10-1988

An Analysis of Average And Marginal Costs of Iowa School Districts

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An Analysis of Average And Marginal Costs of Iowa School Districts

Abstract
Companion reports the effects of declining enrollments and economies of size on per pupil expenditures; (S) various state aid formulas; (3) adjustment options for declining enrollment and economies of size and (4) expenditure patterns and other characteristics by school district size. This report analyzes average and marginal costs for Iowa school districts.

Disciplines
Behavioral Economics | Economic History | Economic Theory | Growth and Development

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AN "ANALYSIS OF AVERAGE AND MARGINAL COSTS OF IOWA SCHOOL DISTRICTS"

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Economics Department
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OCTOBER 1988

DISCUSSION OUTLINE:

A. What changes in district costs are due to changing enrollment?
   - Case I: Short Run
   - Case II: Intermediate Run
   - Case III: Long Run

B. Transitional Costs and Incentives
   - Transitional Marginal Costs
   - Sharing Incentives
   - Restructuring Incentives
   - Technology Incentives

C. Impacts of Declining Pupils Over Time

D. Are School Expenditures Related to Other Factors?
   - Cost Factors
   - Inputs and Wealth Factors

* This analysis was requested by the Interim School Finance Study Committee of the Iowa Legislature. It was presented to the Study Committee in testimony at the State Capitol, Des Moines, Iowa, November, 1988.

** Dr. Mark A. Edelman is an Associate Professor and Extension Public Policy Economist, Department of Economics, Iowa State University. James J. Knudsen is a Predoctoral Graduate Associate who assisted Dr. Edelman. Dr. Edelman was requested to serve as a consultant to the Iowa Department of Education and the Interim School Finance Study Committee of the Iowa Legislature.
AN ANALYSIS OF AVERAGE AND MARGINAL COSTS OF IOWA SCHOOL DISTRICTS

Companion reports (Edelman and Knudsen, Staff Papers 187; 188; 189; 194), review: (1) the effects of declining enrollments and economies of size on per pupil expenditures; (2) various state aid formulas; (3) adjustment options for declining enrollment and economies of size and (4) expenditure patterns and other characteristics by school district size. This report analyzes average and marginal costs for Iowa school districts.

METHODS

All general fund expenditures for each Iowa school district were grouped into six categories: Administration, General Instruction, Special Education, Transportation, Operation and Maintenance, and Other Support Services (See Note Below).

The Department of Education data base for the Secretary's Annual Report includes data defined by object and program code. The following codes were used to define each category.

* Administration includes: Board of Education, Executive Administration, Building Administration, and All Other Administration.

* General Instruction includes: General Education, Career Education, Skill Development, Co-curricular activities, and Continuing Education.

* Special Education includes: Special Education only.

* Transportation includes: Student Transportation only.

Note: The data for the Secretary's Annual Report are collected from school districts by the Department of Education does not contain information by variable and fixed costs, as requested in the scope of work. However this data base does contain data by program and object code. Costs reported for each program and object code may contain both variable and fixed spending. However, the spending categories selected approximate the variable and fixed spending concepts as nearly as possible.
* Operation and Maintenance includes: operation and maintenance costs only.

* Other Support Services includes: Attendance, Guidance Services, Health, Nutrition, Other Student Services, Library, Audio-Visual Services, Other Instructional Support, Central Debt, Central Insurance, and Other Central Support Services.

MARGINAL COSTS OF CHANGING ENROLLMENT LEVELS

Technical terms often mean different things to different people. Therefore it is appropriate to outline definitions first.

Marginal costs are often defined by economists as the change in total costs resulting from the decrease (or increase) of one unit (pupil). The change in total school district costs depends upon which three presumptions about the accounting methods used. Are full or partial budgeting methods used? Are cash or accrual accounting methods used? What length of time period is analyzed?

For purposes of this analysis, partial budgeting of marginal cash expenditures are defined for the short, intermediate and long run. In each case, the marginal cost of declining students is different due to differences in variable cash costs assumed.

