in 1981. The opposite occurs with reduced lunch participation, OBRA contracted the income guidelines from 125-195% of the poverty line to 130-185% of the poverty line. This contraction decreases reduced lunch participation in 1981. The paid lunch income criteria extended from 195% of the poverty line in 1979. Because of the change in the reduced lunch criteria, the paid lunch criteria extends from 185% of the poverty line in 1981. This indirect expansion of the income criteria for paid lunches has a positive effect on participation in 1981. The largest average effect is in the reduced category where

TABLE 6.1 -- Average Change in 1981 Daily Participation per County and the Percentage of 1981 Mean Participation.*

Change in 1981 Participation			% of 1981 Mean Participation		
Free	Reduced	Paid	Free	Reduced	Paid
(1) Drop in Enrollments:					
-422	-80	-407	-10%	-9%	-5.4%
(2) Legislated Changes in Income Criteria (OBRA):					
+565	-312	+196	+13%	-35%	+2.6%
(3) Decline in Economic Conditions:					
+376	+59	-469	+9%	+6.7%	-6.2%
(4) Increase in Paid Price:					
-453					-6%

*The calculation of these figures is in Appendix X. (Average daily participation per county in 1981 is 4282, 882, and 7585 for free, reduced and paid, respectively.)

the decrease represents -35% of mean participation; this is a substantial impact. The average increases in free and paid participation are +13% and +2.6% of mean participation, respectively. Overall, the net effect on participation of OBRA income criteria changes is +449, +3.5% of total participation in 1981.

The declining economic situation increases free and reduced participation and decreases paid participation in 1981. As a percentage of mean participation, the average effect is largest in the free category at +9%, with reduced and paid at approximately the same magnitude, between -6% and +7%.

The increase in paid price decreases paid participation in 1981. The average effect as a percentage of mean participation is -6%. In general, though the magnitudes of the absolute figures are sizable, the average effects as a percentage of mean participation in the paid category are smaller than those for free and reduced.

Interesting results are obtained by comparing the magnitude of the effects from different factors on a specific lunch category. For example, declining enrollments is occasionally cited as the cause of the overall decrease in lunch participation in 1981. But, though declining enrollments decrease lunch participation, it is not the critical factor in any of the lunch categories. The average increase in free participation due to the OBRA change in income criteria, +565, and declining economic conditions, +376, outweigh the effect of the drop in enrollments, -422. The overall decrease in free lunch participation must be explained by more than the drop in enrollments. In the reduced category, declining enrollments, -80, and economic conditions, +59, have relatively small effects on participation when compared to the huge average decrease attributed to the OBRA change in income criteria, -312. For paid lunch participation, the effect of the OBRA change in income criteria is relatively small, +196. But, the drop in enrollments, -407, does not have a larger effect than the average decrease due to declining economic conditions, -469, or the higher lunch price, -453.

This analysis is very valuable as a method of identifying the effects on participation of specific factors. It is limited because a base year must be chosen to complete the comparisons and, therefore, the difference in the behavior of participants in response to the variables is not analyzed. The structural change in the behavior of participants is reflected in the different coefficients for variables in 1979 and 1981. In the following section, by approximating a total differential analysis of the equations, the behavioral effects are identified.

B. Approximation to the Total Differential

In the simulation, behavior is held constant, 1981 coefficients are used. In the total differential approximation, coefficients and variables are allowed to vary. It is evident from the tests of structural change in Section Five that participant behavior did change during the period under study. This second analysis identifies the important behavioral differences.

By approximating the total differential of the equations, differences in participation between 1979 and 1981 are attributed to their two sources within the estimation technique: differences in coefficients (behavioral) and differences in variable levels (economic, demographic, program). A general form for a linear equation can be expressed:

(1) $Y = g + rx,$

where, g and r can be viewed as reflecting behavior, while x represents the variable level. The total differential of this equation is:

(2) $dY = \frac{\partial Y}{\partial g}(dg) + \frac{\partial Y}{\partial r}(dr) + \frac{\partial Y}{\partial x}(dx).$

Suppose the equations representing 1979 and 1981 are expressed:

(3) $Y^{79} = a^{79} + c_i^{79}x_i^{79}$

(4) $Y^{81} = a^{81} + c_i^{81}x_i^{81},$

where, Y is the dependent variable, a is the intercept term, c_i is a coefficient, and x_i is an independent variable. To explain the difference between participation in 1979 and 1981, the components of (3) and (4) are defined according to the total differential in equation (2):

(5) $dY = Y^{81} - Y^{79},$

(6) $\frac{\partial Y}{\partial g} = 1,$

(7) $dg = a^{81} - a^{79},$

(8) $\frac{\partial Y}{\partial r} = x^{81}$

(9) $dr = c^{81} - c^{79},$

(10) $\frac{\partial Y}{\partial x} = c^{81}$

(11) $dx = x^{81} - x^{79}.$

An approximation to the total differential then becomes:

(12) $Y^{81}-Y^{79} = (a^{81}-a^{79})+x^{81}(c^{81}-c^{79})+c^{81}(x^{81}-x^{79}).$

The first two terms on the right-hand-side of equation (12) represent behavioral effects and, the third term represents variable level effects.

An adjustment is made to equation (12) to account for the use of 1981 as a base year. Note that in equation (5) dY is defined by

$Y^{81}-Y^{79}$. This implies a base year of 1981 and therefore, equation (8) equals x^{81}, and equation (10) equals c^{81}. If dY were defined as $Y^{79}-Y^{81}$ then equation (8) would equal x^{79}, and equation (10) would equal c^{79}. The adjustment for this bias is to take the average of the two years. Using the average, equation (8) becomes:

$$(13)\quad \frac{\partial Y}{\partial r} = \frac{(x^{81} + x^{79})}{2},$$

and equation (10) becomes:

$$(14)\quad \frac{\partial Y}{\partial x} = \frac{(c^{81} + c^{79})}{2}.$$

These averages are replaced into equation (12) to yield:

$$(15)\quad Y^{81}-Y^{79}=(a^{81}-a^{79})+\frac{(x^{81}+x^{79})}{2}(c^{81}-c^{79}) + \frac{(c^{81}+c^{79})}{2}(x^{81}-x^{79}).$$

Table 6.2 on the following page, illustrates the total differential breakdown for each of the lunch categories. All of the variables are evaluated at their mean for the calculations. The figures represent differences in daily participation between 1979 and 1981 on average in a county.

It is instructive to examine each of the lunch categories individually, then to compare them. In the free lunch category all of the variable changes increase average participation. Deflated income per capita and unemployment rate contribute to the increase, but, the majority of the increase is attributed to the change in the number eligible. The subtotal for variable differences is +406, and the number eligible variable is credited with +289 of the increase.

Examining behavioral differences in the free category reveals a huge average decrease in participation attributed to the change in the intercept term, -5293. The change in the behavior of the number eligible decreases average participation by a large amount, -1152. Percent urban has a smaller negative effect of -311.

