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COST-SIZE RELATIONSHIP AMONG SCHOOL DISTRICTS IN ILLINOIS, 1974

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Study of the financial impact of the loss of pupils brings to mind a related topic in the field of school finance, e.g., the "optimum" size of school districts relative to costs. The literature contains several examples of fitting an average cost curve to school district size. While the search for "optimum" size relative to costs is normally done in terms of school districts (Hirsch, 1960; Hansen, 1963; Sabulao and Hickrod, 1971; St. Louis and McNamara, 1972), it can also be done in terms of attendance units (Riew, 1965; Cohn, 1968) and even in terms of individual educational programs (Cohn and Hu, 1973). As indicated by Cohn (1974) from general economic theory we anticipate the existence of a U shaped or inverted J shaped curve between costs per unit of service or production and the size of the organization producing the unit or providing the service. Although many mathematical formulations can provide such U shaped curves, the preference in recent cost-size studies is for a parabolic arc which is negative in its linear term and positive in the quadratic term. In the more rigorous studies the quadratic term is accepted only if it is shown to be statistically significant. Goodness of fit of the parabolic function is sometimes improved by either a full log or a semi-log transformation. Assuming the quadratic term is statistically significant, or perhaps can be accepted on some other grounds, then by application of the calculus the inflection point of this parabolic arc can be found by dividing the linear coefficient by twice the value of the quadratic coefficient. This simple procedure will establish "optimum" size relative to cost for a given population of school districts, or other units of analysis, at a given

point in time. Unfortunately, this "optimum" size will vary from population to population and from one point in time to another. Nevertheless, the procedure is as good as anything else we currently have in educational fiscal planning.

At the request of the Illinois Office of Education, the Center has computed these "optimum" points relative to cost for 1974 and thus up-dated information provided in an earlier study of Illinois districts by Sabulao and Hickrod (1971). The data in Table 1 relates size in terms of ADA to costs in terms of current operating expenditures. Many other cost functions are possible of course, e.g., transportation, administration, instruction, etc. However, if the focus is upon district consolidation or reorganization then the more global cost functions are usually the ones of interest. The analysis reveals that districts operating most efficiently in 1974 in a strict size-cost sense are unit districts at 2,432 ADA, high school districts at 874 ADA, and elementary districts at 336 ADA.* Each population is treated separately and thus the "optimum" sizes cannot be added together. It should also be noted that these simple gross or bi-variate functions have relatively low explanatory power. Only about nine and one-half percent of the variance in operating expenditures per pupil in Illinois elementary districts can be explained by size alone. For high school districts, size is a better explanatory variable with almost twenty seven and one-half percent of the expenditure variation attributable to size. Even the transformation of all variables into their common logarithms did not greatly improve this overall goodness of fit.

The three bi-variate scatter charts indicate the expected U shaped curves. However, the elementary chart indicates a pronounced clustering of districts

*See Page 7.

in the positive quadratic portion of the chart and a relatively weak clustering in the negative linear portion of the chart. The high school district chart is, on the other hand, almost a "textbook" example of what should be expected in terms of economies and diseconomies of scale. The different nature of the clustering of districts in the elementary population and the relatively low "optimum" for elementary districts alerts one to the principal limitations of a simple bi-variate analysis of this nature.

As Johns (1975) has pointed out, very few of the cost-size studies control for the "quality" of services being provided. It is therefore quite possible, indeed likely, that elementary districts in excess of the indicated cost optimum here, e.g., 336 ADA, are providing a different character and kind of educational experience than those districts at or near the "optimum" relative to cost alone. Until we have cost-size studies with at least acceptable controls for levels of educational service provided, the kinds of "optimum" size indicated herein must be treated with a good deal of caution.