Many economists define the short run as the period required to complete a production cycle. This recognizes that only certain factors of production may be varied during the production cycle or school year. Other factors are fixed during the cycle, but some of these factors can be altered in the intermediate run. In the long run, all production factors are considered variable.

CASE 1: SHORT RUN - ONLY SUPPLIES ARE VARIABLE

During the school year, there is often very little flexibility to vary the level of expenditures except for books and supplies that are directly required for each student.
administration costs, other instructional costs, transportation costs, operation and maintenance costs, and other support service costs are thought to be "sunk" or fixed. Under this set of assumptions the following equation describes the short run variable costs due to a change in pupil enrollment.

(Eq 1.) Short Run Variable Cost / ADM = $174

In Iowa, most of the books and supplies used by each student are either: (1) purchased by parents, (2) rented from school activity funds or (3) purchased by school district general funds. Books purchased by parents do not affect the short run variable costs of the school district. In the case of books rented from the school activity fund, the rental fees charged over the life of the books are sufficient to cover the replacement costs.

Therefore, the short run variable costs funded by the school are the costs of books, materials and supplies purchased for each student by the general operating fund. These purchases represented 5.4 percent ($174 per ADM) of general operating funds during 1986-87. The conclusion from this analysis is that in the short run, the actual reduction in district cost is likely to be about $175 times the change in the number of pupils.

The marginal state aid revenue for a short run change in pupils is $0 because the state aid formula allows the superintendent to use the larger of the current year enrollment or the previous year enrollment.

CASE II: INTERMEDIATE RUN - INSTRUCTION AND ADMINISTRATION VARY

Over the course of a few years (perhaps something greater
than one year but less than 10 years), as the number of pupils change, more categories of costs become variable. For example, Debertin shows that average teacher cost per pupil directly varies with adjustments in the ratio of pupils and teachers.

<table>
<thead>
<tr>
<th>Pupils / Teacher Ratio</th>
<th>Teacher Cost Per Pupil</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$25,000</td>
</tr>
<tr>
<td>5</td>
<td>5,000</td>
</tr>
<tr>
<td>10</td>
<td>2,500</td>
</tr>
<tr>
<td>15</td>
<td>1,667</td>
</tr>
<tr>
<td>20</td>
<td>1,250</td>
</tr>
<tr>
<td>25</td>
<td>1,000</td>
</tr>
<tr>
<td>30</td>
<td>833</td>
</tr>
</tbody>
</table>

From our regression analyses, we conclude that administration costs as well as instruction costs vary significantly due to enrollment. However, the regression analyses also indicated that transportation costs and operation and maintenance costs were poorly explained by enrollment levels. Transportation costs were associated to the geographic size of the district rather than density or enrollment level.

As a result, our estimates of variable costs due to changing enrollment are based on the assumption that administration and instructional costs (including special education instruction) are variable over the intermediate run. Transportation, operation and maintenance, and other support services are considered to be sunken fixed costs. Under these assumptions, the following equation describes the additional intermediate run costs per pupil due to a pupil enrollment change for an average district.

(Eq 2) Intermediate Run Variable Cost / ADM =

\[
2100.4 + 0.029891(ADM) + 178150(1/ADM)
\]
Based on this formula, the decline in the intermediate run costs due to enrollment declines would generally be greater than the decline in state aid revenue received for most school districts. For example, the decline in marginal revenue from the state aid formula would likely be about $1968 per pupil of ADM change for districts that receive 60 percent of their budget revenue from state aid, ignoring phantom pupils. The lowest intermediate variable cost per pupil is $2246 for school districts with 2500 ADM (Table 1). In this example, if local sources of revenue were held constant during an enrollment decline, the intermediate decline in estimated variable costs would be greater than the state aid decline for such districts.