Substantial increases in free participation are attributed to behavioral effects from income per capita and percent female head of household, +1764 and +3295, respectively. The other positive behavioral effects include unemployment rate, percent black, and percent college. The negative effects of the intercept term and the number eligible outweigh the large positive effects of income per capita and percent female head of household. The subtotal for behavioral effects in the free equation is -696.

TABLE 6.2 -- Results of an Approximation to the Total Differential: Average Variable and Behavioral Differences between 1979 and 1981 per County.*

	Free	Reduced	Paid
Y(81) - Y(79) [Actual]	-289	-238	-2327
VARIABLE LEVEL DIFFERENCES:**			
Number eligible	289	-299	-361
Deflated income per capita	28	12	74
Unemployment rate	89	-2	-558
Deflated paid price			-572
SUBTOTAL	406	-289	-1417
BEHAVIORAL DIFFERENCES [Coefficients]:			
Intercepts	-5293	-1978	-1110
Number eligible	-1152	175	-1471
Deflated income per capita	1764	1485	5260
Percent urban	-311	-310	666
Unemployment rate	588	344	1723
Percent female household	3295	156	-7759
Percent black	96	-114	-203
Percent college	317	296	669
Deflated paid price			1366
SUBTOTAL	-696	54	-859
TOTAL	-290	-235	-2276

*The calculation of these figures is presented in Appendix XI.
**Note that the variable levels do not change for the variables, percent urban, percent female householder, percent black, and percent college; 1980 data is used in both years. As a result, $x^{81} - x^{79} = 0$, and the terms drop out of the differential.

It appears that these negative behavioral effects explain the overall decrease in free participation in 1981. When the two subtotals are added, the negative behavioral effects are greater than the positive variable effects resulting in a total average decrease of -290 for free lunches.

In the reduced category, the effects of variable differences from income per capita, +12, and unemployment rate, -2, are rather small. Most of the change is associated with the number eligible, -299. These variable differences subtotal to an average decrease in reduced participation of -289.

Examining the behavioral differences, there is a large decrease in average reduced participation attributed to the change in intercept terms, -1978. Other behavioral differences negatively affecting reduced participation are percent urban and percent black. Offsetting the negative behavioral differences is the large positive behavioral effect from income per capita, +1485. The positive effect from income per capita combined with the positive behavioral effects of number eligible, unemployment rate, percent female householder, and percent college slightly outweigh the negative behavioral effects. The result is an average increase in reduced participation due to behavioral differences of +54.

When variable and behavioral differences are totalled for reduced participation, the result is an average decrease of -235. However, unlike the free category, variable differences are attributed with decreasing participation, while, behavioral differences have a small positive contribution.

Variable differences for price, unemployment rate, and number eligible have sizable effects on average paid participation with decreases of -558, -572, and -361, respectively. Only deflated income per capita has a positive effect, the small average increase is +74. In the paid equation the subtotal for variable differences is -1417, a substantial average decrease.

There are a number of large effects, both positive and negative, attributed to behavioral differences in the paid category. The change in intercept terms accounts for an average decrease in participation of -1110. The behavioral differences attributed to the number eligible, percent female householder, and percent black are all negative. Though percent black has a relatively small effect on participation, -203, number eligible has a large effect, -1471, and percent female householder a very substantial effect, -7759. Positive behavioral differences are attributed to income per capita, percent urban, unemployment rate, percent college, and price. The economic variables, income per capita, unemployment rate, and price all have large behavioral differences with average increases in participation of +5260, +1723, and +1366, respectively. Despite these large positive effects, the subtotal of the behavioral differences for the paid equation yields an overall negative effect of -859.

In the paid category both variable and behavioral differences decrease participation. Variable differences make a larger contribution, -1417, to the total negative effect of -2276.

For all three equations it appears that the variable level difference in the number eligible is important. The paid equation also has large variable effects from price and unemployment rate. Important behavioral effects are evident in all three equations for the intercept term and income per capita. The number eligible and percent female householder have large effects in the free and reduced categories, while, price and unemployment rate are important in the paid category. It is not clear why unemployment rate is important in both variable and behavioral differences in the paid category and not in the free or reduced categories.

The total differential approximation allows the isolation of behavioral effects not possible in the simulations. There are notably large behavioral effects in all three lunch categories. Unfortunately, though the total differential identifies behavioral effects, it cannot identify the source of the change in behavior. For example, it is possible that the passage of OBRA instituted some structural change in the behavior of participants. The total differential approximation cannot confirm or deny such speculation, though it is important to recognize this possibility.

In the concluding section, a final picture of school lunch participation and the impact of OBRA is presented.

VII. CONCLUSION

A. Purpose of the Study

The 1980 and 1981 Omnibus Budget Reconciliation Acts (OBRA) substantially reduced funding for the National School Lunch Program. The major purpose of this study was to determine the effects of OBRA on school lunch participation in New York State. The difficulties in identifying the effects of OBRA derive from the simultaneous effects of other important factors on participation during the period under study. The effects of economic, demographic, and behavioral changes must be isolated in order to measure program (OBRA) effects. The factors significantly affecting lunch participation are identified, evidence of structural (behavioral) change is tested, and program effects are distinguished from demographic, economic and behavioral effects.

B. The Participation Model and Results

Three linear equations are specified, one for each of the lunch categories with participation (the number of participants) as the dependent variable. Explanatory variables are chosen by application of economic theory and suggestions from previous research, they include: number eligible, income per capita, unemployment rate, urbanization, race, female head of household, education, and price in the paid category.

Specifying the number of participants rather than a participation rate as the dependent variable is an important departure from some of the previous research. This specification allows the separation of factors affecting eligibility (legislation, economic conditions, enrollments) from factors affecting lunch participation (student, family, school, and program characteristics). A complete analysis of the effect of OBRA income criteria changes on lunch participation is possible using this specification, because the relationship between the number eligible and participation is defined by including the number eligible as an explanatory variable.

A three-step estimation procedure is used to test for structural change. The application of that procedure indicates that the least restrictive model, which allows intercepts and coefficients to vary between 1979 and 1981, is appropriate for each lunch category. This suggests that the behavior of participants with respect to the explanatory variables changed during the period under study. The OLS regression results of this model are analyzed to identify the significant determinants of participation. The number eligible, income per capita and race are significant in the free, reduced, and paid equations. Additionally, education and urbanization are significant in the reduced equation, and, unemployment rate, urbanization, race, education, and female head of household are significant in the paid equation.

By modeling free, reduced, and paid lunch participation individually the behavior specific to each lunch category is revealed. This is especially interesting when examining the relationships between the number eligible and lunch participation. The effect of eligibility on participation is greatest in the free category, not an unexpected result. However, the effect of eligibility is greater for paid than reduced participants. The transaction costs (application procedure and welfare stigma) involved in obtaining a reduced meal do not outweigh the benefit of a lower priced meal for many of the potential participants. To increase the effect of eligibility on reduced participation, either price should be lowered or transaction costs decreased.

