SELECTED COST-SIZE RELATIONSHIPS OF HIGH SCHOOL DISTRICTS HAVING ONE ATTENDANCE CENTER IN ILLINOIS

Gloria A. Sabulao
Elwood F. Egelston
Ronald Halinski

Center for the Study of Educational Finance
Department of Educational Administration and Foundations
College of Education and the Graduate School
Illinois State University
Normal, Illinois 61761

January, 1979

Support for this paper came from the General Revenue Funds of Illinois State University and from additional support received from the National Institute of Education through the National Conference of State Legislatures and the Illinois School Problems Commission. Matters of fact or opinion contained herein are solely the responsibility of the authors and in no way reflect the official policy of Illinois State University. As a part of its public service, the University seeks to promote a systematic and thorough discussion of all public policy matters and supports various types of research which contribute to that end.

Table of Contents

Introduction

This study was undertaken to add information about the cost-size relationship of public schools and school districts. A review of literature shows that numerous cost-size studies of schools have been made.(1) However, there was need for a study focusing upon a population of high school districts, each having one attendance center--a high school--to add a new dimension to the literature available.(2)

This interest was fanned by the recently renewed interest in economy of operating schools, the changing nature of schools, and the struggle for financial support by public agencies.

Problem of the Study

The problem of this study was to determine the relationship between the size (average daily attendance) and certain cost factors of operation of Illinois high school districts having only one attendance center. Costs included administrative costs, instructional costs, and operational costs.

Research Variables

The principal variables of this study were size in average daily attendance (ADA) and certain current expenditures. School expenditures included expenditures per pupil in average daily attendance for administrative costs, instructional costs, and operational costs as identified by the Illinois Financial Accounting Manual.(3)

The meanings of the variables are clarified by the following definitions:

1. Size--In this study, size was measured in average daily attendance (ADA) which is the aggregated days attendance of a school district during a reporting period divided by the number of days school was in session during the period. Average daily attendance was based upon the best six months of attendance.(4)

2. Secondary School District--A secondary school district is a school district serving only grades 9 to 12 and under the direction of one board of education. This study included only public supported secondary school districts having one attendance center.

3. Administrative Costs--Administrative costs as used in this study pertain to the monies expended for: salaries, supplies, and travel expenditures of the board of education, superintendent's office, principals, supervisors

and consultants; business and financial administration of the buildings and grounds; such services as legal, research, school census, and public relations; and other sundry expenses connected with administration. Administrative costs are identified in the Illinois Financial Accounting Manual by Account Nos. 501-501.9 and 502.11-502.13.(3)

4. Instructional Costs--These costs include the expenditures for activities dealing directly with or aiding in the teaching of students or improving the quality of teaching. They include the salaries of teachers, teacher aides, certificated personnel as school librarians, and audio-visual, guidance, psychological and television personnel who are performing services for the instructional program, secretaries and clerks, noncertificated personnel, instructional supplies as textbooks, library and audio-visual, other supplies, travel, and others. These costs are indicated by Account Nos. 502.14-502.90 in the Illinois Financial Accounting Manual for local systems.(3)

5. Operating Expenditures--In this study, operating expenditures refer to the total expenditures from the Education Building, Bond and Interest, Transportation, Municipal Retirement, and Rent Fund, less expenditures for the following: tuition paid to other districts, building payments to other districts, adult education, summer school economic opportunity project, capital outlay, transfers out and bond

principal retired divided by the best six months weighted average daily attendance. This definition is found in Illinois Office of Education Form 50-04, School District Annual Financial Report, 1975-76. It should be noted that this varies from the term as it is used to describe income in the state aid formula, and the two should not be confused.

Population

This study included only data about secondary school districts having one attendance center. The districts included were visited for state of Illinois "recognition" (approval) during one of the 1973-74, 1974-75, or 1975-76 school years. High school districts having one attendance center were chosen for this study because data available were for the one school. Data for unit districts (K-12) and for high school districts with more than one school do not show the actual costs for one school attendance center. The emphasis of this study was upon the high school rather than high school districts.

As included in this report, the secondary schools were treated as three populations. The first population included all the single attendance high school districts in Illinois for which data were available. The sizes of these seventy-two schools ranged from a high ADA of 4,752 to a low of 67.

The second population included sixty-two secondary schools with less than 2,000 ADA (1,927 to 67). The third population consisted of forty-one secondary schools with sizes of less than 1,000 pupils (965 to 67 ADA).

The populations of smaller schools were included because it was felt that these schools were more representative of the high school districts in Illinois than the population which included the larger schools. In 1973 there were 143 secondary school districts in Illinois. At that time, secondary school districts of less than 500 enrollment accounted for 38.5 per cent of the state's secondary districts (fifty-four districts), but enrolled 4.1 per cent of the state's high school pupils.(5)

Sources of Data

Data were secured from the following sources:

1. Public School District Profile and Visitation Information Form of the Illinois Office of Education Department of Recognition and Supervision for 1973-74, 1974-75, and 1975-76.

2. Annual Financial Report of the Finance, Grants, Budget, and Reimbursement Division of the Illinois Office of Education.

3. The 1970 Census: Illinois School District Profile of the Center for Educational Finance, Department of

Educational Administration, Illinois State University.(6)

Adjustments to Data

Two cost adjustment indices were used. The first was a geographic cost-of-living index for Illinois counties by which costs were adjusted for varying levels of the cost of living in various parts of the state of Illinois.(7)

Costs were also adjusted by the Consumer Price Indexes. Since cost data were for 1972, 1973, and 1974, ratios were calculated which were used to convert all costs to the 1972 level. (Example: cost index 1972/cost index 1974 $= \frac{125.3}{147.7} = 0.845$.)

Research Questions

The principal concern of this study was upon the relation of school size and various costs. The specific questions studied were:

1. Does the economy and diseconomy scale of cost-size relationship found in other studies of various kinds of school districts also appear to exist for secondary school districts having one attendance area?