Since most districts would have higher intermediate run variable costs and lower proportions of state aid than in this example, we may conclude that the decline in the intermediate run costs due to enrollment declines would be greater than the decline in state aid revenue received. Perhaps this may partially explain why pupil/teacher ratios tend to fall and course units tend to remain relatively constant when enrollment significantly declines over the intermediate run.

CASE III: LONG RUN - ALL COSTS ARE VARIABLE

In the long run, all cost categories are allowed to vary. Regression analysis was used to estimate a total average cost curve for Iowa school districts (See Model 4 in Table 3). Marginal long run costs can be calculated from the total average cost equations. Both equations are reported below.
(Eq 3) Total Long-Run Average Cost / ADM =

\[2683.1 + 0.037443 \text{ (ADM)} + 223250 \text{ (1/ADM)} + 0.66147 \text{ (sqmi)}\]

(Eq 4) Long Run Marginal Cost / ADM =

\[2683.1 + 0.074886 \text{ (ADM)} + 0.66147 \text{ (sqmi)}\]

Note that in both equations, transportation costs are allowed to vary depending upon geographic area of the district. The average geographic size of school districts in Iowa is 130 square miles. This was used for the comparisons made in Table 1.

In theory, if long run marginal costs are less than long run total average costs, the school district could lower average costs by adding more pupils, if they are available. On the other hand, if the marginal costs are greater than long run total average costs, the school district could lower average costs by reducing the number of pupils. Long run total average costs are minimized at districts with 2442 pupils. At that level, long run total average costs equal long run marginal costs.

A note of caution is in order for this type of traditional economic analysis. This theoretical analysis for minimizing long run average costs ignores the spatial, transitional, and political costs associated with structural change. For many, the spatial limitations, transitional costs, and political constraints are viewed to be significant and provide practical barriers that prevent us from converting all districts to 2442 pupils.
Table 1. Estimated Variable and Marginal Costs Per Pupil for Iowa Schools, 1986/87.

<table>
<thead>
<tr>
<th>Dist Size of School ADM</th>
<th>Percent</th>
<th>Short Run Variable Costs * ($/ADM)</th>
<th>Intermediate Variable Costs ** ($/ADM)</th>
<th>Long Run Variable Marginal Costs *** ($/ADM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.3</td>
<td>250</td>
<td>174</td>
<td>2820</td>
<td>3671</td>
</tr>
<tr>
<td>19.7</td>
<td>400</td>
<td>174</td>
<td>2558</td>
<td>3342</td>
</tr>
<tr>
<td>21.4</td>
<td>600</td>
<td>174</td>
<td>2415</td>
<td>3164</td>
</tr>
<tr>
<td>22.0</td>
<td>1000</td>
<td>174</td>
<td>2308</td>
<td>3030</td>
</tr>
<tr>
<td>16.3</td>
<td>2500</td>
<td>174</td>
<td>2246</td>
<td>2952</td>
</tr>
<tr>
<td>5.5</td>
<td>7500</td>
<td>174</td>
<td>2348</td>
<td>3080</td>
</tr>
</tbody>
</table>

* Variable costs include general fund books and supplies.
** Variable costs include administration and instruction costs.
*** Variable costs include all general fund expenditures.

TRANSITIONAL INCENTIVES AND MARGINAL COSTS

The potential impacts of restructuring changes on school district programs, course offerings, and pupil/teacher ratios may provide significant transitional incentives or disincentives, depending upon the perceptions of local opinion leaders. Therefore, the program impacts of the structural change is one of the first components of gauging transition costs.

The transitional costs of achieving economies of size also depend upon the specific local opportunities available. In general, one economic consideration in restructuring is whether the savings from instructional costs, administration, and operating costs under consolidation more than offset the higher transportation costs. In some states, the geographic area of some districts is so large that consolidation is not justified.
Third, transitional costs may depend on the age and adequacy of existing buildings. Is there enough excess capacity and empty seats in existing buildings to handle consolidation without building new buildings? The cost of any new buildings required may significantly alter the transitional costs.