The paid lunch price elasticity of participation is inelastic at -.364 in 1979, and -.37 in 1981. The participation equations reveal that school lunches are an inferior good; the coefficient on income per capita is negative for all lunch categories. The income elasticities range from -1.24 for free lunches in 1981 to -2.98 for reduced lunches in 1979. School lunch status as an inferior good affects the relationship between price and participation in the paid equation. The income effect moderates the total price effect. As a result, price is not significant in the paid equation. When the substitution effect is isolated from the income effect, the compensated price effect is significant.

C. Identifying OBRA Effects

In New York State, participation in all three lunch categories declined from 1979 to 1981. To determine the effects of OBRA legislation on participation, the estimated regression equations are used as tools for policy analysis. Between 1979 and 1981, enrollments declined, the economy headed into a recession, and the behavior of participants changed. The effects of these factors on participation must be isolated from OBRA effects. Two methods are used to complete this analysis. First, simulations are performed with controlled changes in variables. Next, a total differential of the equations is approximated. The first method allows the isolation of demographic, economic and program (OBRA) effects. The second method separates behavioral from variable level effects.

The most striking example of OBRA's effect on lunch participation is in the reduced category where the simulation reveals that income eligibility changes are responsible for decreasing participation an average of -35%. This -35% decline in participation due to income criteria changes is a considerable effect on a low income student group. In addition, OBRA allowed reduced lunch prices to increase substantially in New York State during the period under study, from $.10 in 1979 to $.40 in 1981. This OBRA effect could not be captured in the analysis due to the lack of variation in the price variable across counties. Being able to include this variable could have indicated a more serious OBRA effect on reduced participation than is registered by the income criteria changes.

In the free category, the simulation analysis suggests that OBRA income criteria changes increased participation by +13% and that behavioral changes, identified in the total differential approximation, are responsible for decreasing participation. The total differential approximation indicates that free lunch participant behavior changed in response to certain variables, but, it does not identify why behavior changed. OBRA factors may be associated with these behavioral changes. The analyses do not take into account the more stringent application procedures legislated by OBRA or the possibility of increased welfare stigma associated with the controversy surrounding subsidized lunches at the time. These qualitative differences may have negatively influenced participant behavior in the free category.

According to the simulation, OBRA income criteria changes affected a small increase in paid lunch participation, +2.6%. A review of the simulation and total differential results indicate that a number of different factors are responsible for the decrease in paid lunch participation, including: higher price, declining enrollments and economic conditions, and behavioral changes. The decline in paid participation due to the higher price can be attributed to OBRA legislation to the extent that OBRA is responsible for raising paid prices by reducing the paid reimbursement rate. In addition, OBRA may be related to the decline in participation associated with the change in participant behavior.

Finally, an important consideration for all of the lunch categories is the mitigating effect of changes in school lunch regulations on the effects of OBRA legislation. The school lunch program switched to an offer vs. served method of providing meals. In addition, the method by which schools were reimbursed per meal changed from lesser of cost or reimbursement rate, to the legislated reimbursement rate. Both of these regulation changes represent methods of cost savings to school lunch programs that will moderate some of the negative effects of OBRA budget reductions.

Appendix I

Eligibility Criteria, Reimbursement Rates, and Funding*

*Source: Jones, J.Y. "School Lunch Program: Brief Description, History, and Data." Number 83-539 EPW, The Library of Congress, Congressional Research Service, Washington D.C., 1983, pp.6,7,11-14.

Poverty Guidelines and Income Eligibility for Free and Reduced-Price Lunches 1971-1984 (for a family of four)

	Poverty guidelines	Maximum income eligibility	
		Free	Reduced
1971- Jan.-June	$3,720	$3,720 (100%) a/	$3,720 (100%)
July 1971- June 1972	$3,940	$3,940 (100%) a/	$3,940 (100%)
July 1972- June 1973	$4,110	$4,110 (100%) b/ State option 125% = $5,140	$4,110 (100%) b/ State option 150% = $6,160
July 1973- June 1974	$4,250	$4,250 (100%) State option 125% = $5,310	$4,250 (100%) c/ State option 175% = $7,440
July 1974- June 1975	$4,510	$4,510 (100%) State option 125% = $5,640	$4,510 (100%) c/ State option 175% = $7,900
July 1975- June 1976	$5,010	$5,010 (100%) State option 125% = $6,260	$9,770 (195%) d/ begin Dec. 1975-
July 1976- June 1977	$5,700	$5,700 (100%) State option 125% = $7,130	$11,110 (195%)
July 1977- June 1978	$6,090	$6,090 (100%) State option 125% = $7,610	$11,880 (195%)
July 1978- June 1979	$6,490	$6,490 (100%) State option 125% = $8,110	$12,660 (195%)
July 1979- June 1980	$7,150	$8,940 (125%) e/	$13,940 (195%)
July 1980- Dec. 1980 f/	$8,200	$10,250 (125%)	$15,990 (195%)
Jan. 1981- August 1981 f/	$7,450	$10,270 (125%)	$15,490 (195%)
Sept. 1981- June 1982 g/	$8,450	$10,990 (130%)	$15,630 (185%)

Poverty Guidelines and Income Eligibility for
Free and Reduced-Price Lunches 1971-1984--Continued
(for a family of four)

	Poverty guidelines	Maximum income eligibility	
		Free	Reduced
July 1982-June 1983	$9,300	$12,090 (130%)	$17,210 (185%)
June 1983-June 1984	$9,900	$12,870 (130%)	$18,315 (185%)

a/ Priority for free meals determined on the basis of neediest children at discretion of the State.

b/ Beginning November, all children in families with incomes below the poverty guidelines were declared eligible for free and reduced-price meals. States could offer free meals to children from families with incomes up to 125 percent of guidelines, and reduced-price meals to children from families with incomes up to 150 percent of guidelines.

c/ States could offer reduced price meals to children from families with incomes below 175% of guidelines.

d/ Beginning December 1975, States required to offer reduced-price meals to children from families with incomes between 100 percent and 195 percent of guidelines, or 125 percent and 195 percent of guidelines if State chose to provide free meals to children from families with incomes up to 125 percent of guidelines.

e/ State required to set 125 percent of poverty guidelines as eligibility level for free lunches.

f/ Temporary change enacted under the Omnibus Budget Reconciliation Act of 1980 (P.L. 96-499). Provided for lower poverty guideline but allowed $960 annual standard deduction, which is included in the maximum income eligibility shown.

g/ Change enacted under the Omnibus Budget Reconciliation Act of 1981 (P.L. 97-35). Permanently lowered poverty guideline, eliminated standard deduction and changed free eligibility to 130 percent, and reduced price eligibility to 185 percent, of poverty guideline.

Source: Federal Register for appropriate years.