2. Is there optimum size (in terms of cost relationship) for secondary school districts in Illinois?

3. Do studies of various size groups of secondary school districts show similar cost-size relationships?

Statistical Approaches

In this study, the regression procedure, both linear and curvilinear. was employed. By using the regression equation, the relationship between a dependent or criterion variable and the predictor variables can be analyzed. It was used as a descriptive tool by which the linear and curvilinear relationships were summarized; also, it served as an inferential tool by viewing the relationships in the population as representing a sample of high schools at one point in time taken from a hypothetical population of similar high schools.

The results are summarized in Tables 1, 2, and 3, and show the relationship of the three cost variables to size for each of the three populations: (1) seventy-two high schools whose sizes vary from ADA of 4,753 to 67; (2) sixty-two high schools with ADA of less than 2,000; and (3) forty-one high schools with ADA of less than 1,000.

The following information is included.

1. The dependent cost variables and the independent size variables;

2. The correlation coefficient "r," which indicates the degree to which variation (or change) in one variable is

related to variation (change) in another (it also shows the strength of association among variables and provides a means for comparing the strength among variables);

3. The linear r^2 and quadratic r^2, which are measures of the proportion of variance attributed to one variable;

4. The gain of r^2, which is calculated by subtracting the linear r^2 from quadratic r^2 (this gain is the improvement in the fit of the quadratic mathematical function to the data);

5. The optimum school size (ADA), and the related minimum cost.

Before analyzing the data, a rule was established for selecting the type of "Model" to describe the relationship between the dependent variable and the independent variable. The quadratic model is illustrated when there is a gain in r^2 of five or more percentage points and/or the gain in r^2 is statistically significant (.05). Curves were plotted from the quadratic equation $Y = a + bX + b_1X^2$. The first derivative was calculated to determine the optimum (least cost point) in the relationship of the two variables. The optimum ADA size was then substituted into the estimating equation to determine the minimum cost.

Findings

Finding I: Relation of Administrative Cost to ADA

Table 1 shows the comparative relationship of administrative cost and size (ADA) of the three populations of secondary schools. Data in Table 1 show that the correlation coefficient (r) for each of the three school populations is negative. Also, as the ADA of the populations decreases, the correlation coefficient becomes larger (more negative). A curvilinear relationship exists between ADA and administrative cost per pupil for all three populations, providing about the same amount of gain over use of a linear function. F values of the quadratic model and of the quadratic gain for all three populations are significant at the .01 level. The negative linear relationship suggests that as the size of ADA increases the administrative cost per pupil decreases. This per pupil cost decrease is shown to bear a stronger relationship to size as the schools with larger ADA are removed and the populations with lower ADA are formed. However, Figures 1, 2, and 3 show curves plotted from the quadratic equations and all three figures show that an optimum size (ADA) point exists, and per pupil administrative costs begin to rise for larger size districts. (Sample calculations for determining the optimum size are shown in Appendix A.)

Finding II: Relation of Instructional Cost to ADA

Table 2 shows the comparative relationship of instructional cost and size (ADA) of the three populations of secondary schools. Data in Table 2 show considerable differences among the three high school populations. First the positive correlation coefficient (r) between size and instructional costs of the population with the larger schools does not support the expected economies of scale (lower costs with larger populations). Economies of scale were found for the two other populations (negative correlation coefficients). Fitting a quadratic function in all three models does improve the fit in graphic representation by about 10 per cent for the two populations with larger ADA, and by 23.6 per cent for the population with ADA of less than 1,000.

Figures 4, 5, and 6 show curves plotted from the quadratic equation and the optimum cost-size relationships found by using the first derivative. The data show that as school sizes increase from the very small, instructional costs per pupil reduce up to some optimum point, and then increase with size. However, when the three populations are examined, the relationship between size and cost is not as strong as in the case of administrative cost per pupil.

Finding III: Operational Expenditures with ADA

Table 3 shows the comparative relationship of operational cost and size (ADA) of the three populations of secondary schools. Given a linear model, the data show that when the two populations having larger ADA are considered the operational expense, on the average, does not decrease with increasing size. However, when the schools with larger enrollments are removed from consideration, the smaller schools do show a decrease in per pupil costs of operation with increase in size.

Figures 7, 8, and 9 show the curvilinear relationship which exists between ADA and operating expense per pupil for the three populations. The strength of this relationship for the population with ADA less than 5,000 is essentially the same as that found for instructional costs and administrative costs; for populations with ADA less than 2,000, it is somewhat weaker than that found for the other two cost situations; and for populations with ADA less than 1,000, it is substantially weaker than that found for the two earlier cost-ADA relationships.

Summary of Findings

Findings of this study are inconclusive in some respects; yet some are clearly identified. Findings of the relationship of administrative costs show that for all three population groups there is economy of scale--lower cost associated with larger enrollments. However, a curvilinear relation exists for the three populations. Thus, some evidence of increasing per pupil costs of administration is shown with increased ADA beyond some optimum point.

Instructional costs are shown to have a negative relationship to ADA for the population of schools with ADA below 1,000. Further, the quadratic function is shown to improve the fit in graphic representation of the relationship for the three groups; however, the relationship is not as distinct as for the administrative cost and ADA relationship.

Finally, when ADA and operational costs are considered, the linear correlation coefficient (r) of only the population with the smaller ADA showed some, though minor, economy of scale--larger enrollment with lower costs. Also, for the three populations the quadratic function fit is substantially weaker than that found for the administrative cost and ADA relationship.

Discussion

Findings of this study do suggest that for at least the population of smaller high schools there is an economy of scale relationship between size and various per pupil costs. As with other studies of cost and size, ambiguous findings appear, depending on the cost variable and the nature of the population.

For example, treatment of data about the high school population including larger schools shows that for administrative costs, economy of scale exists for schools below 2,330 ADA and then diseconomy of scale exists as sizes increase. However, when the larger schools are removed from the population, considerable shifting of the "point of efficiency" is noted. With the population of smallest schools, economy of scale exists to size ADA of 635, then diseconomy of scale is seen. Because of the larger number of smaller schools and practical limitations on possible increases in size due to district reorganization in Illinois, the population with just the smaller size schools may be more representative as a reference point for such schools.

