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School district consolidation in a club goods framework

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School district consolidation

in a club goods framework

by

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CHAPTER 1

Introduction

School district consolidation has been a topic of debate in Iowa for decades. Since Iowa is, largely, a rural state there are many small school districts. In addition, the small districts and the large districts tend to have higher per pupil spending than the medium districts. Table 1 illustrates this point.

Table 1. Total spending per pupil (excluding transportation costs) and number of school districts by average daily membership (ADM)[a]

ADM	# OF DISTRICTS	SPENDING PER PUPIL ($)
0-249	58	3578.1
250-399	86	3115.2
400-599	93	2984.8
600-999	96	2925.3
1000-2499	71	2922.9
2500-7499	24	3049.8
7500-	8	3202.6

[a] Secretary's Annual Report, 1986-87. Iowa Department of Education, Des Moines, Iowa.

This table shows that nearly one-third of the school districts (grades K-12) have less than 400 pupils in average daily membership (ADM) and that over half are smaller than 600 pupils. It also shows that the ADM category with the lowest per pupil spending has 1000-2499 students and that more than three-fourths of the school districts in Iowa are smaller than this.

Proponents of school district consolidation argue that small districts should be consolidated so that some of the available economies can be realized. Critics of school district consolidation, however, argue that these numbers do not take into account quality of school services and consolidation costs.

Previous studies of school district consolidation

To answer the question of whether school district consolidation will be beneficial a number of studies have been written. The studies were done both by economists and by experts in education finance and education provision. These studies did not reach a consensus with regard to the benefits (or lack thereof) of school district consolidation but they can be divided into two groups, those that concluded that consolidation is beneficial and those that concluded that consolidation is harmful.

Studies that promoted school district consolidation tend to have one thing in common; they argued that increasing the number of students in a district will lower the cost per pupil in that district. However, they differed in the way they estimated the scale economies and the way and extent that they adjusted for other factors such as quality of school services.

A paper by Webb [29] is an example of the simplest type of analysis. In his paper Webb used overall expenditure per student and instructional expenditure per student for various enrollment categories to determine that the optimal enrollment category for Colorado school districts is 1500-2999 pupils.

Webb's approach has some obvious drawbacks. One problem is that he did not take quality of schooling into account. School districts do not produce homogeneous products; the quality of education provided can vary from district to district and if it varies in a systematic way with regard to district enrollment then consolidation may not be optimal. A second problem is with his use of enrollment categories to determine the optimal enrollment level. If enrollment categories are used, the conclusions are dependent on the choice of categories. In this case the optimal category could easily be misrepresented, with the endpoints off by hundreds of students.

Numerous studies of the educational process have been done by Cohn [9,10,11] including an economy of scale study of Iowa high schools [9]. The method used by Cohn is superior to that used by Webb. Cohn did account for quality in his study. He used the difference between twelfth grade and tenth grade average scores on the Iowa Test of Educational Development (ITED) as an index of quality. He assumed that the differences in average score would measure the gain in achievement provided by the school.

Another way that Cohn improved on studies of the type done by Webb is by using ordinary least squares (OLS) to fit a long run average cost curve. He compared a number of forms for the cost function and settled on a quadratic form as the appropriate one. A quadratic form is the common U-shaped cost curve with a distinct minimum. He estimated this minimum to be at an enrollment of 1500 pupils and that that is the "optimal" school size.

There is one troubling aspect to Cohn's study, however. When he estimated the cost curve, the coefficient on his quality index was not significantly different from zero. There could be a number of reasons why this might occur. First, he could have an accurate measure of quality and quality is unrelated to the average cost of schooling. Intuitively, this does not seem to be likely. Another possibility is that he could have near multicollinearity in his independent variables. In his estimation equations he used various inputs (median teachers' salary, building value per student, course units, etc.) as independent variables. If any of these inputs were linearly related to the quality index, the estimator variances would be large and the likelihood of accepting the hypothesis that they were equal to zero would be increased.

A final reason that the quality index might appear to be unrelated to average cost is that the index of quality may be a poor measure of actual school quality. Since the index is the difference in average class scores it might be a poor index of quality if there were a significant amount of migration into or out of the school or if the dropout rate were large enough. Because of the small size of most of the schools in Iowa it would not take large changes in enrollment to affect the scores. It's impossible to know which of the arguments is correct; however, it seems more likely that there is an error in method than that there is no relationship between average cost and quality.

Research done by Forsythe, Yanagida, and Johnson [13] deals with quality in a different manner. They constructed a quality index from a number of quality proxies in order to have a singular measure of school district quality. The proxies they used to construct their index are pupil-to-teacher ratio, number of credit units offered, average teacher salary, percent of class units taught by properly endorsed teachers, pupil-to-specialist ratio, and the percent of students successfully completing the 12th grade. The quality index was constructed by calculating the mean value for each of the proxies and then, for each district, assigning a value of zero to each of the proxies associated with less quality than average and a value of one to those proxies associated with higher than average quality. These values were then summed for each district with the quality index represented by the total. The quality index has a range of 0 to 6.

Forsythe, Yanagida, and Johnson used this quality index in their estimation of an average total cost curve for school districts in eastern Nebraska. The functional form they chose included average daily attendance (ADA) and 1/ADA as independent variables. This resulted in a nonsymmetric U-shape. Per-pupil total costs were found to be minimized at 1122 students but, because the shape of the cost curve was relatively flat around the minimum, the significant economies of scale were attained by about 400 students. Also, the coefficient on the quality index was positive and significantly different from zero giving support to the hypothesis that providing higher quality educational services is more costly than providing educational services of low quality.

There are two potential problems with the quality index used by Forsythe, Yanagida, and Johnson, however. The first problem is that assigning values of zero and one to the individual proxies based on whether they are above or below average makes no allowance for the magnitude of the deviation from average. For example, a school district that was slightly above average in each category would receive a six as its quality index (the highest score possible) and would rate higher than a district that was the best in five categories but slightly below the mean in one category.

A second potential problem with their index is that each of the proxies is given equal weight in determining the overall index. It would be only a coincidence if each of the proxies were of the same value in producing an educational service. A better quality index would be one that took into account the relative importance of various factors in the production of educational services.

In other research White and Tweeten [30] attempted to determine the optimal school district size for Oklahoma. They improved on other studies by allowing the optimal district size to vary with quality level. The Cohn and the Forsythe, Yanagida, and Johnson studies used a quality index as an independent variable in their estimation of the average cost curve. Because of this, quality was a "shifter" and by construction did not allow the optimum to vary with quality level. On the other hand, White and Tweeten divided the districts into three distinct groups based on the extensiveness of their curriculum. They then estimated separate average cost curves for each group.

White and Tweeten found that districts with more extensive curricula have higher average costs and that the optimal district size increases as the curriculum becomes more extensive. They modeled the per-pupil total costs as a quadratic function of ADA and found the minimum average cost level to range from 550 to 900 pupils depending on the curriculum level. While estimating separate cost curves for various levels of quality is an improvement on other studies, their research could be improved upon by using a better estimate of school district quality than merely breadth of curriculum.

The papers reviewed above represent a sample of the work done on optimal school district size and in support of school district consolidation. Of course, there would be no controversy if there were no detractors. Numerous papers have been written either in outright opposition to consolidation or to argue that the actual savings alluded to in studies of scale economies is overstated.

In a study of New Jersey school districts Walburg and Fowler [28] concluded that the past consolidation of school districts "may have been a move in the wrong direction." They based their conclusion on achievement score data from grades 3, 6, and 9. They regressed these scores on socioeconomic status (SES), expenditure per pupil, and enrollment and found SES to have a significant and positive relationship to test scores, expenditure per pupil to have no effect on test scores, and enrollment to have a significant and negative relationship to test scores. In addition, in support of their conclusion they divided the school districts into twelve enrollment level categories and showed that five of the six smallest categories have above-average scores, whereas all six of the largest categories have below-average scores. This is the evidence that led them to the conclusion that New Jersey is over-consolidated and that consolidation may be detrimental with regard to quality.

While their conclusions may be correct for New Jersey, care must be taken when applying Walberg and Fowler's conclusions to other states. Since New Jersey is an urban state with large school districts, consolidation may mean something entirely different than it does in a small rural state like Iowa. For instance, the smallest six enrollment categories in the Walberg and Fowler study include districts of 36 to 3900 students. While five of these six categories are above average in terms of test scores, the smallest and largest categories of the six have nearly the same score and there is no discernible trend in scores over this range. In Iowa these six enrollment categories would include well over ninety percent of the school districts, so the conclusion that consolidation of districts may lead to lower test scores may not be applicable to Iowa or other rural states.

Other research argued that the savings from consolidation purported by studies of scale economies is not realizable since consolidation is different from adding students to an existing district structure. For instance, a paper by Coleman and LaRocque [12] argued that the higher per pupil costs associated with small school districts are due to lower pupil-to-teacher ratios. Because teacher costs are such a large proportion of total costs, the rate at which teachers are utilized (the pupil-to-teacher ratio) significantly affects per pupil total costs. They further argued that consolidation of small districts with large ones won't result in any total savings but will merely spread the higher costs of the smaller district over a larger base of students. They did concede that savings can occur from reduced administrative costs, but they argued that administrative costs are such a small part of the overall budget that any savings would be insignificant.

The conclusions of Coleman and LaRocque are correct for the districts that they considered. Their study was done for British Columbia, Canada and considered the potential benefits from the consolidation of the smallest 20 school districts in that province. These districts, however, are remote and consolidation offers no reduction in the number of attendance centers or in the number of staff members. Consequently, no savings would accrue due to consolidation.

The problems associated with school district consolidation in British Columbia are not found everywhere that consolidation is being considered. Therefore, the conclusion that consolidation is not beneficial cannot be generalized to all locales.