Fourth, some districts consider consolidation due to property wealth differences. For example, district decision-makers may have more interest in merging with a district with a large power plant than one without. Power plants are large property taxpayers but have few children to educate.

Local politics, economic growth, values, and preferences are important considerations. With declining birth rates, parents represent a declining proportion of the voting public in many communities. Therefore, considerations and values other than preferences of parents are taken into consideration in calculating the political transitional costs.

SHARING INCENTIVES AND MARGINAL COSTS

Iowa provides three types of school district sharing incentives through the school aid formula.

First, Iowa school districts may add one pupil to their state aid weighted enrollment if they share certain math, science, and foreign language teachers. While the extra-state aid depends upon the district's property wealth per pupil, for a typical district with 50 percent of the budget coming from state aid, the special course weight may mean an extra $1600 per shared course.

Second, Iowa school districts may add .05 multiplied by the number of pupils for each administrator shared. There is a maximum on aid for one district of an additional 15 pupils and a
two district maximum of 25 additional pupils. A district with 300 pupils would reach the 15 pupil maximum. Two districts with 500 pupils combined would reach the 25 pupil maximum. Assuming a 50 percent state aid ratio or $1600 per pupil, this would mean an additional $24,000 in state aid for the district with 300 pupils and an additional $41,000 in state aid for the two districts with 500 pupils combined.

The third district sharing incentive is for whole grade sharing. Districts may add .5 multiplied by the number of shared-students to their state aid weighted enrollment. For districts with a 50 percent state aid ratio that are sharing 100 pupils, the additional state aid would amount to $80,000.

REORGANIZATION INCENTIVES AND MARGINAL COSTS

The Iowa code provides two types of incentives for school district reorganization. First, districts with less than 600 pupils that reorganize, receive a property tax levy rate reduction of $1/1000 valuation financed by additional state aid. This property tax credit is phased out by $.20/1000 per year over five years. For taxpayers in a district with $100,000,000 in property valuation, the first year property tax credit would reduce property taxes by $100,000.

Iowa also provides "supplemental aid" for districts with less than 600 pupils that reorganize. For supplemental aid, the state guarantees the previous property tax rate of each district for five years. There is no limit specified on the amount of aid. This provision is a significant incentive. For example, consolidating districts could theoretically build new buildings and have the bonds paid off over five years at state expense.
TELECOMMUNICATION INCENTIVES

New telecommunications technologies are viewed as an alternative to school district sharing in some states. Such technologies may be used for selected specialized subjects. Presently, Iowa requires that certified teachers be present at each downlink site when satellite and fiber optics technologies are used by teachers at remote teaching stations. The certified teacher requirement is viewed by some administrators as a disincentive for adopting this new technology. As a result, the Iowa telecommunications policy may tend to shift local emphasis toward the school sharing and restructuring options.

ADJUSTMENT IMPACTS OF DECLINING ENROLLMENT OVER TIME

Regarding "phantom" or "ghost" pupils, an analysis was conducted to determine how long school districts normally take to make intermediate adjustments to school expenditures. Two sets of three regressions included total expenditures as the dependent variable. The independent variables for the first set of regressions included ADM and the percent decline in ADM for each of the previous four years. When using lagged values in this fashion, multicollinearity among the independent variables is likely to be present. However, even with this likelihood, it appears that changes in enrollment are likely to affect school district expenditures for 2 to 3 years after such enrollment changes take place.

<table>
<thead>
<tr>
<th>Year of Expenditures</th>
<th>Percent Decline in ADM</th>
<th>1 Year</th>
<th>2 Year</th>
<th>3 Year</th>
<th>4 Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1986/87</td>
<td>*</td>
<td>*</td>
<td>**</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>1985/86</td>
<td>*</td>
<td>**</td>
<td>*</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>1984/85</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year of Lagged Expenditures</th>
<th>1 Year</th>
<th>2 Year</th>
<th>3 Year</th>
<th>4 Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1986/87</td>
<td>*</td>
<td>**</td>
<td>**</td>
<td>-</td>
</tr>
<tr>
<td>1985/86</td>
<td>*</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1984/85</td>
<td>*</td>
<td>*</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

* Significantly different from zero at the p = .05 level.
* Significantly different from zero at the p = .01 level.
- Not significantly different from zero.
NA data not available.