This study does support the idea that economy can be achieved by eliminating the very small high schools. Furthermore, the curvilinear relationship of cost and size shown by other researchers is supported. Thus, this study serves to provide additional information to those who must ultimately make the decisions about inefficiency in operation and size of schools and districts which must be made. Although a larger sample size might seem to be desirable, such a population would be difficult to secure because of the variance of financial practices, record keeping, and other economic-related matters among the various states.

TABLE 1

REGRESSION VALUES OF ADMINISTRATIVE COSTS[a] WITH DIFFERENT SIZE (ADA) PUPIL POPULATIONS

High School Populations	Correlation Coefficient r	Linear r^2	Quadratic r^2	Gain r^2	Optimum School Size	Minimum Cost Per Pupil at Optimum School Size
<u>All High Schools</u>						
ADA: Below 5,000 N = 72	-0.214	0.046	0.211[b]	0.165[b]	2,330	$74
ADA: Below 2,000 N = 62	-0.420[b]	0.177[b]	0.392[b]	0.215[b]	1,136	$65
ADA: Below 1,000 N = 41	-0.599[b]	0.358[b]	0.516[b]	0.158[b]	635	$67

[a]Costs = per pupil costs

[b]Significant at .01 level

TABLE 2

REGRESSION VALUES OF INSTRUCTIONAL COSTS[a] WITH DIFFERENT SIZE (ADA) PUPIL POPULATIONS

High School Populations	Correlation Coefficient r	Linear r^2	Quadratic r^2	Gain r^2	Optimum School Size	Minimum Cost Per Pupil at Optimum School Size
All High Schools						
ADA: Below 5,000 N = 72	0.297[b]	0.088[c]	0.187[b]	0.099[c]	1,315	$704
ADA: Below 2,000 N = 62	-0.040	0.002	0.133[c]	0.132[c]	960	$624
ADA: Below 1,000 N = 41	-0.283[b]	0.080	0.316[c]	0.236[c]	531	$584

[a]Costs = per pupil costs

[b]Significant at .05 level

[c]Significant at .01 level

TABLE 3

REGRESSION VALUES OF OPERATIONAL COSTS[a] WITH DIFFERENT SIZE (ADA) PUPIL POPULATIONS

High School Populations	Correlation Coefficient r	Linear r^2	Quadratic r^2	Gain r^2	Optimum School Size	Minimum Cost Per Pupil at Optimum School Size
<u>All High Schools</u>						
ADA: Below 5,000 N = 72	0.373[b]	0.139[b]	0.186[b]	0.047[c]	775	$1,226
ADA: Below 2,000 N = 62	0.090	0.008	0.069	0.061	854	$1,143
ADA: Below 1,000 N = 41	-0.132	0.017	0.172[c]	0.155[c]	503	$1,049