Research by Holland and Baritelle [20] provided further evidence that the consolidation of school districts may not be universally beneficial. They used a separable programming approach to determine optimal school districts for a single county in the state of Washington. They concluded that savings from consolidation would be approximately 1.3% and that this was too small to justify consolidation.

Holland and Baritelle conceded that scale economies do exist for the districts in the study and that all districts were currently operating below capacity. However, they argued that the county was sparsely populated enough that consolidation would result in increases in explicit transportation costs nearly as large as the savings from more intensive utilization of other resources.

In a study of California school districts Kenny [22] found that the existence of scale economies was not sufficient to conclude that consolidation should take place. Kenny's paper was the only one that showed the provision of educational services within a typical cost minimization framework. His model showed that school providers, acting optimally, would act to provide educational services at a level where increasing returns exist. Because of this, the existence of scale economies does not imply consolidation is necessary but neither does it imply that consolidation will not be beneficial.

To summarize, the studies of school district consolidation that have been done to date have fallen into two groups, those that support consolidation and those that refute the consolidation advocates. The studies that support school district consolidation use the existence of scale economies as support for their argument. Most of these studies attempt to make adjustments for school district quality and they do so in a number of ways. The most common methods used are to use test scores or input characteristics as proxies for quality or to construct an index from test scores or input characteristics. In addition to the research reviewed here, Fox [14] has done an extensive review of school economies-of-size research, and generally district level studies have concluded that size economies do exist.

The case against school district consolidation is made in a number of ways. One argument is that consolidation will lower the quality of educational services. Another common argument is that the savings implied by scale economies research is not fully realizable. Usually, remoteness or population sparsity are cited as reasons why transportation costs may rise to offset the savings from consolidation. And last, Kenny [22] has argued that the mere existence of scale economies is not sufficient to imply that school districts are too small and should be consolidated.

Statement of purpose

The dichotomy in the research on school district consolidation, in addition to the continued public debate on the matter, leads to the conclusion that further research in the area is needed. Improving on the current state of research in the field in order to make more informed policy decisions is the purpose of this study.

The main problem with the current research is that it tends to be evidence in support of a conclusion rather than the derivation of a conclusion from a sound theoretical and empirical base. This is a problem on both sides of the argument. The research in support of consolidation tends to use potential cost savings as an argument for consolidation, and the research against consolidation uses the analysis of specific cases to refute the existence of savings. Neither body of research begins with a theoretical model of educational service provision and uses it to derive a conclusion.

Throughout the current literature the problem of school district quality is a concern. The problem is how to measure it and what happens to it when consolidation takes place.

The purpose of this study is to advance the research into school district consolidation by using the theory of clubs to provide a theoretical basis to analyze the process of school district consolidation and to use a multiple-indicator, multiple-cause estimation technique to estimate school district quality along with other standard econometric techniques to predict the effects of school district consolidation in general.

This study will proceed in the following way. Chapter 2 will outline the basic club good model that will be used throughout the study. Chapters 3 and 4 will adapt the model to the specifics of school district consolidation; Chapter 3 will consider the effects of districts of constrained size and their merger, and Chapter 4 will consider the effect of state aid to school districts. Chapter 5 will be the empirical chapter including the estimation of school district quality and estimation of the efficient production of school services. Finally, Chapter 6 will discuss the implications of the estimation for the theoretical model and make generalizations about the process of consolidation and its predicted effect on efficiency and quality.

CHAPTER 2

Introduction

Goods and services can be classified with regard to their rivalry in consumption and their exclusivity. Classifying them over these two characteristics aids in determining what type of model is appropriate to analyze the provision of the good or service in question.

Goods are exclusive if some individuals (usually nonpayers) may be kept from consuming them. School services are by nature exclusive since it is possible to keep some people from consuming the service. However, as a matter of public policy the public elementary and secondary schools do not exclude any individuals. Consequently, the issue of exclusion is not important in considering the provision of public school services.

In terms of rivalry of consumption, goods and services can be grouped in three ways. The first group would be goods that are completely rival in consumption. Consumption of a rival good by an individual precludes all other individuals from consuming that particular unit of the good. On the other end of the spectrum are goods that are completely nonrival. These goods, once provided, may be consumed by anyone and everyone with each individual receiving the same amount of the good and with each additional consumer in no way diminishing the amount consumed by the others.

The third type of good lies in between these extremes and could be characterized as a congestible good. A congestible good is a good that can be consumed by more than one individual but is not completely nonrival in consumption. In other words, there is a facility that a number of people may use but each additional consumer produces some congestion that lessens the service received by the original consumers. An example of a congestible good is a roadway. As traffic is increased on a fixed stretch of road congestion, occurs. As cars are added noise increases, speed may decrease, and the likelihood of an accident increases; consequently, the addition of automobiles to the roadway imposes a cost on the drivers already on it. This additional cost manifests itself as reduced service to the users of the road.

The provision of school district services can also be characterized as a congestible good. At a particular point in time a school district has employed a certain number of inputs (teachers, principals, school buildings, etc.). The level of service provided to the students and the community is not just a function of the amount of these inputs employed but also the number of students utilizing the inputs. Adding students to a particular level of inputs increases crowding, increases the pupil-to-teacher ratio, and decreases the quality of the educational service provided.

The provision of school district services should be modelled as a congestible good.

Local public service provision framework

Congestible goods have a number of different names in the economics literature. They are referred to at various times as congestible goods, mixed goods, local public goods or services, and club goods. The club goods title is generally associated with goods that are excludable and the other names are used with goods whether excludable or not.

The current literature in this field has its beginning in a classic paper by Tiebout [27]. Tiebout's paper was a response to earlier work in the area of pure public goods (both nonexcludable and nonrival in consumption). He argued that the conclusions about the provision of pure public goods did not necessarily hold for goods provided by local governments. Since the seminal paper by Tiebout, much has been done to explain the efficient provision of local public goods and services and club goods. Many papers design a rigorous framework for Tiebout's exposition and then use it to explain and expand Tiebout's conclusions and, in some instances, to investigate other relevant characteristics of club good or local public good provision (Adams and Royer [3], Adams [1,2], Allen, Amacher and Tollison [5], Buchanan [8], McGuire [23], and Oakland [24], for instance).

Most studies of efficient provision of local public goods and club goods will use, at least, the assumptions made by

Tiebout:

> 1. Consumer-voters are fully mobile and will move to that community where their preference patterns, which are set, are best satisfied.
>
> 2. Consumer-voters are assumed to have full knowledge of differences among revenue and expenditure patterns and to react to these differences.
>
> 3. There are a large number of communities in which the consumer-voters may choose to live.
>
> 4. Restrictions due to employment opportunities are not considered. It may be assumed that all persons are living on dividend income.
>
> 5. The public services supplied exhibit no external economies or diseconomies between communities.
>
> 6. For every pattern of community services set by, say, a city manager who follows the preferences of the older residents of the community, there is an optimal community size.
>
> 7. The last assumption is that communities below the optimum size seek to attract new residents to lower average costs. Those above optimum size do just the opposite. Those at an optimum try to keep their populations constant [27].

When considering the provision of school services in Iowa some of these assumptions seem quite unrealistic. In particular, because Iowa is largely a rural state, many people are tied to specific localities due to their jobs, and there does not exist a large number of communities within commuting distance from those jobs. Because of these limitations, school service provision in Iowa is a special case of local public service provision where mobility is limited; therefore, school district size (number of students) is constrained.

The first part of the theoretical discussion considers an unconstrained model, however. The unconstrained model is closely related to that of Adams and Royer [3] and Adams [1,2] and has some characteristics of a model described by McGuire [23].

Education can be provided at various service levels (X_s) with service level being dependant upon the amount of educational inputs purchased (X) and the number of students utilizing these inputs (N). The expenditure per student (E) is simply the price of the educational inputs (P_x) multiplied by the quantity of purchased inputs divided by the number of students. The objective of the school decision-makers is to maximize the level of service with respect to the number of students and amount of inputs and subject to an exogenously determined level of average expenditure (E^*). The constrained maximization problem for the school administrators can be written:

$$L=X_s(X,N)+\lambda[E^*-P_xX/N]$$

The first order conditions that follow from maximizing L with respect to X, N, and λ are:

$$\partial L/\partial X = \partial X_s/\partial X-\lambda P_x/N = 0 \qquad (1)$$

$$\partial L/\partial N = \partial X_s/\partial N+\lambda P_xX/N^2 = 0 \qquad (2)$$

$$\partial L/\partial \lambda = E^*-P_xX/N = 0 \qquad (3)$$

Dividing Equation 2 by Equation 1 reveals the service maximizing condition:

$$\frac{-\partial X_s/\partial N}{\partial X_s/\partial X} = \frac{X}{N}.$$

This situation is illustrated graphically in Figure 1. In this diagram X_s is an isoservice locus that maximizes the quality of schooling for a fixed level of per student expenditure, E^*. Since educational service is a function of inputs and the number of students, (i.e., $X_s = X_s(X,N)$), the slope of the isoservice locus can be determined by totally differentiating the equation of service provision:

$$dX_s = (\partial X_s/\partial X)dX + (\partial X_s/\partial N)dN.$$

Because $dX_s=0$ along an isoservice locus, the slope of the isoservice locus is:

$$\frac{dX}{dN} = -\frac{\partial X_s/\partial N}{\partial X_s/\partial X}.$$

The isoexpenditure line is a ray from the origin that represents the utilization rate of the inputs. Its slope can be determined by totally differentiating the expenditure equation:

$$dE = (X/N)dP_x - (P_x X/N)dN + (P_x/N)dX.$$

Since dE=0 along an isoexpenditure line and P_x is a parameter the slope of the isoexpenditure line is:

$$\frac{dX}{dN} = \frac{X}{N}.$$

Consequently, at the point of tangency of the isoservice locus and the isoexpenditure line the necessary condition for service maximization is met. This point is a point of technical efficiency; it is the optimal level of inputs and