It may be important to recognize that the need for a longer "de-ghost" may be related to how rapidly enrollment is declining. For example, districts with one percent decline in enrollment could perhaps make their adjustment in one year. Districts with a two percent decline, might make their adjustments in two years. And districts with a three percent or greater decline might make their adjustments within three years.

If the need for adjustment is shorter than the length of the "de-ghost" aid, then the aid may encourage inefficiency and translate into rather substantial increases in per pupil funding with little basis for empirical justification. However, in the final analysis, the length of the "de-ghost" aid is a political rather than an economic decision.

Two additional alternative approaches are described more fully in our previous report. A three-year moving average of enrollment could be used. Or alternatively, the "de-ghost" aid
could be phased out over three years by counting all of last year's decline, two-thirds of the decline from two years ago, and one-third of the decline from three years ago. (Edelman and Knudsen, Staff Paper 189 Revised).

ARE SCHOOL EXPENDITURES RELATED TO OTHER FACTORS?

This section reviews the regression analyses that were conducted. The data used are from three different sources. Most of the data are from the Iowa Department of Education, Secretary's Annual Report. However, some of the data analyzed are from the Iowa Department of Education, Basic-Education Data Survey. The income and property tax data were obtained through the Legislative Fiscal Bureau from the Iowa Department of Revenue and Iowa Department of Management.

EXPENDITURES AND COST CHARACTERISTICS?

After review of the literature, several models were constructed to evaluate the existence of economies of scale in Iowa school expenditures. Five models were selected (Table 3).

* Model 1 represents the standard parabola or U-shaped average cost curve similar to the form used in earlier work by Sheffield.

* Model 2 represents an hyperbola or L-shaped average cost curve that continuously declines to the right.

* Models 3, 4 and 5 represent an asymmetric U-shaped average cost curve that is somewhat similar to Model 2 except that a minimum may be reached and average costs may rise as size increases.
Table 3. Regression Results From Empirical Models Used to Estimate an Average Cost Function for Iowa Schools, 1986/87.

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>3394.8*</td>
<td>2870.0*</td>
<td>2795.8*</td>
<td>2683.1*</td>
<td>2611.3*</td>
</tr>
<tr>
<td>ADM</td>
<td>-.09667*</td>
<td>-</td>
<td>.035135*</td>
<td>.037443*</td>
<td>.041694*</td>
</tr>
<tr>
<td>ADM $^2$</td>
<td>.0000037*</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1/ADM</td>
<td>-</td>
<td>196510*</td>
<td>212500*</td>
<td>223250*</td>
<td>195130*</td>
</tr>
<tr>
<td>Input Index</td>
<td>96.845*</td>
<td>77.971*</td>
<td>75.093*</td>
<td>70.999*</td>
<td>72.061*</td>
</tr>
<tr>
<td>Area</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>.66147*</td>
<td>-</td>
</tr>
<tr>
<td>$R^2$</td>
<td>.1507</td>
<td>.6226</td>
<td>.6456</td>
<td>.6526</td>
<td>.6368</td>
</tr>
</tbody>
</table>

* Significant at the $p = .05$ level.

The standard U-shaped form of Model 1, provides the poorest fit as signified by the lowest $R^2$ value. The other four models do not differ greatly. However the modified U-shaped form of Models 3 and 4 appear to fit the data better as signified by a slightly higher $R^2$. Inspection of the actual data plotted by district size (Figure 1) shows a slight upturn to the average expenditure data at higher enrollment levels. Notice the greater number of school districts below 2000 pupils and that there is considerably wider variation in average expenditures per pupil among these districts than for the larger districts (Figure 2).