[a]Costs = per pupil costs

[b]Significant at .01 level

[c]Significant at .05 level

ADA AND ADMINISTRATIVE COST PER PUPIL

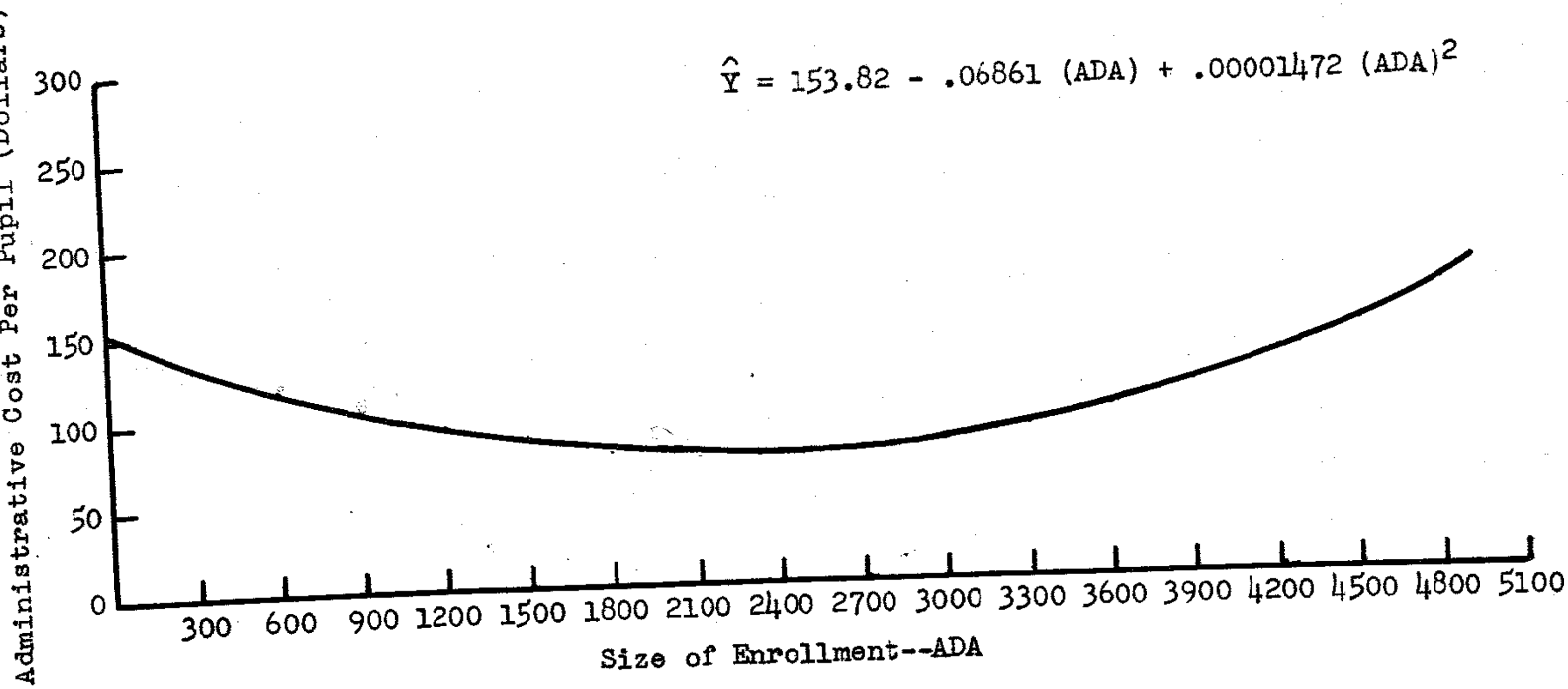

FIGURE 1. ADA Less Than 5000

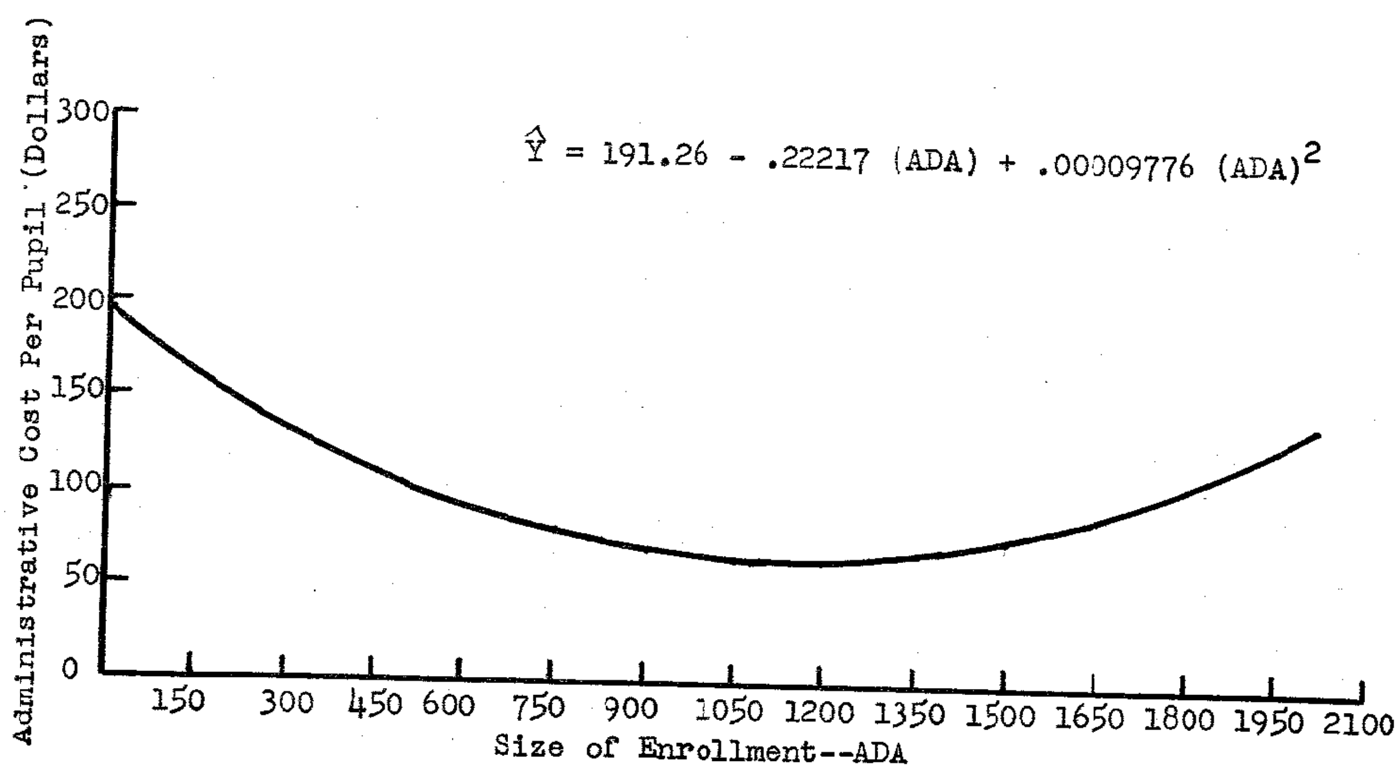

FIGURE 2. ADA Less Than 2000

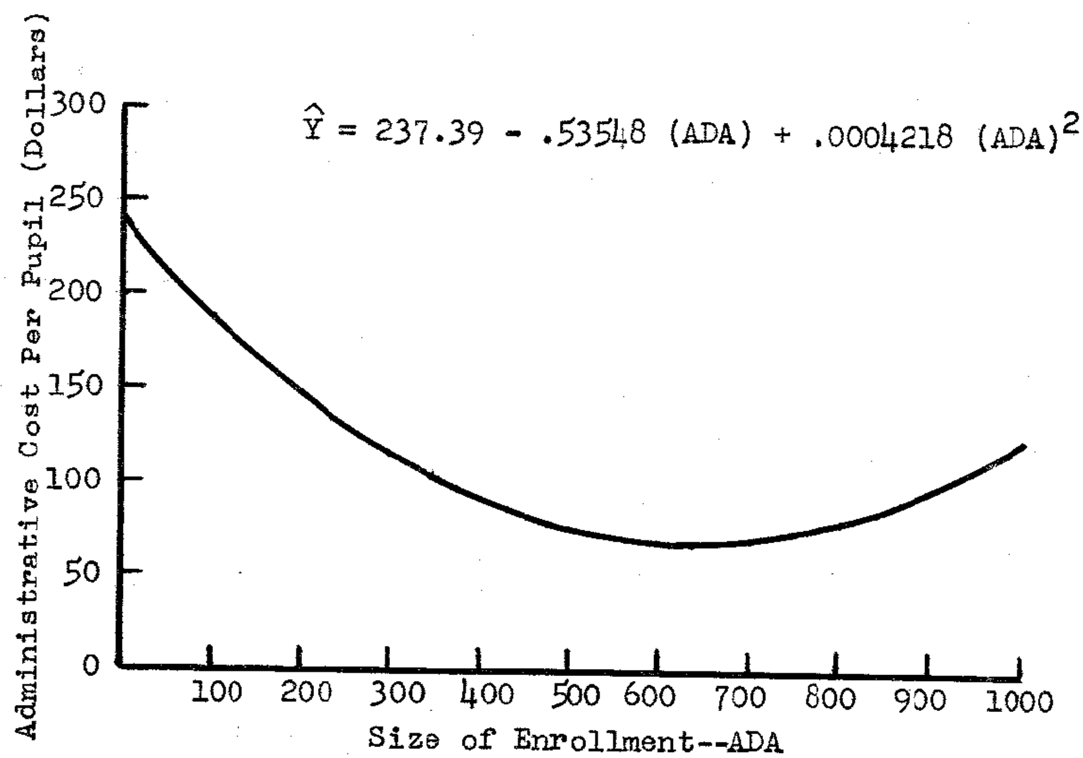

FIGURE 3. ADA Less Than 1000

ADA AND INSTRUCTIONAL COST PER PUPIL

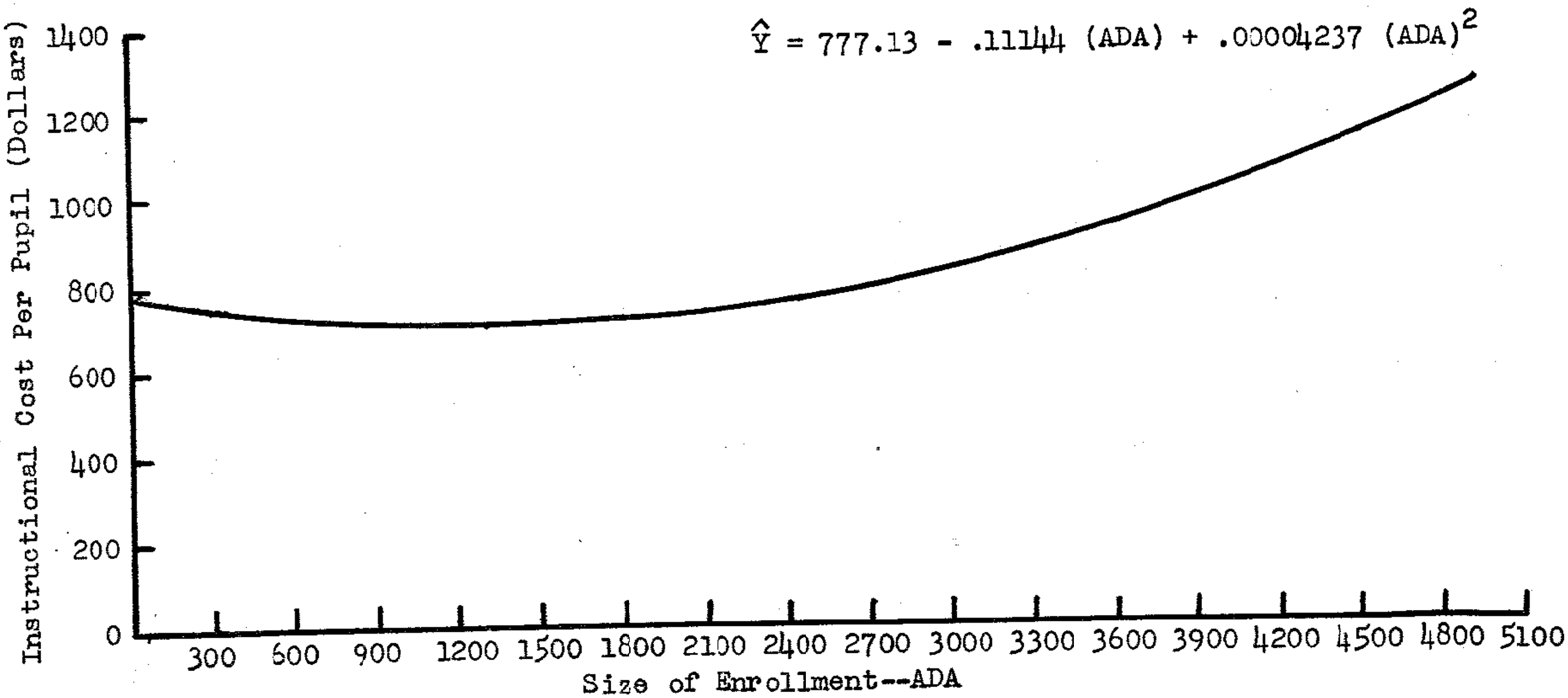

FIGURE 4. ADA Less Than 5000

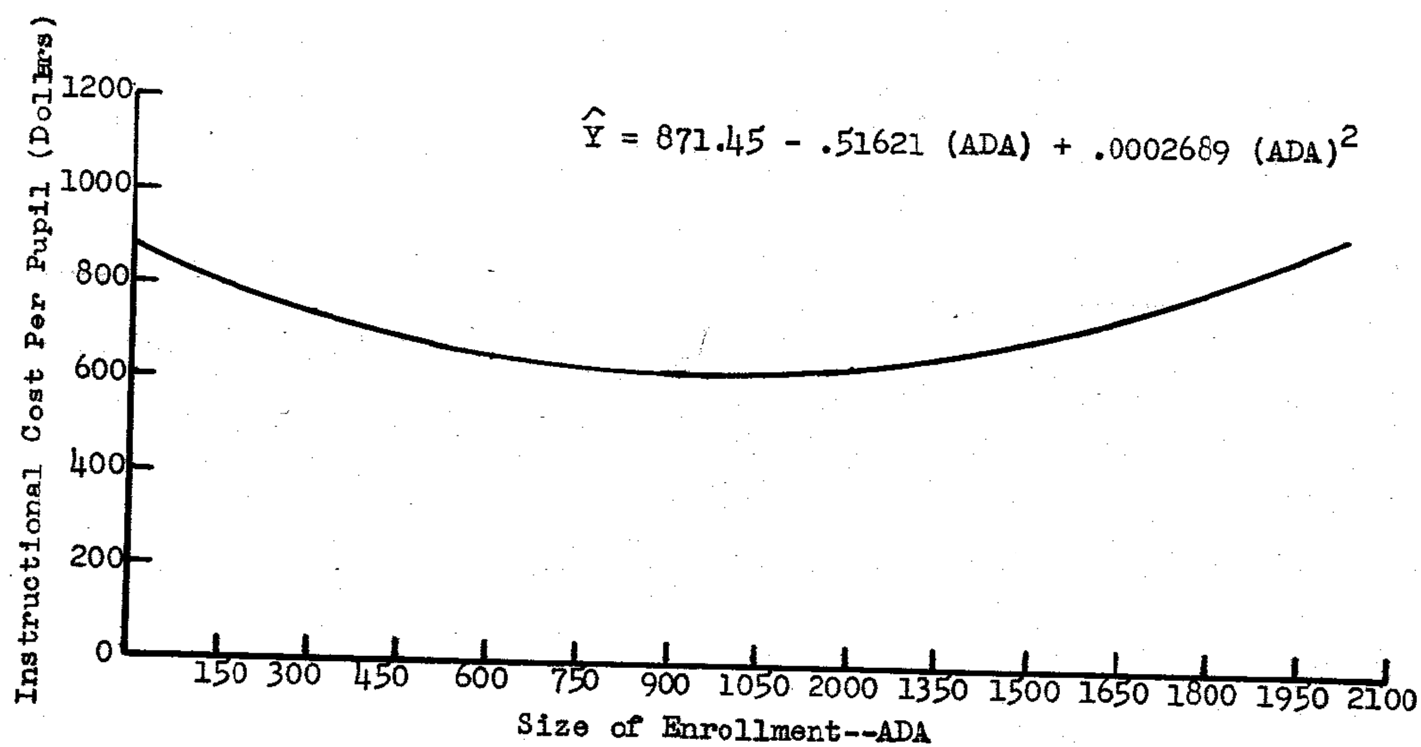

FIGURE 5. ADA Less Than 2000

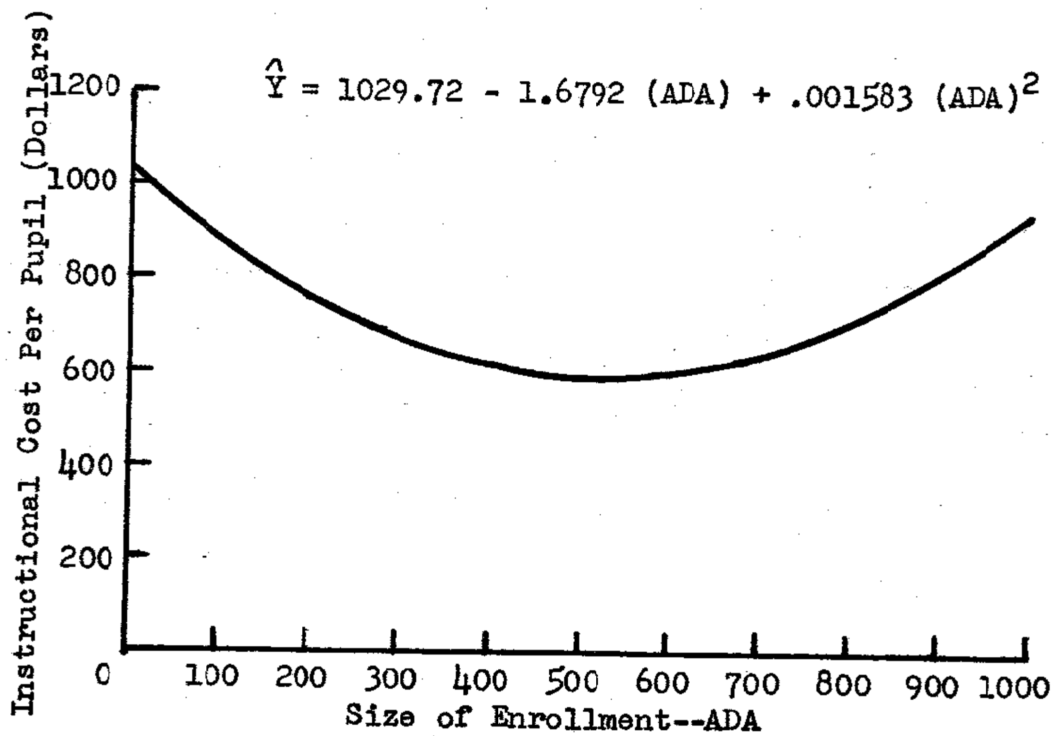

FIGURE 6. ADA Less Than 1000

ADA AND OPERATING EXPENDITURE PER PUPIL

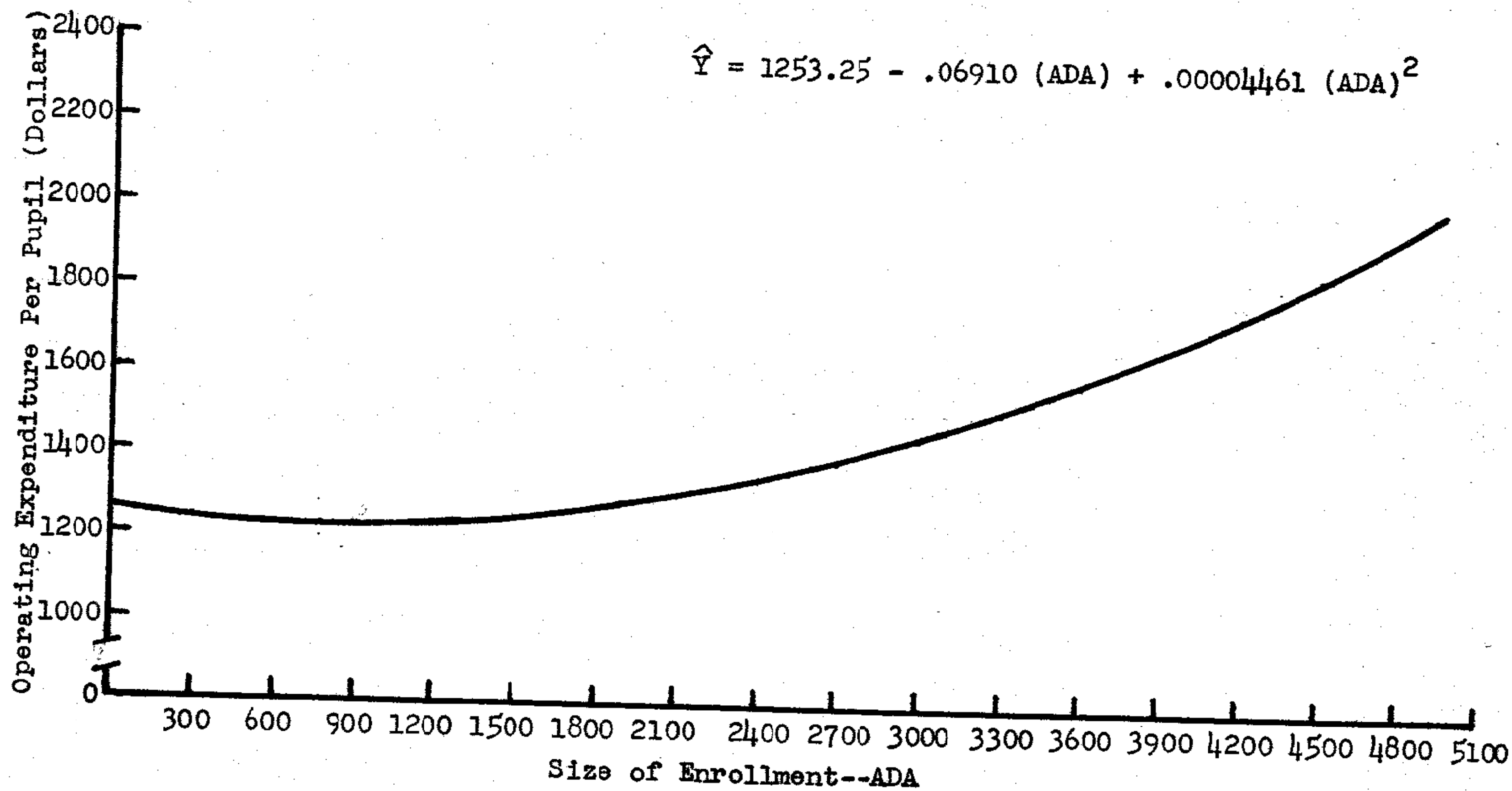

FIGURE 7. ADA Less Than 5000

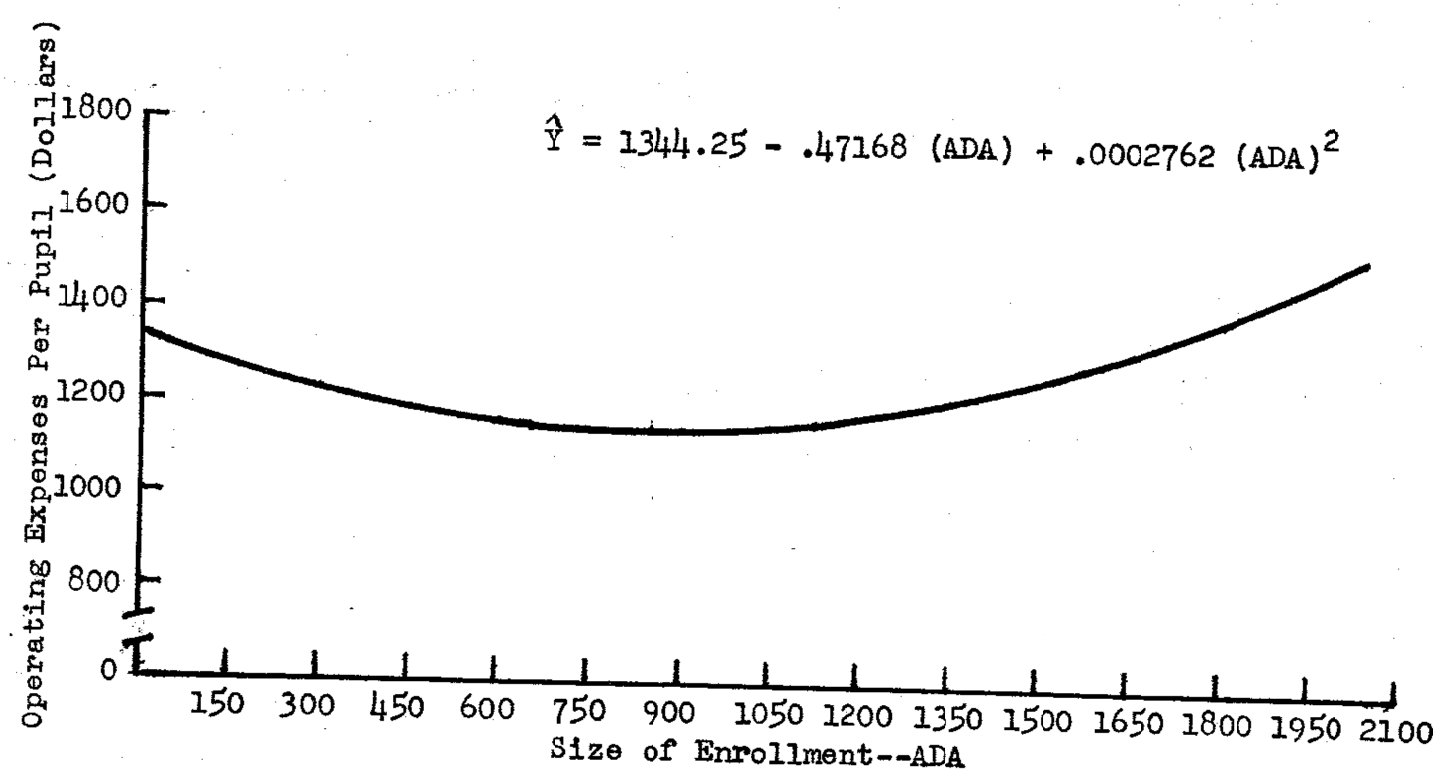

FIGURE 8. ADA Less Than 2000

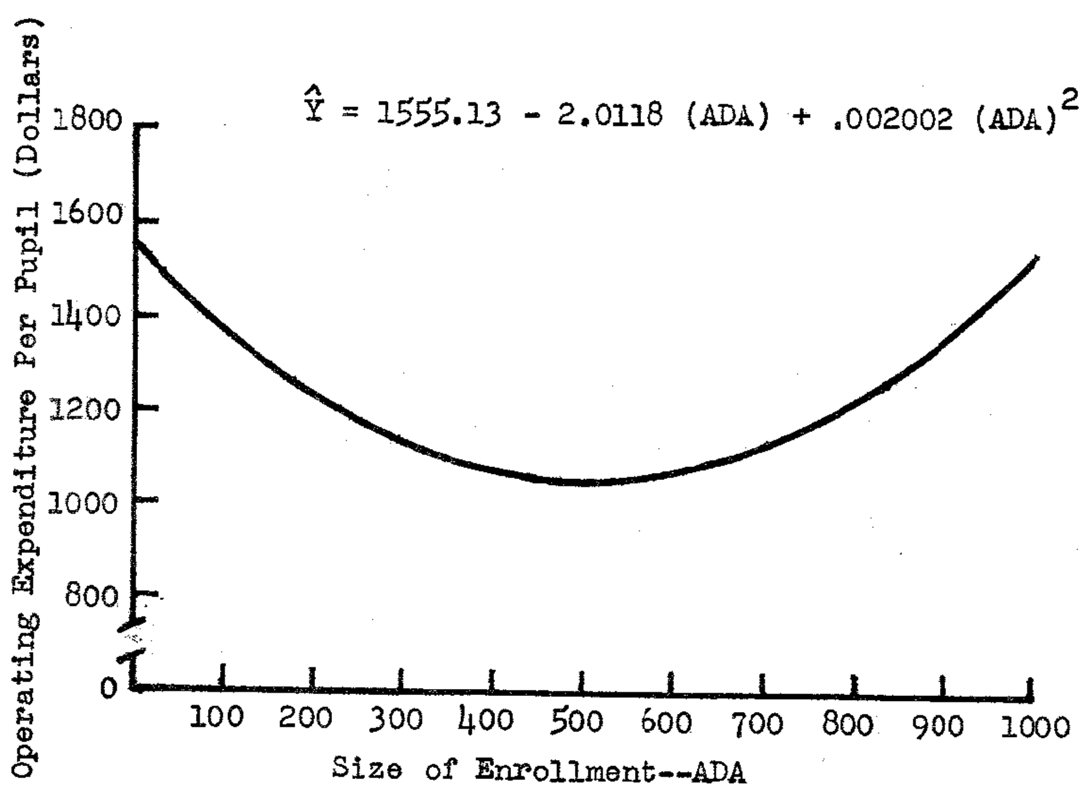

FIGURE 9. **ADA Less Than 1000**

Notes and Bibliographic Data

1. Examples of some recent ones of those studies include:

Nethercutt, Harold Lindy. "An Analysis of Certain Cost Quality Factors Related to the Size of Arkansas School District." Ed.D. dissertation, University of Arkansas, 1971.

Ottey, Wilford Leroy. "Size, Cost, and Educational Opportunities in Selected Pennsylvania School Districts." Ed.D. dissertation, University of Pennsylvania, 1971.

Ovait, Stanley Wixson. "A Study of the Optimum Size of High Schools." Ed.D. dissertation, Michigan State University, 1966.

Sabulao, Casar M. "The Relationship of Size and Cost for the Three Types of School Districts in the State of Illinois." Ph.D. dissertation, Illinois State University, 1970.

Monographs include:

Hickrod, G. Alan, R. G. Chaudhari, T. W. C. Yang, and B. C. Hubbard, Cost-Size Relationship Among School Districts in Illinois (Normal, Illinois: Center for the Study of Educational Finance, Department of Educational Administration, Illinois State University, 1974).

Sabulao, Cesar M., and G. A. Hickrod, Optimum Size of School Districts Relative to Selected Costs, December 1970.

Sher, Jonathan P., and Rachel B. Tompkins. Economy, Efficiency and Equality: The Myths of Rural School and District Consolidation (Washington, D.C.: National Institute of Education, U.S. Department of Health, Education, and Welfare, 1976).

2. This research used data for the doctoral study: Glorina Sabulao. "Relationships Among High School Size, Costs, and Selected Variables." Ph.D. dissertation, Illinois State University, 1977. Special assistance was given by G. Alan Hickrod, Director, Center for the Study of Educational Finance, Illinois State University, and Serafin T. Depakakibo, Jr., a graduate student from the Philippines.

3. Illinois Financial Accounting Manual for Local Education Agencies (Springfield, Illinois: Finance and Claims Section, Department of Fiscal Management, June 1975).