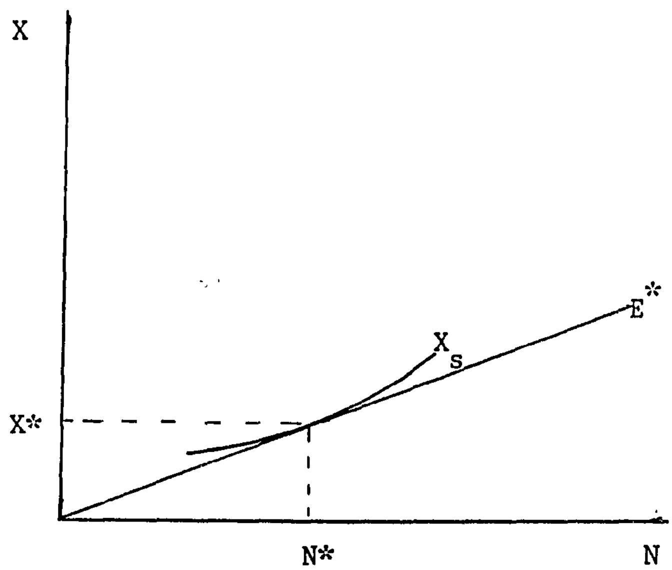

Figure 1. A point of technical efficiency

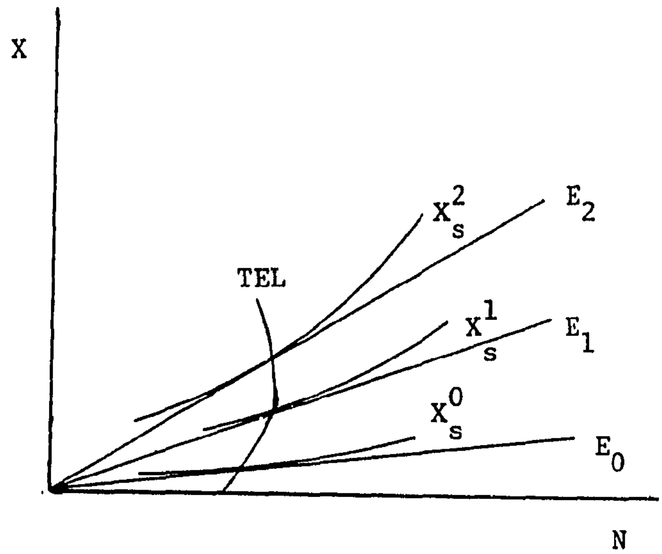

Figure 2. The technical efficiency locus (TEL)

number of students for that level of service. In Figure 1, the optimal number of students is represented by N^* and the required inputs are represented by X^*.

If service level is maximized for every possible level of per-student expenditure the resulting set of tangency points is the technical efficiency locus (TEL). This locus is shown in Figure 2. It could be positively sloped, negatively sloped or backward bending, and the nature of this locus will be the focus of the empirical estimation of Chapter 5.

The service level and average expenditure chosen will depend upon the preferences of the community. Community members are assumed to have homogenous preferences. They receive utility from the educational service provided and from a bundle of private goods (X_r). Their utility function can be written as $U=U(X_s,X_r)$. Their income (y) can be spent on the private good or on the public service. Their budget constraint is:

$$y = P_r X_r + aE$$

where a represents the proportion of the number of students to the number of taxpayers (N_t) and P_r is the price of the private good. For simplicity, let X_r be the numéraire and $P_r=1$. The Lagrangian expression for the representitive individual's constrained utility maximization problem is:

$$L = U(X_s(X,N),X_r) + \lambda[y - X_r - (aP_xX)/N]$$

The individual maximizes L with respect to X, N, and X_r. The first order conditions are:

$$\partial L/\partial X_r = \partial U/\partial X_r - \lambda = 0 \qquad (1)$$

$$\partial L/\partial X = (\partial U/\partial X_s)(\partial X_s/\partial X) - (\lambda a P_x)/N = 0 \qquad (2)$$

$$\partial L/\partial N = (\partial U/\partial X_s)(\partial X_s/\partial N) + (\lambda a P_x X)/N^2 = 0 \qquad (3)$$

$$\partial L/\partial \lambda = y - X_r - (aP_x)/N \qquad (4)$$

Dividing condition 3 by condition 2 reveals:

$$-\frac{\partial X_s/\partial N}{\partial X_s/\partial X} = \frac{X}{N}.$$

In other words, the maximization of utility by the representitive individual and hence, the community, will occur at a level corresponding to a point on the technical efficiency locus. In fact, each affordable point along the technical efficiency locus maps into X_s and X_r space to become the frontier of possible choices for the individual. Each point is a possible point of utility maximization depending on the utility function of the individual.

Therefore, a representative individual's constrained utility maximization determines the optimal level of service, the optimal school district size, the optimal expenditure per student and the optimal level of input usage. This process is illustrated in Figure 3. The left panel shows the consumer's utility maximization problem with the individual choosing X_r and X_s. The right panel shows levels of inputs and enrollment that are implied by the consumers choices.

In this "Tiebout world" the community has the ability to encourage or discourage movement into the community by people

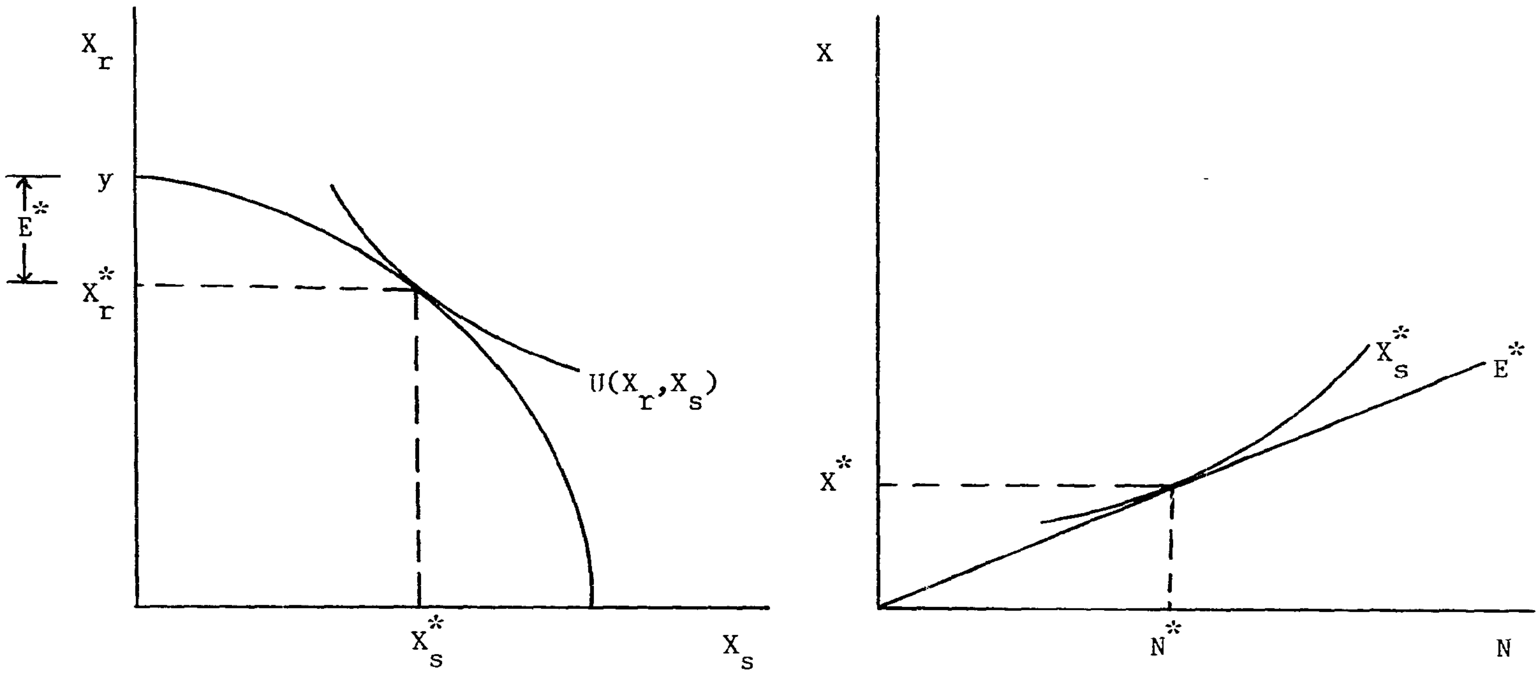

Figure 3. The consumer's maximization problem

with the same preferences and incomes and so guarantee the efficient provision of the local public good. In this world there are as many community types as there are types of people and there is the exact number of people available to insure the efficient provision of the local public good or service in each community.

CHAPTER 3

Introduction

The model presented in Chapter 2 is a general club good or congestible public good model. In order to use this model to describe the provision of school district services some modifications must be made. The first modification, and the subject of this chapter, is the elimination of the free mobility assumption. In most models of congestible public goods an optimal community or club size is guaranteed through the movement of members. However, in order for this assumption to hold individuals must have perfect mobility and a large number of choices of where to live. Since Iowa is a rural state and many of its citizens are tied to particular communities because of their jobs and/or farms it is unrealistic to assume that individuals have free mobility or many choices about where to live. Likewise, it is unrealistic to think that communities can set a service level and entice the optimal number of families to move to the community. For these reasons the general club model must be modified to allow for this additional constraint.

A size-constrained model

The modification of the general model is to consider the choices available to the school administrators and to the community when the number of students is no longer a choice variable. The problem for the school administrators becomes an uninteresting one. Since the administrators are operating with a level of spending fixed by the community's utility maximization and if the number of students is also constrained, the number of inputs to purchase and hence, the service levels are residuals.