School Lunch Cash Reimbursement Rates, Calendar Years 1972-1984

1972

PAID	6 cents
REDUCED PRICE	+ 40 cents (i.e., 46 cents) less the highest charge for meals
FREE	+ 40 cents (i.e., 46 cents)

1973

PAID	8 cents
REDUCED PRICE	+ 40 cents (i.e., 48 cents) less the highest charge for meals
FREE	+ 40 cents (i.e., 48 cents)

1974 a/

	January - June	July - December
PAID	10 cents	11 cents
REDUCED PRICE	+ 35 (45) cents	+ 39.5 (50.5) cents
FREE	+ 45 (55) cents	+ 49.5 (60.5) cents

1975

	January - June	July - December
PAID	11.75 cents	12.25 cents
REDUCED PRICE	+ 42.5 (54.25) cents	+ 44.5 (56.75) cents
FREE	+ 52.5 (64.25) cents	+ 54.5 (66.75) cents

1976

	January - June	July - December
PAID	12.5 cents	13.0 cents
REDUCED PRICE	+ 46.75 (59.25) cents	+ 48.5 (61.5) cents
FREE	+ 56.75 (69.25) cents	+ 58.5 (71.5) cents

1977

	January - June	July - December
PAID	13.25 cents	14.0 cents
REDUCED PRICE	+ 50.0 (63.25) cents	+ 53.0 (67.0) cents
FREE	+ 60.0 (73.25) cents	+ 63.0 (77.0) cents

1978

	January - June	July - December
PAID	14.5 cents	15.25 cents
REDUCED PRICE	+ 55.0 (69.5) cents	+ 58.25 (73.5) cents
FREE	+ 65.0 (79.5) cents	+ 68.25 (83.5) cents

1979

	January - June	July - December
PAID	15.75 cents	17.0 cents
REDUCED PRICE b/	+ 51.50 (67.25) cents	+ 56.25 (73.25) cents
FREE	+ 71.50 (87.25) cents	+ 76.25 (93.25) cents

1980

	January - June	July - December
PAID	17.75 cents	18.50 cents
REDUCED PRICE	+ 59.50 (77.25) cents	+ 63.50 (82.0) cents
FREE	+ 79.50 (97.25) cents	+ 83.50 ($1.02) cents

School Lunch Cash Reimbursement Rates, Calendar Years 1972-1984
Continued

	1981 c/	
	January - June	July - December
PAID	16.0 cents	17.75 cents
REDUCED PRICE	+ 63.5 (79.5) cents	+ 71.50 (89.25) cents
FREE	+ 83.5 (99.5) cents	+ 91.50 ($109.25) cents

	1982-1983 d/	
	Sept. 1981 - June 1982	July 1982 - June 1983
PAID	10.5 cents	11.0 cents
REDUCED PRICE	+ 58.75 (69.5) cents	+ 64.0 (75.0) cents
FREE	+ 98.75 (109.5) cents	+104.0 (115.0) cents

	July 1983-June 1984 e/
PAID	11.5 cents
REDUCED PRICE	+ 68.75 (80.25) cents
FREE	+108.75 (120.25) cents

a/ Reimbursement rates permanently set and indexed semi-annually for increases in the CPI. January 1, 1981 inflation adjustment was eliminated under the provisions of the Omnibus Reconciliation Act of 1980 (P.L. 96-499).

b/ Beginning in 1979, the reduced price rate was lowered to 20 cents less than the free rate unless a State set a standard meal charge of less than 20 cents for each such lunch. In that case, the reduced price rate was to be the lower of either 10 cents less than the free rate or the difference between the free rate and the meal charge. This exception was eliminated under the provisions of the Omnibus Reconciliation Act of 1980 (P.L. 96-499). At that time all but five States and the Trust Territories were receiving the higher reduced price payment.

c/ Effective January 1, 1980 and through September 1981, the basic rate for all meals was reduced by 2.5 cents in all school districts where less than 60 percent of the lunches were served free or at reduced price. This reduction was affected under the provisions of the Omnibus Reconciliation Act of 1980 (P.L. 96-499) and was operative only through September 1981 when the law was changed again. The January 1, 1981 inflation adjustment was eliminated by this law.

d/ Reflects changes enacted under the Omnibus Budget Reconciliation Act of 1981 (P.L. 97-35). Two cents additional allowed for school districts where 60 percent or more of meals are served free and at reduced price.

e/ Rate totals are 2 cents higher in school districts where 60 percent or more of the lunches are served free and at reduced price. Rates apply for one full school year from July to June.

Source: Federal Register. Notice of payment rates for each of years 1972-1983.

Federal Cash Assistance for the National School Lunch Program a/
(Obligations in thousands of dollars)

Fiscal Year	Basic b/ (Section 4)	Special Assistance Section 11	Total
1947	$59,853		$ 59,853
1948	53,948		53,948
1949	58,752		58,752
1950	64,521		64,521
1951	68,156		68,156
1952	66,294		66,294
1953	67,071		67,071
1954	67,177		67,177
1955	68,935		68,935
1956	66,826		66,826
1957	83,775		83,775
1958	83,708		83,708
1959	93,794		93,794
1960	93,647		93,647
1961	93,628		93,628
1962	98,680		98,680
1963 c/	108,537		108,537
1964	120,793		120,793
1965	130,413		130,413
1966	139,016	$ 1,866	140,822
1967	147,657	1,958	149,615
1968	154,732	4,878	159,610
1969	161,151	42,021	203,172
1970	167,995	132,012	300,007
1971	225,667	306,155	531,882
1972	248,418	491,357	739,775
1973	324,102	555,307	879,409
1974	407,923	681,540	1,089,463
1975	466,856	818,373	1,285,229
1976	511,300	998,350	1,509,650
TQ d/	66,856	125,786	192,642
1977	561,674	1,105,251	1,666,925
1978	618,200	1,205,793	1,823,993
1979	677,511	1,324,489	2,002,000
1980	724,371	1,379,465	2,103,836
1981	763,675	1,608,800	2,372,475
1982	425,000	1,620,300	2,045,300
1983 (est.) e/	438,000	1,829,400	2,267,400
1984 Admin. Req. e/	460,000	1,916,948	2,377,848

a/ Does not include commodities or cash payments in lieu of commodities.

b/ Includes Federal revenues provided under all of section 4. This includes the basic assistance provided for lunches served free or

at reduced price which also receive special assistance subsidies shown under column 2.

c/ Although funding for the special assistance program was authorized beginning in FY 1963, the program was not funded until FY 1966.

d/ Transition Quarter--period from July 1 through September 30, 1976 just prior to the official change in the fiscal year from July 1 through June 30 to October 1 through September 30.

e/ U.S. Department of Agriculture, Food and Nutrition Service. FY84 Budget Explanatory Notes.

Source: U.S. Department of Agriculture.