However, even if researchers were able to affect good controls for quality of educational services there would continue to be considerable public policy debate over what, if anything, should be done with these "optimum" size figures. At least two schools of thought exist about diseconomies of scale in the public schools. One school holds that these diseconomies of scale are caused by "necessarily existent" school districts that cannot be reorganized or can be reorganized only with a great deal of force being exerted at the state level. Therefore it follows to this group of theorists that if one places a high priority on equalizing

educational opportunity then the proper course of action for the state government is to help the local school districts meet these high costs of providing "quality" education in small school districts. This sort of thinking has led to so-called "sparsity corrections" in half of the states of the Union (McLure, 1947; Johns, 1975). As might be expected rural school educators and state legislators from rural areas are strong proponents of this point of view. The opposing school of thought believes that there are very few of these so-called "necessarily existent" schools and that the taxpayer is being forced to pay an inordinately high price for local pride and local loyalties. This opposing school of thought, to which a number of economists belong, would build rewards and/or penalties into state grant-in-aid systems so that schools would find it attractive to reorganize, consolidate, cooperate, and otherwise reduce the high cost of "smallness" (Cornell, 1967; Cohn, 1974). Others believe the disadvantages of "bigness" more than outweigh the high costs of "smallness" and would not find these penalties or even rewards acceptable (Coleman, 1972). At least one study believes that both points of view must somehow be included in a state school finance structure (Hooker and Mueller, 1970).

We should finally warn against any fixation on "magic numbers" although the temptation to do so is understandable for state planning purposes. As Hickey (1969) points out, the "optimum" size will vary depending upon the criterion used to judge "optimum." In fact, if certain criteria are used, such as achievement test scores, it may prove impossible to find any "optimum" at all (Kiesling, 1968). When factors other than costs are included and the approach is also

"expert judgment" rather than more exact quantitative procedures, the range of opinions as to "optimum" size is apt to be great. Purdy (1966) for example, reported minimum size recommendations in Ohio to range from 1,600 to 20,000 for 1-12 districts. More recently in Illinois a state commission arrived at the following "minimum" sizes for Illinois school districts: units--1,500; secondaries--500; elementaries--1,000 (Task Force, 1973). The findings of the Task Force do seem to support the cost "optimums" noted here for unit districts and for secondaries, but they are quite different for elementaries. The Task Force presumably took into consideration program variables as well as strictly cost considerations.

Loss of pupils will probably focus more attention on the high costs of small schools in Illinois. However, it is far from clear just what the electorate wants to do about these costs. Lack of knowledge about the relation of variables other than cost to school size is a further limiting factor. It is also not clear that district size is the most important aspect of the situation; it could very well be attendance center size, or educational program size. Finally, some schools will probably always be small no matter what the actions of the state government. The educational opportunities of children in these "forever small" schools cannot be ignored.