The administrator's constrained problem is illustrated in Figure 4. Points along the vertical line from $\bar{N}$ represent the relevant service level and expenditure choices for the community, and once the expenditure level is chosen the administrator can only purchase the requisite number of inputs.

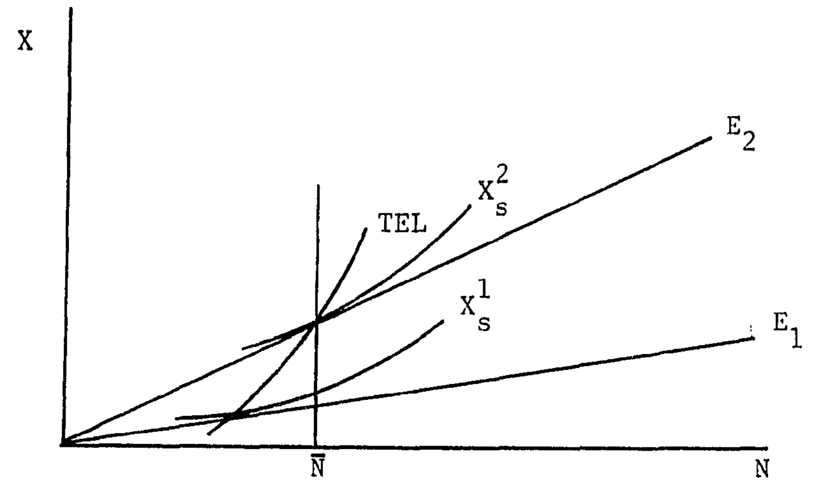

Figure 4. The effect of an enrollment constraint

The constrained optimization for the individual becomes

$$L=U(X_s(X,\bar{N}),X_r)+\lambda[y-X_r-(aP_xX)/\bar{N}]$$

where all variables are as previously defined. The first order conditions are:

$$\frac{\partial L}{\partial X} = \frac{\partial U}{\partial X_s}\frac{\partial X_s}{\partial X} - \frac{\lambda a P_x}{\bar{N}}$$

$$\frac{\partial L}{\partial X_r} = \frac{\partial U}{\partial X_r} - \lambda$$

$$\frac{\partial L}{\partial \lambda} = y - X_r - (aP_x X)/\bar{N}$$

These conditions yield the typical result that utility will be maximized where the marginal rate of substitution between X and X_r is equal to the ratio of their marginal costs. The difference between this condition and the one illustrated in the previous chapter is that now there is the additional constraint of $\bar{N}$.

Graphically, the service level and expenditure combinations from Figure 4 can be mapped into X_r, X_s space in order to illustrate the opportunities available to the community. Because of the additional constraint the new opportunity frontier must lie everywhere on or below the unconstrained one. The unconstrained frontier and the constrained one may share some points. They will share the vertical intercept since this represents a point where none of the service is purchased and so the community size makes no difference. They will also share points at any service level that has $\bar{N}$ as a technically efficient size. At points other than these the constrained opportunity set must lie below the unconstrained one because more must be spent to attain any particular service level when the size of the community is not the efficient one.

Figure 5 illustrates an enrollment-constrained opportunity set. The outer boundary (dotted line) represents the unconstrained boundary. The constraint on enrollment will make the community worse off unless they would choose to offer no service or a level of service that is technically efficient.

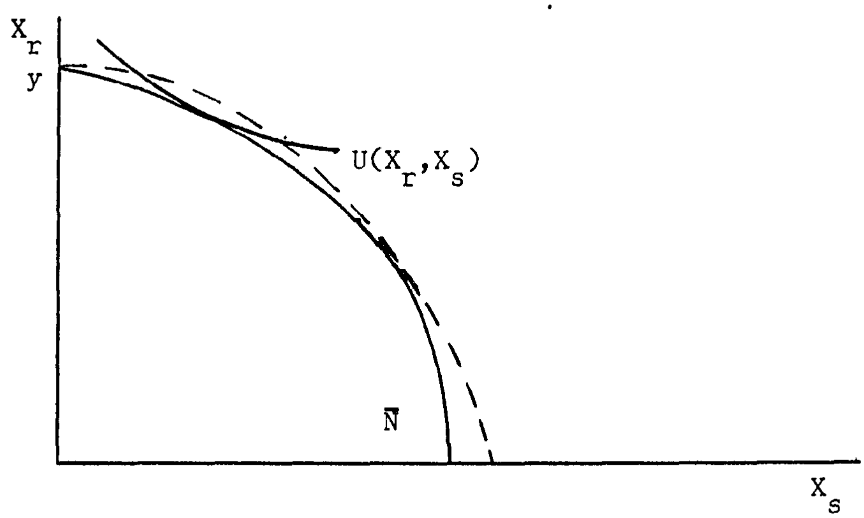

Figure 5. An enrollment-constrained opportunity set

Figure 5 illustrates only one enrollment-constrained opportunity set. However, there are as many of these constrained boundaries as there are possible size constraints. The unconstrained boundary is the outer envelope of all the enrollment-constrained boundaries.

<u>School district consolidation and the TEL</u>

If the model outlined above accurately describes the provision of school district services, the process of school district consolidation is the movement from one constrained level of enrollment to another. A movement from one constrained enrollment level to another does not necessarily make the community better off. Whether consolidation makes the community better off depends on the nature of the community's preferences and the nature of the map of constrained opportunity sets.

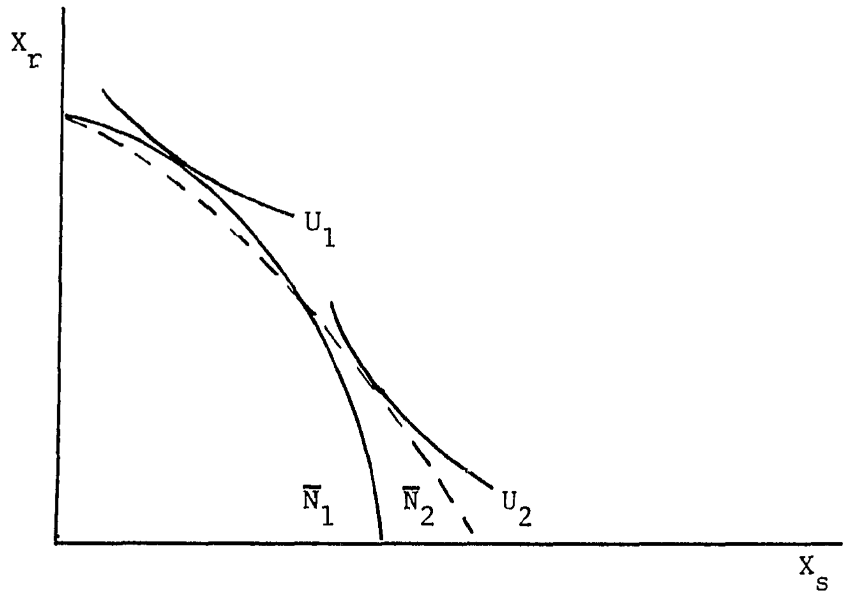

Figure 6. Two constrained opportunity boundaries and two possible indifference curves

Figure 6 shows two possible enrollment-constrained boundaries, $\bar{N}_1$ and $\bar{N}_2$, and two indifference curves from different preference sets, U_1 and U_2. If preferences are described by U_1, school district consolidation will make the community better off if $\bar{N}_1 > \bar{N}_2$ and worse off if $\bar{N}_2 > \bar{N}_1$. On the other hand, if preferences are described by U_2 school district consolidation will benefit the community when $\bar{N}_2 > \bar{N}_1$ and the community will be worse off with consolidation if $\bar{N}_1 > \bar{N}_2$.

Consequently, in order to draw conclusions about the effects of school district consolidation it is necessary to have information about a community's preferences and about the nature of the map of constrained opportunity boundaries.

The nature of the technical efficiency locus reveals information about the map of constrained opportunity boundaries. As shown in Chapter 2, the affordable points on the TEL map into X_s, X_r space to form the unconstrained opportunity boundary. Each point on this boundary is associated with an optimal community size and the optimal size changes along it depending on the slope of the TEL. If the TEL is upward sloping, the optimal community size increases downward along the unconstrained frontier. If the TEL is downward sloping, the optimal community size decreases downward along the unconstrained frontier. If the TEL is backward bending, the optimal community size first increases then decreases downward along the unconstrained frontier. Finally, if the TEL is vertical, there is a single optimal community size along the unconstrained frontier.

Since school district provision is provided in a size constrained world it is necessary to know how the constrained boundaries behave. Figures 7, 8, 9, and 10 illustrate this for the four cases mentioned above. Because any constrained boundary is tangent to the unconstrained one at the point that corresponds to its constrained size, the constrained frontiers will behave in a particular way depending upon the way the optimal community size changes along the unconstrained frontier and consequently, upon the slope of the TEL.

Figure 7 illustrates two enrollment-constrained frontiers and the unconstrained frontier (broken line). Since the TEL is upward sloping, the constrained boundary associated with N_1 represents a smaller enrollment constraint than the one associated with $\bar{N}_2$. In this case small districts provide low levels of service most efficiently and large districts provide high levels of service most efficiently. Therefore, consolidation of two districts that are providing low levels of service may make them worse off and consolidation of two districts offering high levels of service may make them better off.

Figure 8 shows the opposite case. Here the constrained boundary, $\bar{N}_1$, is associated with a larger enrollment than the one associated with $\bar{N}_2$. In this case larger districts provide low levels of service most efficiently and small districts provide high levels of service most efficiently. A consolidation of districts offering low levels of service would be beneficial whereas a consolidation of high service providers may be detrimental.

Figure 9 shows the case when the TEL is backward bending. In this case the constrained opportunity boundaries share two interior points with the unconstrained frontier and the small districts provide high and low levels of service most efficiently with large districts providing average levels of service most efficiently. Consolidation would most likely be beneficial with districts of medium quality.