Appendix II

NESNP Regression Results*

Regression results for analysis of Lunch Program participation frequency--price status subgroups

Explanatory variable	All students	Free	Full/reduced
Male	0.4787*	0.3015*	0.5428*
Age of child	-0.0823*	-0.1215*	-0.0499
Age of child--squared	-0.0176*	-0.0105+	-0.0208*
Black	0.0031	-0.0609	0.1670
Hispanic	0.2350	0.0424	0.2396
Other ethnic group	0.1375	0.6216+	0.2280
Log of meal price	-1.9875*		-1.4191*
Price status--free	-2.4105*		
Price status--reduced	-1.1482*		-0.6980
Log per capita income	0.0505	0.0914	0.0061
Log family size	-0.1001	0.1996	-0.2673
Parental education	-0.1254*	-0.0999	-0.1290+
% food money away from home	0.0040	0.0017	0.0034
Can eat lunch at home	-0.5139*	-0.0806	-0.7703*
Child decides where to eat	-0.6031*	-0.3872*	-0.7466*
Cost of School Lunch	-0.2798*	-0.0326	-0.3884*
Convenience of School Lunch	0.5245*	0.2158*	0.6706*
Nutrition of School Lunch	0.2915*	0.0993	0.3678*
Nutrition most important	-0.2132+	0.0689	-0.4122*
Suburban	-0.3932*	-0.0047	-0.5145*
Central city	-0.3588*	0.2689	-0.5839*
Northeast region	-0.3358+	0.1861	-0.4505+
Southern region	-0.0295	0.8433*	-0.2967
Western region	-0.0243	-0.3490	-0.0700
Faculty eat with students	0.2664+	-0.0382	0.3841*
A la carte available	-0.1960+	-0.2076	-0.2252
USDA Breakfast available	0.2262+	-0.1559	0.4509*
Student nonresponse bias	-1.4254*	-1.0839+	-2.0483*
Intercept term	10.0242*	3.7096*	7.8110*
R^2	0.2718	0.1330	0.2488
Degrees of freedom	5844	2069	3750

* T ratio significant at $p < 0.01$ (two-tail test).
\+ T ratio significant at $p < 0.05$ (two-tail test).

*Source: United States Department of Agriculture and System Development Corporation. "National Evaluation of the School Nutrition Programs." The American Journal of Clinical Nutrition, vol.40, no.2, August 1984, p.444.

Appendix III

Assignment of Counties

In order to properly estimate the number eligible for free, reduced, and paid lunches, detailed information regarding the income status of school-age children in counties is necessary. Due to the limited amount of income information available at the county level, counties are matched to a census-defined Standard Metropolitan Statistical Area (SMSA), the Rural census designation, or a combination of census categories. Matched counties are assumed to follow the income distribution for school-age children of the SMSA, Rural, or combination category to which they are assigned.

The census defines nine SMSA's in New York State, they are: Albany-Schenectady-Troy, Binghamton, Buffalo, Nassau-Suffolk, New York-New Jersey, Newburgh-Middletown, Rochester, Syracuse, and Utica-Rome. The nine SMSA's and the Rural census designation do not provide sufficient diversity to match all of the 57 counties in the study. Detailed income figures are available for all of New York State, excluding the New York City counties, therefore, additional categories are created using census data.[1] The newly-formed categories and their definitions follow:

NonSMSA -- New York State minus the total of the SMSA's.

Average NonSMSA and Rural -- A simple average of the NonSMSA category and the census-defined Rural category.

Average Total SMSA and NonSMSA -- The sum of all the SMSA's averaged with NonSMSA.

Weighted Average Total SMSA and Rural -- The sum of the SMSA's averaged with the census-defined Rural category, weighted by the frequency of their occurance in New York State.

SMSA Mix -- A specific SMSA averaged with one of the other categories, i.e., Rochester and Rural.

The criteria used to match an individual county with a SMSA, Rural, or one of the new combination categories contains three elements:

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[1]The detailed income data are from the 1980 Census of Population, Characteristics of New York State, United States Department of Commerce, Bureau of the Census, Chapter D, Section 2, Table 245, Persons Below Specified Poverty Level in 1979 by Relationship, Age, Sex, Race, and Spanish Origin, pp.34-1444-1563. Under the sub- heading "related children 5-17 years," the data include: the number in all income categories, below 100%, 125%, 150%, 175%, and 200% of the poverty line. The data are available for the nine SMSA's, Rural, New York State, and selected cities. New York City is subtracted from New York State and the New York-New Jersey SMSA for this study.

poverty rates, location, and urbanization. The census does make some relevant income information available by county, specifically, the number of children ages 5-17 below 100% and 125% of the official poverty line and the number of children ages 5-17 in all income categories.[2] These figures are used to compute the following poverty rates:

$$\frac{\text{\# of children ages 5-17 below 100\% of the poverty line}}{\text{\# of children ages 5-17 in all income categories}}$$

$$\frac{\text{\# of children ages 5-17 below 125\% of the poverty line}}{\text{\# of children ages 5-17 in all income categories}}.$$

The same two poverty rates are computed for each individual county, the nine SMSA's, Rural, and the combination categories. County poverty rates are then compared to the poverty rates from the SMSA's, Rural, and combination categories to find the one that best matches. Using this process to match up counties, assumes that if the income distributions of school-age children match at 100% and 125% of the poverty line, then the distributions will continue to match over the range of 130%, 185% and 195% of the poverty line.

The location of the counties is an important component of the matching process. A county must at least border a census-defined SMSA to be matched with the SMSA, or a SMSA Mix category. Urbanization of the counties is another factor considered. The percent of a county's population in urbanized areas is evaluated.[3] Maps of the counties are studied to determine the number and size of city population centers. A county with a high urban percentage and many, large city population centers is not assigned to a category such as Rural, NonSMSA, or a combination of the two.

Counties are assigned using the numerical criteria of the poverty rates, but, the location and urbanization of the counties are also important in the decision-making process. The assignment of counties is not treated lightly, because the process determines the income distribution a county matches and this is critical to the final determination of the number of eligible students.

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[2]The county income data are from the 1980 Census of Population, Characteristics of New York State, Chapter C, Section 2, Table 181, Poverty Status in 1979 of Families and Persons for Counties, pp. 34-985-990.

[3]The percent in urban areas is listed by county in the 1980 Census of Population, Characteristics of New York State, Chapter A, Table 3, Population of Counties by Urban and Rural Residence: 1980 and 1970, p.34-9.

Appendix IV

Linear Interpolation

Specific income criteria define the school lunch eligible sets for free, reduced, and paid. Though income information available for Standard Metropolitan Statistical Areas (SMSA) and census-defined Rural areas is more extensive than that available for counties, the exact guidelines must be interpolated. The free lunch income criteria in 1981 and the reduced lunch income criteria in 1979 and 1981 are interpolated.

The 1981 free lunch income criteria is 130% of the poverty line, the 1979 and 1981 reduced lunch income criteria are 125-195% and 130-185% of the poverty line, respectively. The data points available are the number of children ages 5-17 below 125%, 150%, 175%, and 200% of the poverty line.

Applying the equation for a line, $y = mx + b$, to the available data points, approximations are obtained for the number of children ages 5-17 below 130%, 185%, and 195% of the poverty line. The number below 130% of the poverty line is interpolated between 125% and 150%. The numbers below 185% and 195% of the poverty line are interpolated between 175% and 200%.

In the final step, the reduced lunch income guidelines are distinguished from the free lunch income guidelines. The number of children ages 5-17 below 125% of the poverty line are subtracted from the number below 195% of the poverty line to define the income guidelines for reduced lunches in 1979. The number of children ages 5-17 below 130% of the poverty line are subtracted from the number below 185% to define the income guidelines for reduced lunches in 1981.