Each model includes an input index as an independent variable. The input index is a composite of five input characteristics: pupil/teacher ratio, course units, district average teacher experience, number of instructional support staff, and school building value/pupil. Each district was assigned values of "1", "0", and "-1" depending upon whether the
Figure 1: Plot of Average Expenditures Per Pupil for Iowa School Districts, 1986-87.

Legend: A = 1 observation, B = 2 observations, etc.
+ = symbol for average plot of Model 4 for each district size group.

Note: 388 observations hidden.
Note: 307 observations hidden.

Figure 2: Plot of Average Expenditures Per Pupil for Iowa School Districts With Less Than 2000 Pupils, 1986/87.
Legend: A = 1 observation, B = 2 observations, etc.
+ = symbol for average plot of Model 4 for each district size group.
district was in the higher third, middle third, or lower third of all school districts with respect to each characteristic. All five values were added for the input index. Larger values of the index implies lower pupil/teacher ratios, larger course selection, more instructional support, more experienced teachers, and more investment in buildings.

The input index is used rather than individual variables for parsimony and to avoid problems of multicollinearity. In all cases, the coefficient on the input index is positive, and significant from zero indicating that higher index values are associated with higher costs. The index was included to provide an adjustment for differences across similar sized districts due to input differences in course units, pupil/teacher ratios, teacher experience, support staff, and building investment.

Square miles of the district was added as an independent variable to Model 3 in order to create Model 4. This allows for an adjustment depending upon district size. Both area and density (students per square mile) were originally added. However, pupil density was an insignificant explanatory variable. Therefore, only area (square miles) was added in Model 4.

In addition, Model 5 was run and is exactly the same as Model 3, except in this run the dependent variable was average school expenditures per pupil excluding transportation. The explanatory power of the regression was only slightly lower than Models 3 and 4. One explanation for this might be the Iowa law places spending controls on the total operating budget including transportation. This may contribute to a shift and an increase in the variation of per pupil school expenditures excluding...
transportation due to the variability of per pupil transportation costs across districts. The plot of expenditures excluding transportation for districts under 2000 enrollment (Figure 3) continues to indicate wide variation in average expenditures per pupil compared to data with transportation included (Figure 2).

As a result, Models 4 and 5 were selected as the most appropriate models for predicting school expenditures depending upon whether transportation expenditures are included or excluded from the analysis. A comparison of the predicted and actual group means provide additional support that the appropriate form has been used in the regressions (Table 4).

Table 4. A Comparison of Predicted and Actual Values for Average Expenditures per Pupil of Iowa School Districts, 1986/87.

<table>
<thead>
<tr>
<th>District Size</th>
<th>Transportation Included</th>
<th>Transportation Excluded</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exp./ADM Exp./ADM</td>
<td>Exp./ADM Exp./ADM</td>
</tr>
<tr>
<td>0-249</td>
<td>3671 3833</td>
<td>3402 3578</td>
</tr>
<tr>
<td>250</td>
<td>3342 3115</td>
<td>2962 2925</td>
</tr>
<tr>
<td>250-399</td>
<td>3164 2985</td>
<td>2848 2923</td>
</tr>
<tr>
<td>400</td>
<td>3030 2848</td>
<td>2794 2923</td>
</tr>
<tr>
<td>400-599</td>
<td>3099 2950</td>
<td>2950 3050</td>
</tr>
<tr>
<td>600</td>
<td>3168 3079</td>
<td>2950 3202</td>
</tr>
<tr>
<td>600-999</td>
<td>3146 3305</td>
<td>2925 3202</td>
</tr>
<tr>
<td>1000</td>
<td>2952 3168</td>
<td>2794 3050</td>
</tr>
<tr>
<td>1000-2499</td>
<td>2848 3079</td>
<td>2923 3202</td>
</tr>
<tr>
<td>2500</td>
<td>2794 3079</td>
<td>3050 3202</td>
</tr>
<tr>
<td>2500-7499</td>
<td>2950 3079</td>
<td>3050 3202</td>
</tr>
<tr>
<td>7500</td>
<td>2950 3079</td>
<td>3050 3202</td>
</tr>
<tr>
<td>7500-up</td>
<td>3079 3305</td>
<td>3050 3202</td>
</tr>
</tbody>
</table>

The following points summarize the cost function regressions:

* Iowa school districts exhibit a modified U-shaped average costs curve.
Note: 309 observations hidden.