Figure 10 shows the case of a vertical TEL. In this case there is only one optimal school district size and consolidation will be beneficial as long as the consolidation moves the districts closer to the optimal size.

Because the likelihood of successful consolidation depends upon the nature of the relationship between the constrained opportunity boundaries, estimation of the TEL can provide some insight into this relationship and also the potential for beneficial consolidation of school districts.

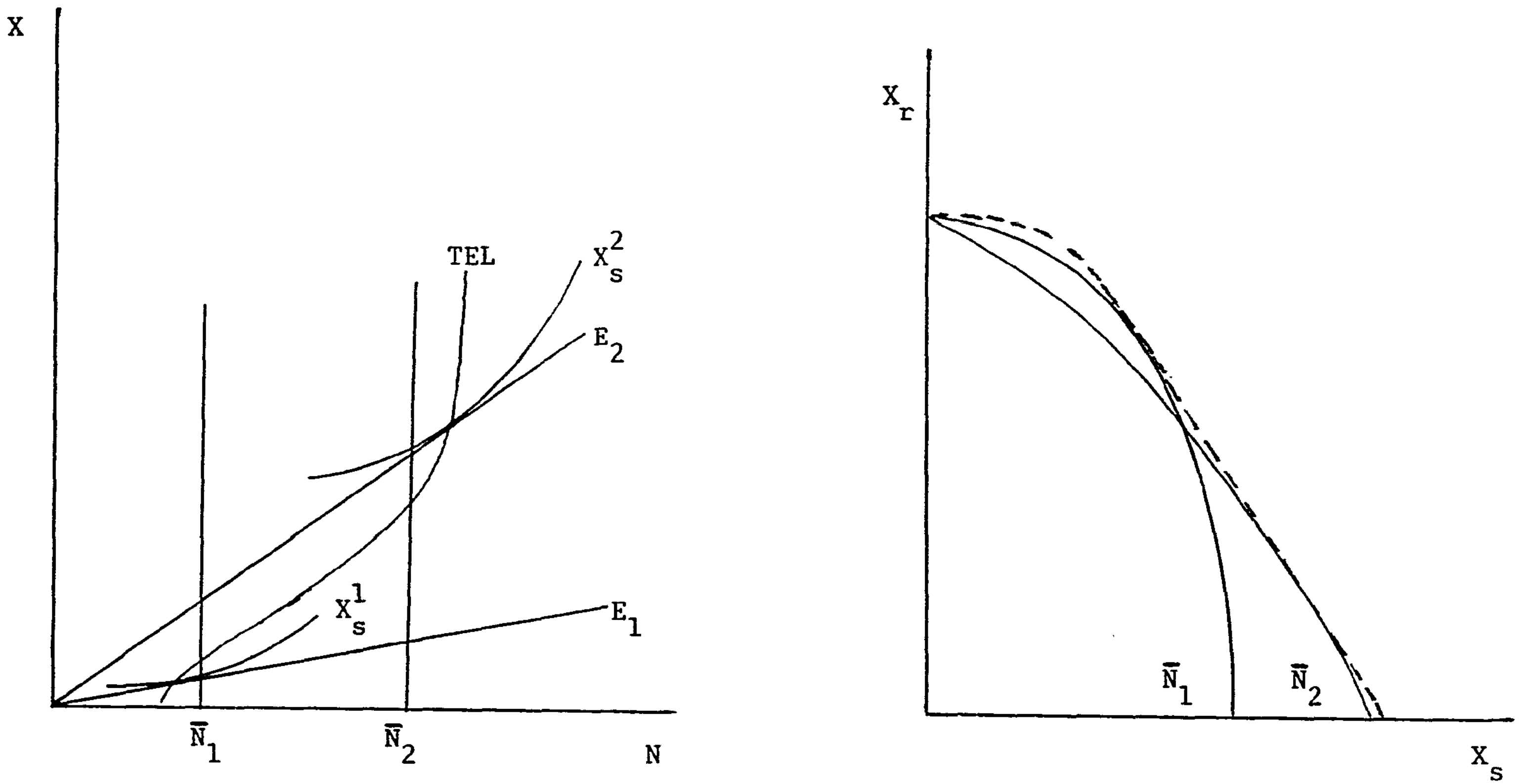

Figure 7. The case of an upward sloping TEL

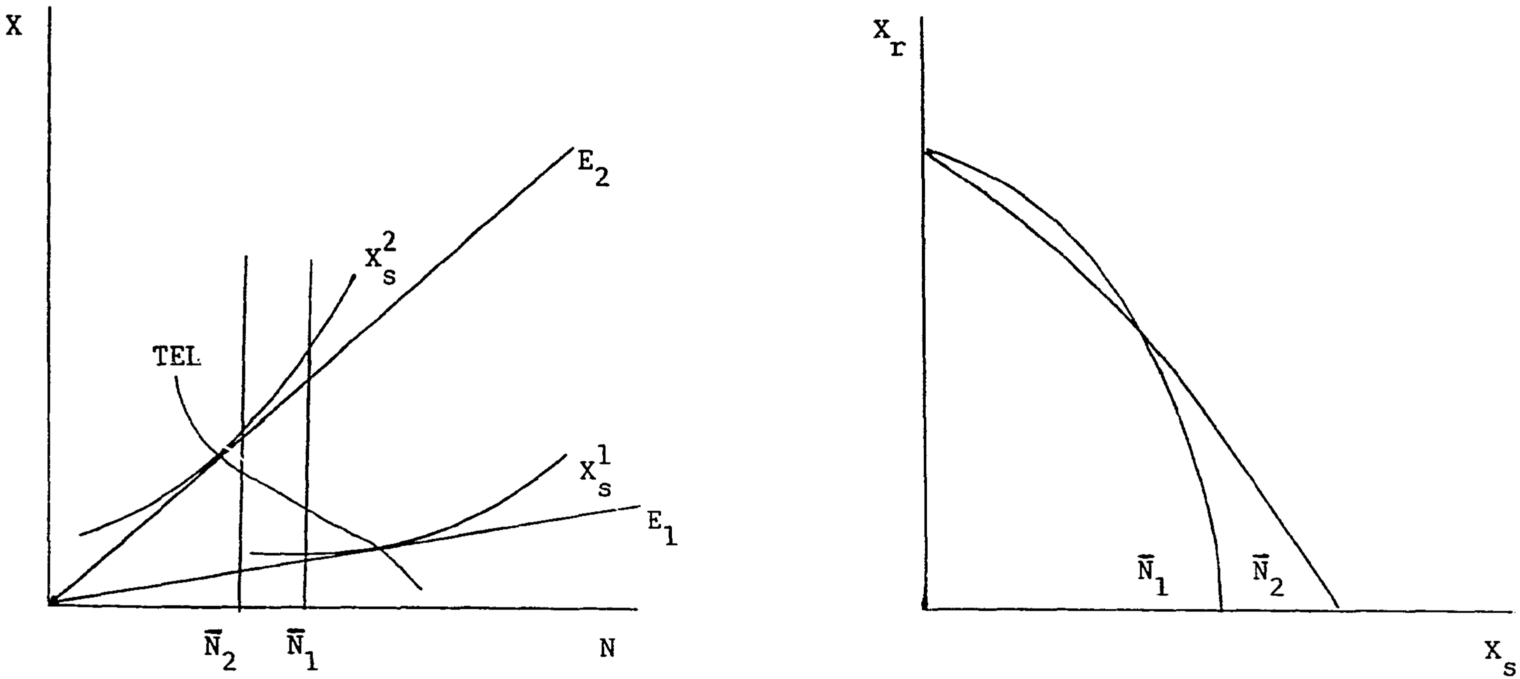

Figure 8. The case of an downward sloping TEL

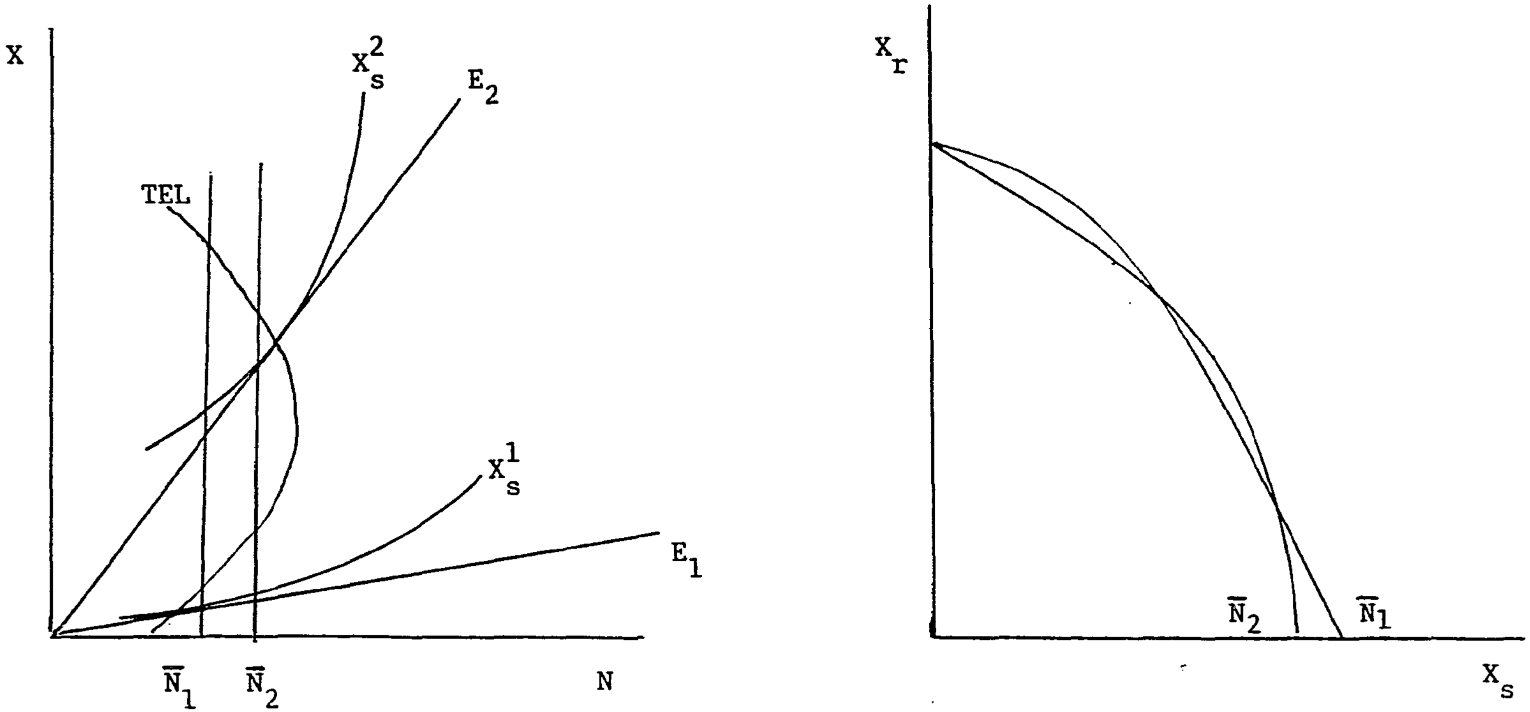

Figure 9. The case of a backward bending TEL

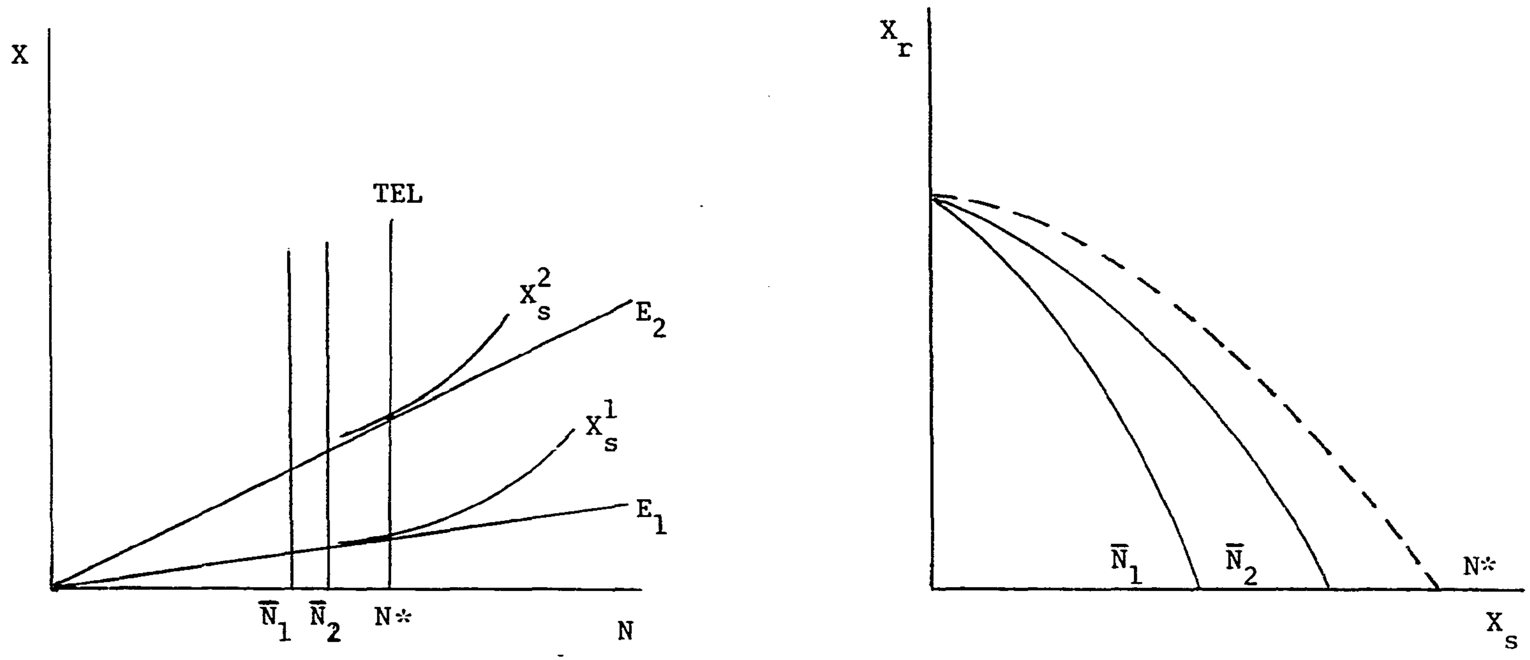

Figure 10. The case of a vertical TEL

CHAPTER 4

The effect of state aid

A second modification to the general model that should be considered is the influence of transfers from outside the district in the form of monetary aid to the district. Previously, the model assumed that the service was fully funded by the locality; however, the district receives a substantial amount of funding from outside the district. Nearly all of these transfers comes from the state's school finance formula. The state finances these transfers through its own tax system but the transfers and the tax within a district are not related. Consequently, individuals don't associate an increase in their state taxes with an increase in school services. Within the model then the income referred to, y, is income net of state taxes.

Iowa uses a foundation plan to finance school services. This plan is designed to equalize educational opportunity by providing relatively property poor school districts with more state money than property rich districts. The general form of the aid formula is:

$$S = F - \$5.40(V)$$

where S is the state aid per pupil, F is the foundation level or the level of spending the state equalizes over, \$5.40 is the minimum tax rate (per \$1000 of property value) districts must charge, and V is the property valuation per pupil. In addition there is a $200 minimum state aid allotment for rich districts that have an implied zero or negative state aid figure.

The state aid formula results in different school districts receiving different amounts of state aid per student. When examining the choices made by individual school districts this disparity is irrelevant. What's important is the amount of state aid that is received by the district and the manner in which it is distributed.