Appendix V

Calculating Average Paid Price per County

Data enumerating paid lunch price by county are not available. Though subject to state approval, paid lunch prices vary with each school district and between elementary and secondary schools. In addition, the state Department of Education is only required to maintain records of school district prices for two years prior to the current school year. In order to determine paid lunch price in the Fall of 1979 and 1981, an average price per county is calculated using information from the School Financial File tapes that are published by the New York State Department of Education.

The total sales of lunches are recorded for public schools, each school year per school district in the School Financial Files. This dollar figure includes sales of reduced and paid lunches. School district level sales data is summed to counties and a procedure is devised to compute an average price from total county sales of lunches. The number of reduced price meals served during the year is multiplied by the legislated price. This figure represents total sales of reduced lunches. When this figure is subtracted from total sales of all lunches, the total sales of paid lunches is obtained. Dividing total sales of paid lunches by the number of paid lunches served during the year, yields an average paid lunch price. In equation form:

Total lunch sales - (# of reduced meals served x reduced lunch price) = sales of paid lunches.

Sales of paid lunches/# of paid meals served = average paid lunch price.

As the above description illustrates, determining the total number of reduced and paid meals served in the school years 1979-80 and 1981-82 is crucial to estimating an average paid price. The procedure is complicated because data on the number of reduced and paid meals served in the school years 1979-80 and 1981-82 is not available by county. The New York State Education Department, Bureau of School Food Management could only provide average daily participation (ADP) in each lunch category by county for October 1979 and 1981. However, complete month by month data are available by county for the more recent years, 1983-84 and 1984-85. The 1983-84 and 1984-85 reports contain data describing ADP and the number of meals served per month in each lunch category by county.

The number of meals served in the school years 1979-80 and 1981-82 are calculated using the 1983-84 and 1984-85 reports. In order to compute the total number of meals served in 1979-80 and 1981-82, the average daily participation (ADP) data for October is converted into the number of meals served in October and the number of meals served in October is used to calculate the total number of meals served in the school year.

The 1983-84 and 1984-85 reports are used to convert October ADP data into the number of meals served in October, by providing the average number of school days in the month of October. October ADP data are multiplied by the average number of school days in October to obtain the number of meals served in the month of October. In equation form:

ADP, October x average # of school days, October = # of meals served, October.

Assuming that the distribution of meals served per month during the school year does not vary over time, the 1983-84 and 1984-85 reports can be used to evaluate the percentage of total meals served in the month of October. When the number of meals served in October is divided by the percentage of total meals served in October, the total number of meals served in the school year is obtained. In equation form:

# of meals served, October/percentage of meals served, October = total # of meals served in school year.

The computation of the total number of meals served in the school year must be repeated twice for each year, 1979-80 and 1981-82. Once to compute the total number of reduced price meals served and then to compute the total number of paid lunch meals served.

Appendix VI

Tests of Structural Change

To determine if structural change occurred between 1979 and 1981, the three models specified in Johnston (1984) are estimated and then statistically tested against each other. The models and tests to be performed are:

Models:

MODEL I:

$$\begin{bmatrix} Y_1 \\ Y_2 \end{bmatrix} = \begin{bmatrix} i_1 & X_1 \\ i_2 & X_2 \end{bmatrix} \begin{bmatrix} a \\ B \end{bmatrix} + u$$

common regression for both periods

MODEL II:

$$\begin{bmatrix} Y_1 \\ Y_2 \end{bmatrix} = \begin{bmatrix} i_1 & 0 & X_1 \\ 0 & i_2 & X_2 \end{bmatrix} \begin{bmatrix} a_1 \\ a_2 \\ B \end{bmatrix} + u$$

differential intercepts, common slope

MODEL III

$$\begin{bmatrix} Y_1 \\ Y_2 \end{bmatrix} = \begin{bmatrix} i_1 & X_1 & 0 & 0 \\ 0 & 0 & i_2 & X_2 \end{bmatrix} \begin{bmatrix} a_1 \\ B_1 \\ a_2 \\ B_2 \end{bmatrix} + u$$

differential intercepts, differential slopes

The matrix notation:

Y_1 = The dependent variable in 1979
Y_2 = The dependent variable in 1981

i_1 = The intercept term in 1979
i_2 = The intercept term in 1981

X_1 = The explanatory variables in 1979
X_2 = The explanatory variables in 1981

a = The coefficient on the intercept term
a_1 = The coefficient on the intercept term in 1979
a_2 = The coefficient on the intercept term in 1981

B = The coefficients on the explanatory variables
B_1 = The coefficients on the explanatory variables in 1979
B_2 = The coefficients on the explanatory variables in 1981

u = The error term

Tests:

1) Model I against Model II tests for differential intercepts in the two years. The test statistic is:

$$F = \frac{RSS1 - RSS2}{RSS2/(n - k - 1)} \sim F(1, n - k - 1)$$

2) Model II against Model III tests for differential slope coefficients in the two years. The test statistic is:

$$F = \frac{(RSS2 - RSS3)/(k - 1)}{RSS3/(n - 2k)} \sim F(k - 1, n - 2k)$$

3) Model I against Model III tests for differential regressions, slopes and intercepts. The test statistic is:

$$F = \frac{(RSS1 - RSS3)/k}{(RSS3/(n - 2k)} \sim F(k, n - 2k)$$

Notation:

RSS1 = Residual sum of squares, Model I
RSS2 = Residual sum of squares, Model II
RSS3 = Residual sum of squares, Model III

n = The number of observations

k = The number of explanatory variables

The actual tests for the free, reduced, and paid lunch categories are listed below:

1) Test of differential intercepts, Model I vs. Model II, H_o: $a_1 = a_2$.

Free Participation Equation

$\frac{264,000,000 - 251,000,000}{251,000,000/(114 - 8 - 1)} = 5.438$, reject H_o at 5%.

Reduced Participation Equation

$\frac{20,216,995 - 20,176,373}{20,176,373/(114 - 8 - 1)} = .2114$, do not reject H_o at 5%.

Paid Participation Equation

$\frac{699,000,000 - 686,000,000}{686,000,000/(114 - 9 - 1)} = 1.971$, do not reject H_o, 5%.

2) Test of differential slope vectors, Model II vs. Model III, H_o: $B_1^* = B_2^*$.

Free Participation Equation

$$\frac{251,000,000 - 211,000,000/(8-1)}{211,000,000/(114 - 16)} = 2.654, \text{ reject } H_o \text{ at 5\%.}$$

Reduced Participation Equation

$$\frac{20,176,373 - 17,478,737/(8-1)}{17,478,737/(114 - 16)} = 2.16, \text{ reject } H_o \text{ at 5\%.}$$

Paid Participation Equation

$$\frac{686,000,000 - 536,000,000/(9-1)}{536,000,000/(114 - 18)} = 3.358, \text{ reject } H_o \text{ at 5\%.}$$

3) Test of differential regressions (intercepts and slopes), Model I vs. Model III, H_o: $B_1 = B_2$.