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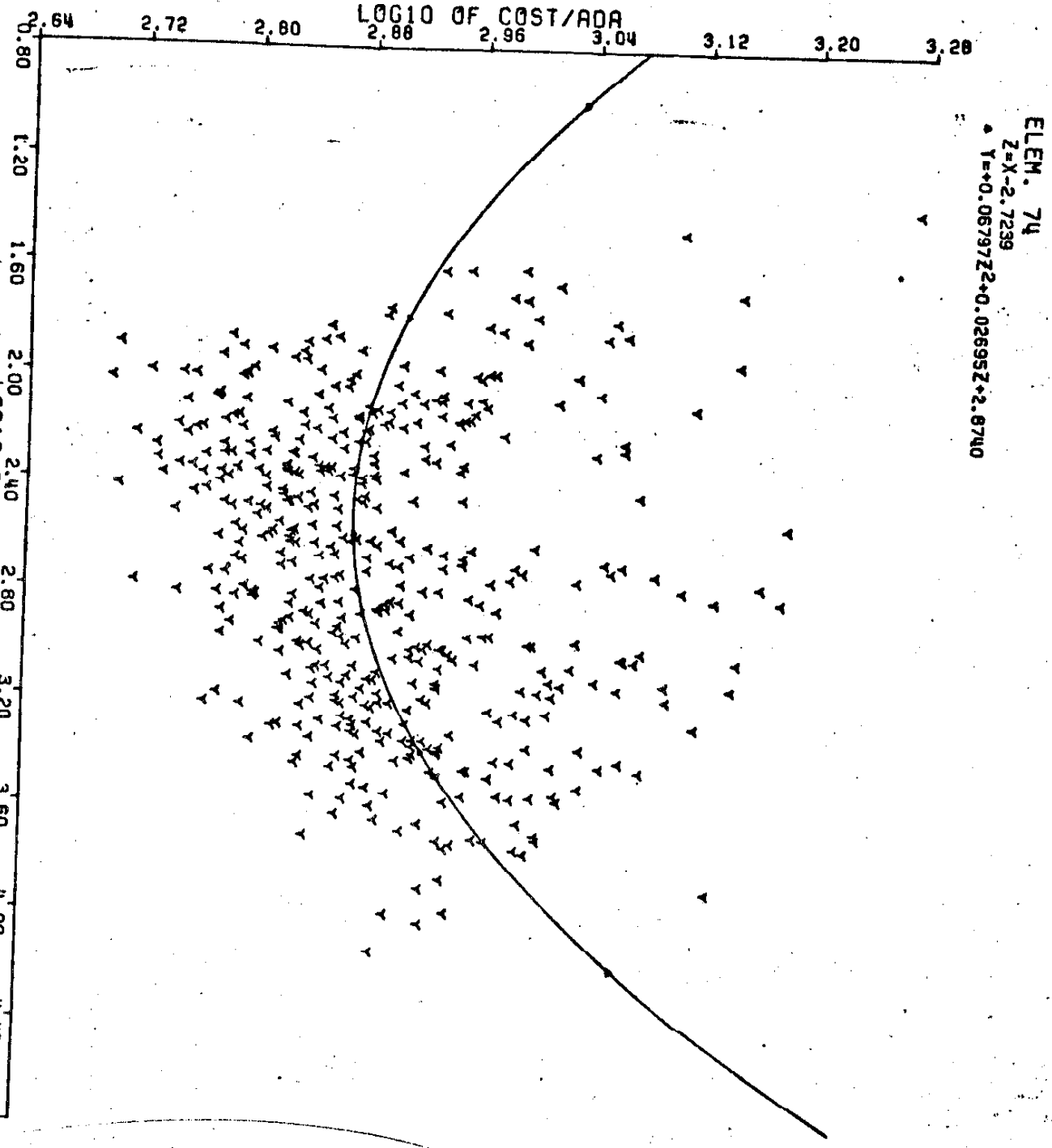
*From Page 2.
Eighty four percent of the unit districts are below the optimum, 50 percent of the high school districts and 41 percent of the elementary districts. The corresponding percentage of pupils below the optimum size are: twenty seven percent for unit districts, nine percent for high school districts and six percent for elementary districts.