The pertinent question is: what are the effects, if any, of state aid on the decisions of school administrators and community members? School administrators are interested in maximizing the school district quality subject to a fixed level of expenditure. The expenditure level is determined by the community and, in an unconstrained world, inputs and enrollment are choices. In a size-constrained world only inputs are a choice. The school administrator's choices in either model reflect the interaction between inputs and enrollment subject to the exogenously determined spending level. Because of this the school administrator's choices and the position of the technical efficiency locus are unaffected by the source of the money.

The decisions by community members are affected by the state aid, however. A representative individual's budget constraint becomes:

$$y + aS = X_r + aP_x/N.$$

The addition of state aid will not affect the individual's desire to be maximize utility on the opportunity boundary. It will affect the location of that boundary, though.

Figure 11 shows the effect of the state aid payment when enrollment is not constrained and Figure 12 shows the effect of state aid in a size-constrained model. In both figures the choices made reflect an assumption that both the private good and school services are normal goods.

The shift outward in the opportunity boundary reflects the new higher spending levels afforded by the state aid. On the left side of both figures the affordable expenditure levels were associated with those levels between 0 and E_2. After state aid is received a new maximum spending level, E_3, is achievable. Because of the constraints placed on state aid the minimum spending level in both cases is now E_1. The new opportunity boundary in Figure 11 is the TEL up to E_3 mapped into X_s, X_r space. The new enrollment-constrained opportunity frontier in Figure 12 results from mapping the input-expenditure combinations along $\bar{N}$ up to E_3 into X_s, X_r space.

The dotted portion of the after-aid opportunity boundaries reflect constraints imposed by the state on the district. The first constraint is that the state aid be spent on school services and the other is that the district provide at least the funding guaranteed by the $5.40 tax levy. A corner solution, utility maximization at the level of service implied by the $5.40 level, is a possibility; however, in Iowa all school districts are levying taxes higher than this level.[1]

Modifying the model to include state aid has implications when considering school district consolidation. To effectively comment on the effects of consolidation it is necessary to take into consideration combining districts with equal property valuation per pupil and state aid payments. It is necessary also to consider the consolidation of districts with differing property valuation per pupil and state aid per pupil.

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[1] According to information received from the Iowa Department of Management the lowest school district levy for 1986 was $5.65 per thousand for Okoboji school district and it was the only district below $7.00.