Free Participation Equation

$$\frac{264,000,000 - 211,000,000/8}{211,000,000/(114 - 16)} = 3.077, \text{ reject } H_o \text{ at 5\%.}$$

Reduced Participation Equation

$$\frac{20,216,995 - 17,478,737/8}{17,478,737/(114 - 16)} = 1.919, \text{ do not reject } H_o, \text{ 5\%.}$$

Paid Participation Equation

$$\frac{699,000,000 - 536,000,000/9}{536,000,000/(114 - 16)} = 3.244, \text{ reject } H_o \text{ at 5\%.}$$

Each of the lunch categories test differently, but, because all of the categories test positively for different slope vectors, Model III is selected as the most appropriate.

Appendix VII

Compensated Price Effect

Using Slutsky's equation it is possible to separate the income from the substitution effect and define the compensated price effect.

Slutsky's Equation:

$$\frac{\partial q}{\partial p} = \frac{\partial q}{\partial p}\Big|_{u=u} - (q)\frac{\partial q}{\partial y}.$$

The left-hand-side of the equation represents the total price effect. The first term on the right-hand-side of the equation is the substitution effect, the second term is the income effect. For a normal good the income effect reinforces the substitution effect, the opposite is true for inferior goods. Because school lunches are an inferior good, the income effect moderates or "washes out" the substitution effect. It is possible to separate out the income effect by solving for the substitution effect in Slutsky's equation. This calculation is performed on the price coefficients in the paid participation equation:

$$\frac{\partial q}{\partial p}\Big|_{u=u} = \frac{\partial q}{\partial p} + (q)\frac{\partial q}{\partial y}.$$

The first term on the right-hand-side of the equation is the coefficient on price, the second term is the coefficient on income per capita multiplied by average participation.

1979:

$$\frac{\partial q}{\partial p}\Big|_{u=u} = -8042 + (9912)(-3.07)$$

$$= -38,472$$

1981:

$$\frac{\partial q}{\partial p}\Big|_{u=u} = -5266 + (7585)(-2.22)$$

$$= -22,105$$

In order to compute a t-statistic for the compensated price coefficients, a new standard error is calculated. The variances are calculated according to Snedecor and Cochran (1980), variance of a linear function. Taking the square root of the variances yields the new standard errors:

S_e, 1979 = 7110 $\qquad$ S_e, 1981 = 6687.

The new t-statistics:

1979 = -38,472/7110 = -5.41, Significant @ 1%.
1981 = -22,105/6687 = -3.31, Significant @ 1%.

Appendix VIII

Testing Number Eligible Coefficient Vs. One

If every student eligible for a lunch participated, the coefficient on number eligible would be one. Therefore, the coefficients on number eligible in each of the equations are tested to determine if they are significantly different from one. The test statistic:

$$t = \frac{\text{coefficient} - 1}{\text{standard error of the coefficient}}.$$

All of the coefficients are significantly different from one at 5%, with the exception of the free coefficient in 1979.

Free Coefficients

1979:

(1.02 - 1)/.045 = .444

1981:

(.814 - 1)/.04 = -4.65

Reduced Coefficients

1979:

(.177 - 1)/.0115 = -71.56

1981:

(.212 - 1)/.016 = 49.25

Paid Coefficients

1979:

(.310 - 1)/.012 = -57.5

1981:

(.253 - 1)/.013 = -57.46

Appendix IX

Testing Differences in Magnitudes of Coefficients

A procedure outlined for comparing regression coefficients from different populations in James (1951) is used to test the difference in the magnitudes of the coefficients. The hypothesis is stated:

(1) H_o: $b^1 = b^2$.

The test statistic is:

(2) $h = \sum w_i (b^i)^2 - (\sum w_i b^i)^2 / w$,

distributed Chi Square with n-1 degrees of freedom, where n equals the number of coefficients being compared. If h is greater than the critical value, H_o is rejected. The following are defined:

(3) $w_i = \frac{1}{\text{var}(b^i)}$

(4) $w = \sum w_i$.

The coefficients on number eligible, income per capita, unemployment rate, percent female householder, and percent black are tested for differences between the free and reduced equations.

Free vs. Reduced

Number Eligible

1979:

$b_F = 1.018$ $b_R = .177$ $w_F = 494$ $w_R = 7692$

h = 495, Reject H_o @ 5%.

1981:

$b_F = .814$ $b_R = .212$ $w_F = 625$ $w_R = 3846$

h = 380, Reject H_o @ 5%.

Income Per Capita

1979:

$b_F = -1.14$ $b_R = -.538$ $w_F = 8.85$ $w_R = 106$

h = 13.5, Reject H_o @ 5%.

1981:

b_F = -.857 b_R = -.298 w_F = 10.4 w_R = 126.6

h = 7.93, Reject H_o @ 5%.

Unemployment Rate

1979:

b_F = 49.57 b_R = -25.5 w_F = .00005 w_R = .00064

h = .135, Do not reject H_o @ 5%.

1981:

b_F = 128.4 b_R = 20.9 w_F = .00005 w_R = .0006

h = .782, Do not reject H_o @ 5%.

Percent Female Householder

1979:

b_F = 1654 b_R = 1043 w_F = .000000003 w_R = .0000004

h = .0232, Do not reject H_o @ 5%.

1981:

b_F = 29344 b_R = 2350 w_F = .000000003 w_R = .00000003

h = 2.352, Do not reject H_o @ 5%.

Percent Black

1979:

b_F = 29518 b_R = 9022 w_F = .000000005 w_R = .000000068

h = 4.44, Reject H_o @ 5%.

1981:

b_F = 33081 b_R = 4811 w_F = .000000098 w_R = .00000007

h = 5.18, Reject H_o @ 5%.

The coefficients on number eligible are also tested for differences between the free and paid, and reduced and paid equations.

Free vs. Paid

Number Eligible

1979:

$b_F = 1.018$ $b_P = .31$ $w_F = 494$ $w_P = 6944$

$h = 524$, Reject H_o @ 5%.

1981:

$b_F = .814$ $b_P = .253$ $w_F = 625$ $w_P = 5882$

$h = 413$, Reject H_o @ 5%.

Reduced vs. Paid

Number Eligible

1979:

$b_R = .177$ $b_P = .31$ $w_R = 7692$ $w_P = 6944$

$h = 462$, Reject H_o @ 5%.

1981:

$b_R = .212$ $b_P = .253$ $w_R = 3846$ $w_P = 5882$

$h = 256$, Reject H_o @ 5%.

Appendix X

Simulation Calculations

In order to isolate specific variable effects, 1979 conditions are simulated in 1981. Using 1981 as the base year, 1979 variable levels for enrollments, income criteria, economic conditions, and paid price are substituted into the equations. Subtracting the hypothetical equation from the original equation identifies the impact on participation of the specific variable change:

(1) $(Y_o - Y_h) = (a + BX_o) - (a + BX_h)$ where,

Y_o = actual participation
Y_h = hypothetical participation

$a + BX_o$ = equation with original variable
$a + BX_h$ = equation with hypothetical variable.