Figure 3: Plot of Average Expenditures Per Pupil Excluding Transportation for Iowa School Districts, 1986-87.
Legend: A = 1 observation, B = 2 observations, etc.
+ = symbol for average plot of Model 5 for each size group.
* Average costs including transportation are minimized at $2952 per pupil and 2442 pupils. However, most size economies (within $100 per pupil) are achieved at 900 pupils.

* Average costs excluding transportation are minimized at $2792 per pupil and 2163 pupils. When excluding transportation expenditures, economies of size are lower and most size economies (within $100 per pupil) are achieved at 800 pupils.

INPUT CHARACTERISTICS AND WEALTH

Two additional regression equations were run to analyze school district characteristics not directly associated with economic cost functions, but related to expenditure patterns (Table 5). Model 6 represents an analysis of four variables used in constructing the input index. The signs on these variables reflect how each is related to average expenditures. Due to the multicollinearity, it is not appropriate to use the input coefficients in Model 6, however it is more appropriate to interpret the signs of the coefficients as follows:

* As pupil/teacher ratios increase, expenditures per pupil tend to decline.

* As course units, teacher experience, and building value per pupil rise, expenditures per pupil also rise.

Note that the $R^2$ value for Model 6 (Table 5) is only slightly lower than the value for Model 3 (Table 3). From this we conclude that the input index in Model 3 is nearly as efficient in explaining the variation of the dependent variable as are the separate input variables in Model 6. However, the input index avoids the multicollinearity problem.

Model 7 evaluates relationships between expenditures per pupil and measures of economic status and local effort.
Table 5. Regression Results with Inputs and Wealth Factors as Explanatory Variables for Iowa School Expenditures Per Pupil, 1986/87.

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Model 6:</th>
<th>Model 7:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>2397.1*</td>
<td>1433.4*</td>
</tr>
<tr>
<td>ADM</td>
<td>-.0039</td>
<td>.018775*</td>
</tr>
<tr>
<td>1/ADM</td>
<td>215940*</td>
<td>184860*</td>
</tr>
<tr>
<td>Area</td>
<td></td>
<td>.91908*</td>
</tr>
<tr>
<td>Input Index</td>
<td></td>
<td>55.845*</td>
</tr>
<tr>
<td>Pupil/Teacher Ratio</td>
<td>-34.034*</td>
<td></td>
</tr>
<tr>
<td>High School Course Units</td>
<td>5.8313*</td>
<td></td>
</tr>
<tr>
<td>Teacher Experience</td>
<td>35.552*</td>
<td></td>
</tr>
<tr>
<td>Building Value/ADM</td>
<td>.017507*</td>
<td></td>
</tr>
<tr>
<td>Adj. Gr. Income/ADM</td>
<td></td>
<td>.0067886*</td>
</tr>
<tr>
<td>Property Valuation/ADM</td>
<td></td>
<td>.0021*</td>
</tr>
<tr>
<td>Property Tax Levy Rate</td>
<td></td>
<td>58.154*</td>
</tr>
<tr>
<td>R</td>
<td>.6508</td>
<td>.7407</td>
</tr>
</tbody>
</table>

* Significant at the p = .05 level.

Specifically, the measures of wealth included in Model 7 are adjusted gross income per pupil and property valuation per pupil. The measure of local effort is the school property tax general fund levy rate. All three variables are significant.

* Increases in valuation per pupil, adjusted gross income per pupil, and school levy rate are associated with increases in expenditures per pupil.
REFERENCES