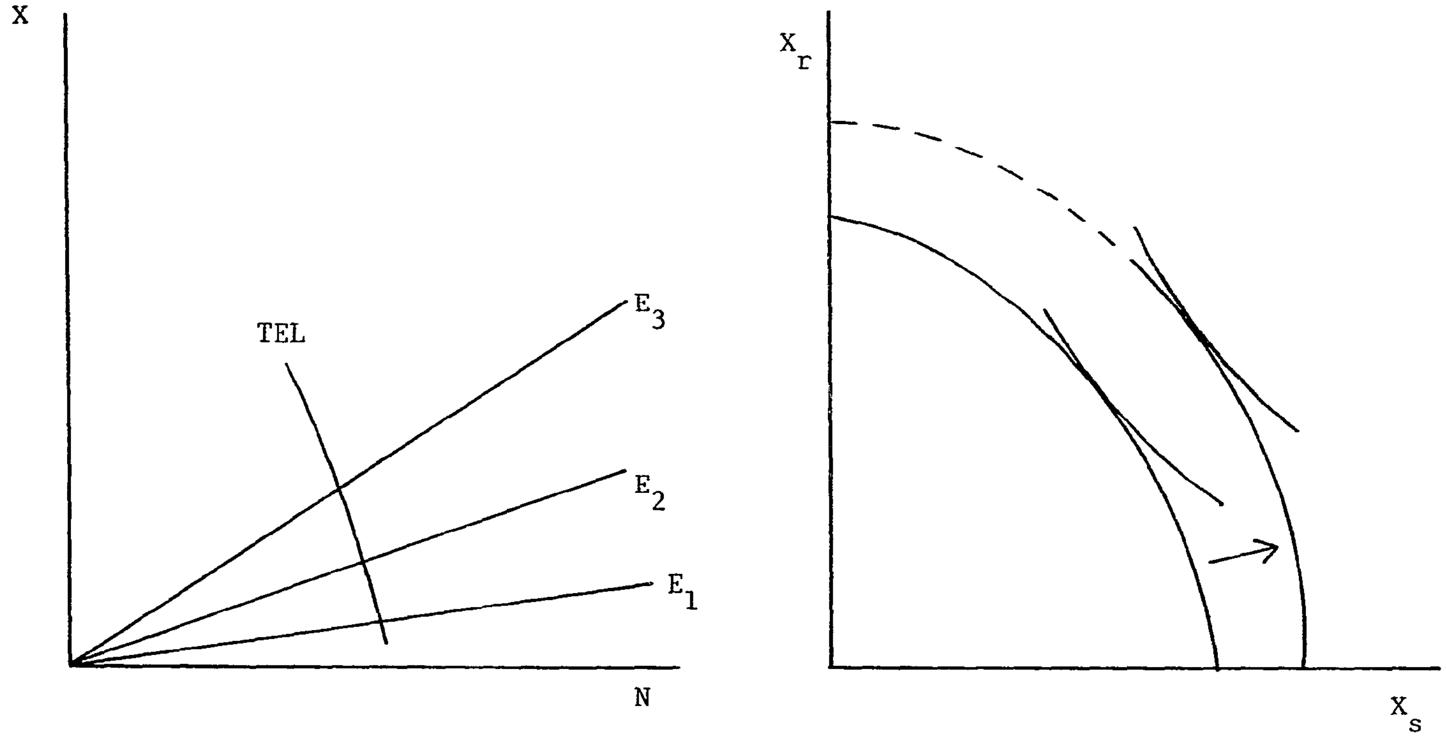

Figure 11. State aid in an unconstrained model

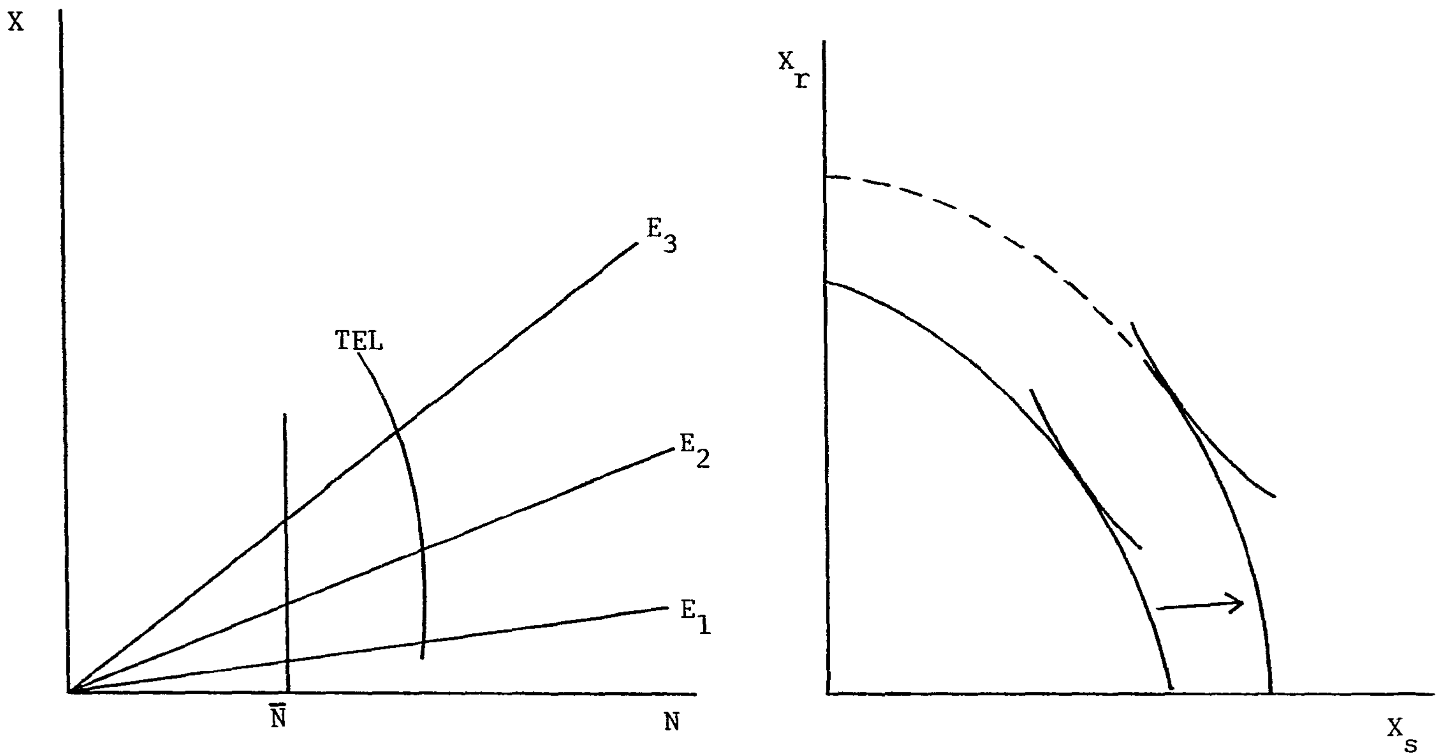

Figure 12. State aid in an enrollment constrained model

CHAPTER 5

In Chapter 3 it was shown that, in order to make predictions about the effects of consolidation, the nature of the technical relationship in the production of school services must be known. In particular knowing the slope of the technical efficiency locus provides information about the pattern of the constrained opportunity boundaries.

Unfortunately, economic theory does not allow a judgement to be made about this slope. Therefore, this relationship must be estimated using the data at hand.

Estimating the slope of the technical efficiency locus poses a problem, however. Since the school districts are operating in a constrained world with regard to size, it is unlikely that they are operating at points along the technical efficiency locus. Consequently, no observations on the technical efficiency locus are available directly. However, inferences about the locus can be made.

In order to make inferences about the technical efficiency locus it's useful to realize that any iso-service locus can be mapped into average expenditure and enrollment space. This situation is illustrated in Figure 13. The result is a constant-service average expenditure curve with a minimum at the same enrollment level as the technically efficient point on the iso-service locus. If a series of constant-service average expenditure curves is estimated,

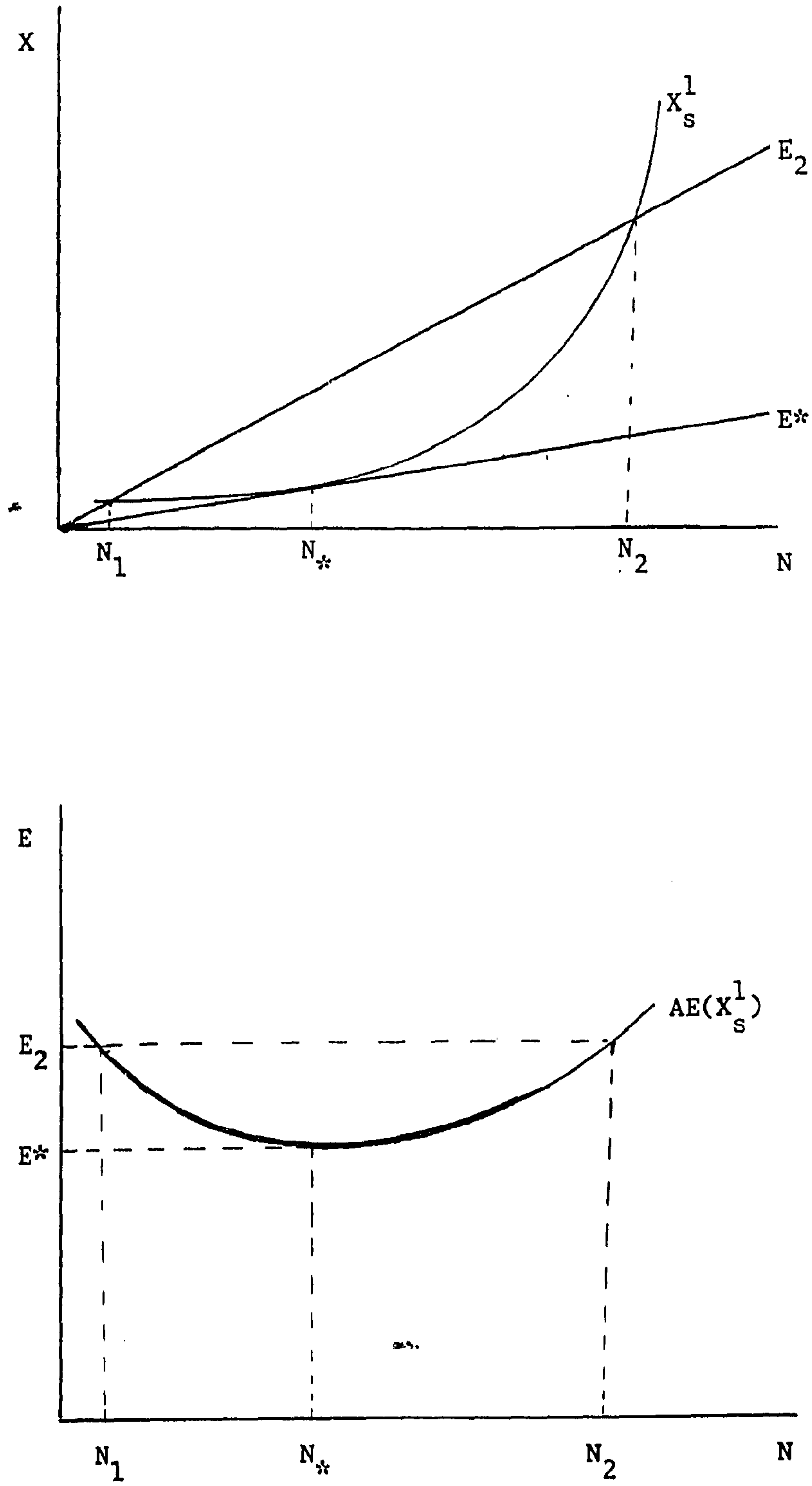

Figure 13. Constant service average expenditure curve

their minima will represent the characteristics of the technical efficiency locus.