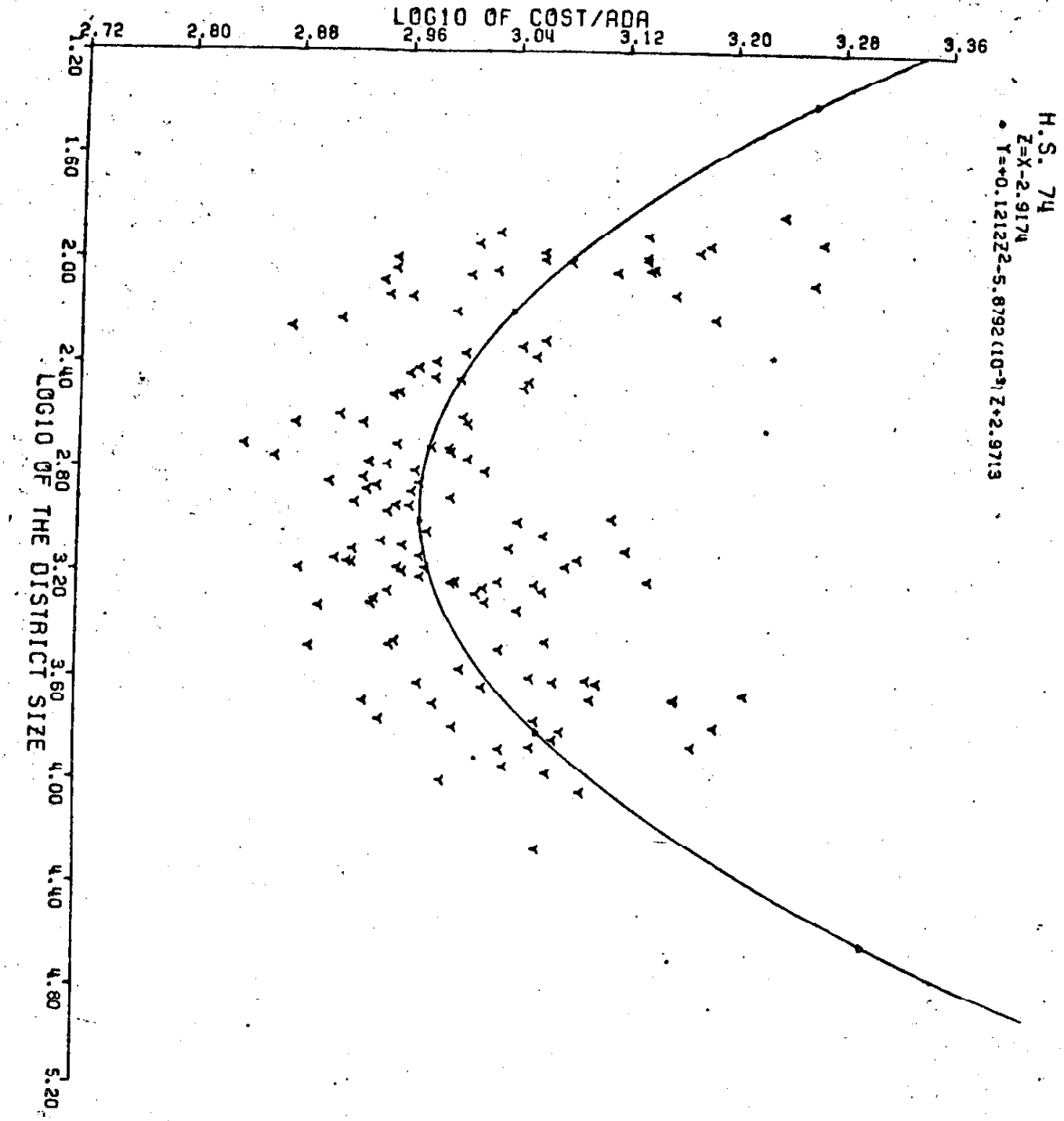
TABLE 1

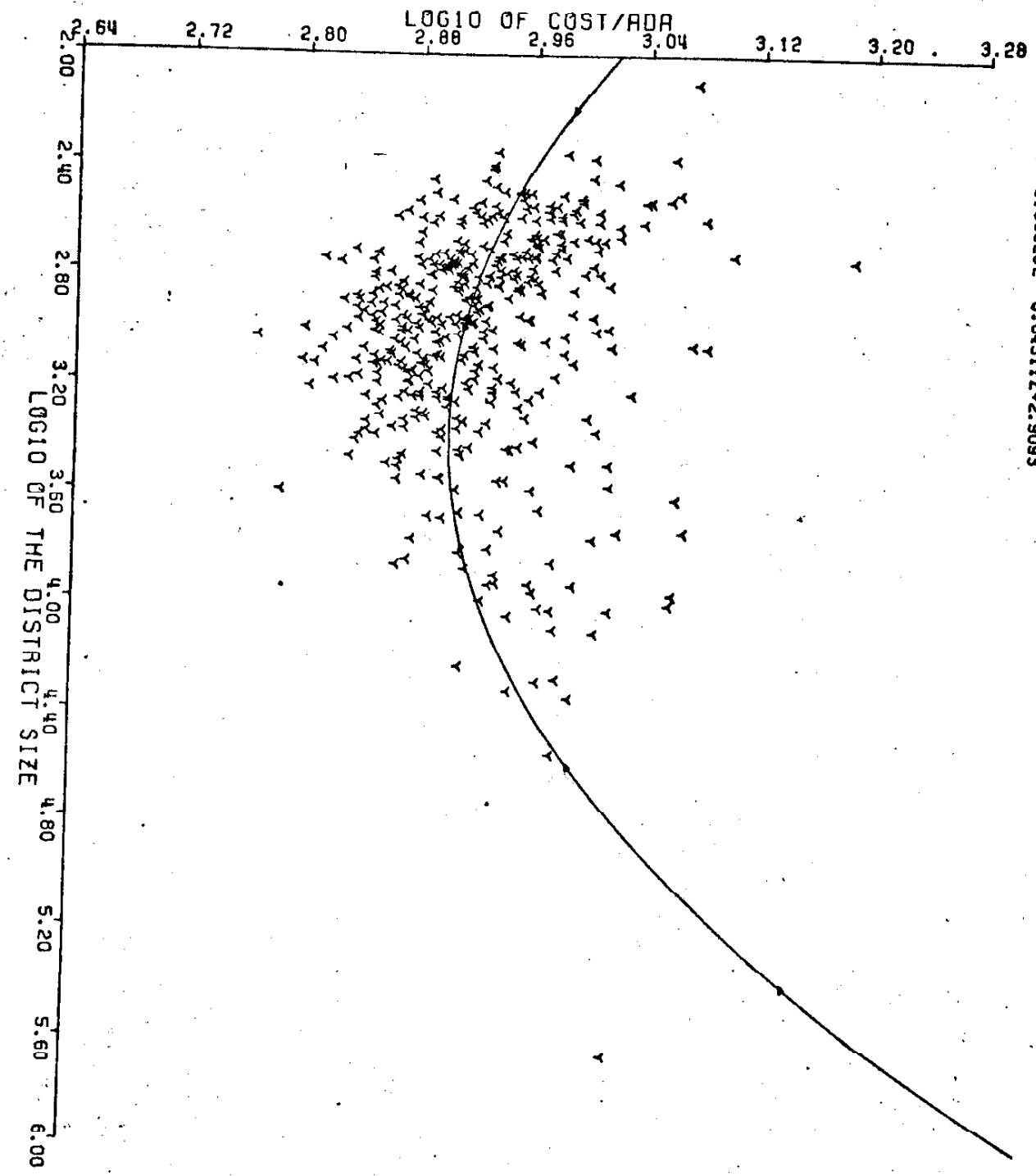
COST-SIZE RELATIONSHIP IN 1974

	Elementary	High School	Unit
a	3.3062	4.0178	3.5901
b_1	-0.3443	-0.7114	-0.4066
b_2	0.0681	0.1209	0.0600
R^2	0.0947	0.2744	0.1310
Optimal Size	336	874	2432
Least Cost	743.61	936.28	797.55

Log (total cost per ADA) = $a + b_1 \text{Log ADA} + b_2 (\text{Log ADA})^2$


LOG10 OF COST/ADA
2.64
2.72
2.80
2.88
2.96
3.04
3.12
3.20
3.28
LOG10 OF THE DISTRICT SIZE
0.80
1.20
1.60
2.00
2.40
2.80
3.20
3.60
4.00
4.40
4.80
ELEM. 74
Z=X-2.7239
Y=+0.06797Z2+0.02695Z+2.8740


LOG10 OF COST/ADA
2.72
2.80
2.88
2.96
3.04
3.12
3.20
3.28
3.36
LOG10 OF THE DISTRICT SIZE
1.20
1.60
2.00
2.40
2.80
3.20
3.60
4.00
4.40
4.80
5.20
H.S. 74
Z=X-2.9174
Y=+0.121222-5.8792(10-1)Z+2.9713


LOG10 OF COST/ADA
2.64
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2.96
3.04
3.12
3.20
3.28
LOG10 OF THE DISTRICT SIZE
2.00
2.40
2.80
3.20
3.60
4.00
4.40
4.80
5.20
5.60
6.00
UNIT 74
Z=X-3.0284
Y=+0.060282Z2-0.04311Z+2.9093