4. Illinois Office of Education. State, Local, and Federal Financing for Illinois Public Schools, 1977-1978 (Springfield, Illinois: Illinois Office of Education, November 1977), pp. 6-10.

5. Illinois Committee on School Organization. "Opportunities for Excellence." Illinois Organization and Structure Task Force, Governor's Commission on Schools, March 1973, p. 19.

6. 1970 Census: Illinois School District Profiles. (Springfield, Illinois: Illinois Office of Education in Cooperation with Illinois State University, 1975).

7. McMahon, Walter W., and Carroll Melton. A Cost of Living Index for Illinois Counties and School Districts (Springfield, Illinois: Illinois Office of Education, 1977).

Appendix A

Following is a demonstrated calculation made by plotting the curve in Figure 1 and determining the optimum cost-size relationship. Similar calculations are used throughout the discussions of the other bivariate cost relationships.

The equation is:

$$\hat{Y} = a + bx + b_1x^2$$

where: Y = Cost (the minimum cost for the optimum size);

a = The constant term (the intercept value of the regression line in the graph);

b = The regression coefficient of the linear term;

b_1 = The regression coefficient of the quadratic term;

x = Independent variable (ADA);

x^2 = Independent variable squared (ADA squared).

The quadratic function relating administrative cost per pupil to size for schools with ADA less than 5,000 (Figure 1) is:

$$\hat{Y} = 153.82 - .06861\ (ADA) + .00001472\ (ADA)^2$$

To obtain the optimum size and cost as a concern of the study, the first derivative (Y^1) is obtained and substitution made as follows:

$$Y^1 = -.06861 + 2(.00001472)\ ADA$$

The first derivative is set = 0 and the equation is solved for ADA:

$$0 = -.06861 + 2(.00001472)\ ADA$$

$$.00002944\ ADA = .06861$$

$$ADA = 2{,}330$$

That is, a minimum cost occurs at ADA = 2,330.

The estimated cost, then, is:

$$\hat{Y} = 153.82 - .06861\ (2{,}330) + .00001472\ (2{,}330)^2$$

$$\hat{Y} = \$74$$