Because most of the variables in the original and the hypothetical equation are the same, the majority of terms cancel out in the subtraction process. The simulations are calculated using the mean value of the variables. The equations and actual calculations follow; the numbers represent the hypothesized change in 1981 daily participation on average for a county.

(1) Drop in Enrollments

(coefficient number eligible, 1981)(poverty rate, 1981)[(enrollments, 1981 - enrollments, 1979)].

Free Participation Equation

(.814)(.2068)[(35,212 - 37,716)] = -422.

Reduced Participation Equation

(.212)(.1505)[(35,212 - 37,716)] = -80.

Paid Participation Equation

(.253)(.643)[(35,212 - 37,716)] = -407.

(2) Legislated Changes in Income Criteria (OBRA)

(coefficient number eligible, 1981)(enrollments, 1981)[(poverty rate, 1981 - poverty rate, 1979)].

Free Participation Equation

(.814)(35,212)[(.2068 - .1871)] = 565.

Reduced Participation Equation

(.212)(35,212)[(.1505 - .1923)] = -312.

Paid Participation Equation

(.253)(35,212)[(.643 - .621)] = 196.

(3) Decline in Economic Conditions

(coefficient number eligible, 1981)(enrollments, 1981)[(poverty rate, 1981 w/'81 economic conditions - poverty rate, 1981 w/'79 economic conditions)] + (coefficient income per capita, 1981)[(income per capita, 1981 - income per capita, 1979)] + (coefficient unemployment rate, 1981)[(unemployment rate, 1981 - unemployment rate, 1979)].

Free Participation Equation

(.814)(35,212)[(.2068 - .199)] + (-.857)[(6174 - 6202)] + (128.42)[(7.96 - 6.96)] = 376.

Reduced Participation Equation

(.212)(35,212)[(.1505 - .1465)] + (-.298)[(6174 - 6202)] + (20,89)[(7.96 - 6.96)] = 59.

Paid Participation Equation

(.253)(35,212)[(.643 - .654)] + (-2.22)[(6174 - 6202)] + (-442)[(7.96 - 6.96)] = -469.

(4) Increase in Paid Price

(coefficient paid price, 1981)[(paid price, 1981 - paid price, 1979)].

(-5266)[(.535 - .449)] = -453.

Appendix XI

Approximation of the Total Differential

By approximating the total differential of the equations, differences in participation between 1979 and 1981 are attributed to their two sources within the estimation technique: differences in coefficients (behavioral) and differences in variable levels (economic, demographic, program). The expression derived in Chapter Six to approximate the total differential is illustrated below:

$$(1)\quad Y^{81}-Y^{79}=(a^{81}-a^{79})+\frac{(x^{81}+x^{79})}{2}(c^{81}-c^{79})$$

$$+$$

$$\frac{(c^{81}+c^{79})}{2}(x^{81}-x^{79}).$$

The first two terms on the right-hand-side of the equation represent behavioral effects and the final term represents variable level effects.

All of the variables are evaluated at their mean. Variable levels do not change for the variables, percent urban, percent female householder, percent black, and percent college; 1980 data is used in both years. As a result, $x^{81} - x^{79} = 0$, and the terms drop out of the differential. The actual calculations for each of the lunch categories follow; the final figures represent differences in daily participation between 1979 and 1981 on average in a county.

Free Participation Equation

$Y^{81} - Y^{79}$ [Actual]

4282 - 4571 = -289

Variable Level Differences:

$$\frac{(c^{81}+c^{79})(x^{81}-x^{79})}{2}$$

Number eligible = (.916)(5806 - 5491) =	289
Income per capita = (-.999)(6174 - 6202) =	28
Unemployment rate = (89)(7.96 - 6.96) =	89
Subtotal	406

Behavioral Differences [Coefficients]:

$(a^{81} - a^{79})$ [Intercepts]

-344 - 4949 = -5293

$$\frac{(x^{81}+x^{79})(c^{81}-c^{79})}{2}$$

Number eligible = (5649)(.814 - 1.018) =	-1152
Income per capita = (6188)(-.857 - (-1.142)) =	1764
Percent urban = (45)(-10 - (-3.08)) =	-311
Unemployment rate = (7.46)(128.42 - 49.57) =	588
Percent female household = (.119)(29,344 - 1654) =	3295
Percent black = (.027)(33,081 - 29,518) =	96
Percent college = (14.63)(15.49 - (-6.17)) =	317
Subtotal	-696

Total -290

Reduced Participation Equation

$Y^{81} - Y^{79}$ [Actual]

882 - 1120 =	-238

Variable Level Differences:

$$\frac{(c^{81}+c^{79})(x^{81}-x^{79})}{2}$$

Number eligible = (.194)(4230 - 5771) =	-299
Income per capita = (-.418)(6174 - 6202) =	12
Unemployment rate = (-2.2)(7.96 - 6.96) =	-2
Subtotal	-289

Behavioral Differences [Coefficients]:

$(a^{81} - a^{79})$ [Intercepts]

1211 - 3189 =	-1978

$$\frac{(x^{81}+x^{79})(c^{81}-c^{79})}{2}$$

Number eligible = (5000)(.212 - .177) =	175
Income per capita = (6188)(-.298 - (-.538)) =	1485
Percent urban = (45)(3.37 - 10.25) =	-310
Unemployment rate = (7.46)(20.89 - (-25.21)) =	344
Percent female hsehold = (.119)(2350 - 1043) =	156
Percent black = (.027)(4811 - 9022) =	-114
Percent college = (14.63)(-7.71 - (-27.93)) =	296
Subtotal	54
Total	-235

Paid Participation Equation

$Y^{81} - Y^{79}$ [Actual]

7585 - 9912 =	-2327

Variable Level Differences:

$$\frac{(c^{81}+c^{79})(x^{81}-x^{79})}{2}$$

Number eligible = (.282)(25,175 - 26,454) =	-361
Income per capita = (-2.65)(6174 - 6202) =	74
Unemployment rate = (-558)(7.96 - 6.96) =	-558
Deflated paid price = (-6654)(.535 - .449) =	-572
Subtotal	-1417

Behavioral Differences [Coefficients]:

$(a^{81} - a^{79})$ [Intercepts]

25,794 - 26,904 =	-1110

$$\frac{(x^{81}+x^{79})(c^{81}-c^{79})}{2}$$

Number eligible = (25,815)(.253 - .310) =	-1471
Income per capita = (6188)(-2.22 - (-3.07)) =	5260
Percent urban = (45)(70.82 - 56.03) =	666
Unemployment rate = (7.46)(-442 - (-673)) =	1723
Percent female household =(.119)(-58,390 - 6809)=	-7759
Percent black = (.027)(28,007 - 35,534) =	-203
Percent college = (14.63)(-104.71 - (-150.46)) =	669
Deflated paid price = (.492)(-5266 - (-8042)) =	1366
Subtotal	-859
Total	-2276

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