Estimation of constant-service average expenditure curves requires that it be possible to quantify school district service or quality. As mentioned in Chapter 1, there are a number of ways this is done in the literature. However, this study does something different. Quality is modelled as an unobservable variable. The multiple-indicator, multiple-cause model is used to estimate school district quality.

Estimation of school district quality

Estimating unobservable variables has been discussed at length by Zellner [31], Goldberger [17,18], Joreskog and Goldberger [21], and Robinson [26] among others and applied by Robins and West [25], Becketti and Hakkio [6], and Gertler [15,16]. Specifically, the model to be estimated for school district quality is:

$$y_1 = \alpha_{10} + \alpha_{11}\, y^* + \delta_1\, s + \mu_1 \tag{1}$$

$$y_2 = \alpha_{20} + \alpha_{21}\, y^* + \delta_2\, s + \mu_2 \tag{2}$$

$$y^* = \beta_0 + \beta_1\, x_1 + \ldots + \beta_n\, x_n + \varepsilon \tag{3}$$

where y_1 and y_2 are indicators of school quality, y^* is the unobservable school quality variable, s is an index of socioeconomic status, the xs are causes of school quality, and the μs and ε are disturbances. It is assumed that $E(\mu)=0$, $E(\varepsilon)=0$, $E(\mu\mu')=\Theta^2$, $E(\varepsilon\varepsilon')=\sigma^2$, $E(\mu y^*)=0$, and that $E(\varepsilon x')=E(\varepsilon\mu')=E(x\mu')=E(s\mu')=0$. After substituting Equation 3 into Equations 1 and 2, the reduced form becomes:

$$y_1 = \alpha_{10} + \alpha_{11}(\beta_0 + \beta_1 x_1 + \ldots + \beta_n x_n + \varepsilon) + \delta_1 s + \mu_1 \quad (1')$$

$$y_2 = \alpha_{20} + \alpha_{21}(\beta_0 + \beta_1 x_1 + \ldots + \beta_n x_n + \varepsilon) + \delta_2 s + \mu_2 \quad (2')$$

The variance-covariance matrix for the above system is:

$$\Omega = \alpha\sigma^2\alpha' + \Theta^2$$

where $\boldsymbol{\alpha}$ is a 2x1 column vector of the quality coefficents.

Assuming that the error terms are distributed normally and that the x vectors are fixed and measured without error, the log of the likelihood function, except for the irrelevant constant term, has been shown by Joreskog and Goldberger [21] to be

$$L = -N/2\ \{\log|\Omega| + \mathrm{tr}(\Omega^{-1}\mathbf{W})\} \quad (4)$$

where N is the sample size and **W** is the sample variance-covariance matrix of the reduced form residuals. The model is estimated using full-information maximum likelihood, as recommended by Aigner et al. [4].

<u>The data</u>

The estimation outlined above requires a cross-sectional data set of observations on school districts. Observations of indicators, causes, and a socioeconomic variable are needed to estimate school district quality, and average expenditure is needed to estimate the constant-service average expenditure curves.

Past research on educational production provides insight on the variables that are used for causes (inputs) and indicators (outputs). Hanushek [18] and Bridge, Judd, and Moock [7] provide lengthy reviews of this literature. The causes used are, generally, limited to what is available to the researcher from the relevant state Department of Education. Typically, researchers use variables to proxy the quality of teachers (teacher education, experience, and average salary), the utilization rate of staff (pupil-to-teacher ratio, class size, and pupil-to-specialist ratio), the quality of curriculum (course units and course breadth), and the physical investment in the schools (school building value and number of library books). By far, the most used indicator of a school district's output is some type of standardized test score.

For this study, the indicators of school district quality are test scores provided by the Iowa Testing Center. The Center has provided an achievement index compiled from the scores on The Basic Skills Test administered to students in grades 3 through 8. In addition, 1986 Iowa Test of Educational Development scores have been provided for high school students. These are district composite scores. Also, the Center has provided an index of socioeconomic status compiled from census data on income and education.

The data on quality causes and school district expenditure have been provided by the Iowa Department of Education from the 1986-87 Secretary's Annual Reports and the

Basic Education Data Survey. Variables included in the data set are expenditures, average daily membership, FTE teachers, FTE administrators, course units, teacher experience, teacher salary, and school building valuation.

The variables used as causes, indicators, socioeconomic index, and expenditures are listed along with their means and standard deviations in Table 2.

Maximum likelihood estimates of school district quality

Table 3 presents the maximum likelihood estimates of the model. The first estimates presented are for the indicator equations. Because the empirical implications of the model are invariant with respect to the multiplication of the quality coefficients by some constant and the division of the cause coefficients and σ by the same constant or with respect to the addition of a constant to β_0, and the subtraction of α times that constant from α_0 the model must be normalized to identify the parameters, determine a scale for y^* and uniquely determine the parameters (Robins and West [25]). This is done by setting the constant and the quality coefficient in equation 1' equal to zero and one.

The signs on the parameters in the indicator equations are as might be expected. Quality seems to have a positive and significant effect on test scores as does socio-economic status.

The signs on the parameters in the cause equation are as

Table 2. Means and standard deviations of variables

Variable	Mean	Standard Deviation
Causes		
Average daily membership (Students)	1088.02	2271.76
Pupil to teacher ratio	14.54	2.26
Pupil to administrator ratio	196.91	56.00
Course units	54.58	20.29
Average teacher experience (Years)	13.01	2.58
Average teacher salary (Dollars)	19805.60	2497.56
Facilities valuation per pupil (Dollars)	8431.93	3153.62
Indicators		
Achievement index	62.94	3.28
Eleventh grade ITED scores	18.69	1.57
Other variables		
Index socio-economic status	92.93	3.88
Average expenditure per student	3096.73	454.40

Table 3. Maximum likelihood estimates of school district quality, N=387 (t-values in parentheses)

<u>Indicator equations</u>

	α_0	α	δ
Achievement	0	1	.2338 (5.36)
Grade 11 ITED scores	.0255 (.007)	.2211 (3.06)	.1029 (5.30)

<u>Cause equation</u>

	β
Constant	36.46 (9.54)
Average daily membership	-.000450 (-2.92)
Pupil-teacher ratio	-.18861 (-1.49)
Facility valuation per pupil	.000112 (2.17)
Average teacher salary	.000262 (2.17)
Course units	-.01678 (-.99)
Teacher experience	.21178 (2.69)
Pupil-administrator ratio	-.000278 (-.063)

might be expected with the exception of the coefficient on course units. One possible explanation for the negative sign rather than the expected positive sign is that the number of course units is closely linked to the number of students in the district and that this effect wipes out any beneficial effect of additional course units. In addition, the coefficients on ADM, facility valuation per pupil, average teacher salary, and average teacher experience are significantly different from zero at the .05 level. The coefficient on pupil to teacher ratio is significantly different from zero only at the .15 level and the coefficients on number of course units and pupil to administrator ratio are not significantly different from zero.

To judge model adequacy the model was re-estimated without the restrictions implied by the multiple-indicator, multiple-cause model. The two models were then compared and a test statistic, twice the log of the likelihood ratio, was computed. This statistic is asymptotically distributed as chi-square with six degrees of freedom and was equal to 11.998. The hypothesis that the restrictions on the model implied by the MIMIC model were valid was accepted at the .05 level of significance.

<u>The index of quality</u>

The coefficient estimates for the cause equation and the characteristics of each district were then used to determine a quality index for each school district. This "predicted" quality index had a mean of 41.15 and a standard deviation of 1.33. The districts were ranked on this index and divided into five groups to determine if the various levels of quality had an effect on the nature of the average expenditure curves. Descriptive statistics for the five groups are listed in the appendix.

Estimation of average expenditure curves

Three different average expenditure curves were estimated for each of the five quality levels. For every model and every quality the dependent variable used was per-pupil expenditure not including transportation costs. The three functional forms are the most common forms used in the literature of school district cost estimation. The first and third models both include 1/ADM (ADMI) as an explanatory variable and the first also includes ADM on the right-hand side. The difference between the two is that the first model will reach a minimum and turn up, in terms of average expenditure, while the third model will decline continuously as ADM increases. The second model is the "typical" quadratic form that includes ADM and the square of ADM (ADMSQ) as explanatory variables. The three different models were estimated for each quality level so that a judgement can be made, not only about the minima, but also whether the structure of the average expenditure curve differs from quality level to quality level.

The results of the ordinary least squares' estimation of the constant-service average expenditure curves are presented in Table 4. In addition, a fourth model that included ADM, 1/ADM, and ADMSQ was estimated. The results for this model are presented in the Appendix. Quality level one is associated with the 79 school districts with the highest predicted quality, quality level two is associated with the 88 second-highest rated districts, quality level three represents the middle 90 school districts, quality level four represents the 97 school districts in the next-to-last group, and quality five represents the bottom 82 school districts. It's important to remember that the ratings are measures of relative position and that there aren't necessarily any "bad" school districts (or good ones).

For each quality level the appropriate model seems to be the first one. This model has the highest R^2 and each coefficient is significantly different from zero at the .05 level and has the sign consistent with economic theory. An interesting point to note is that the R^2 has a tendency to decline as quality declines. This means that the number of students becomes less important to the explanation of the variation in per pupil spending as quality level decreases.

<u>Average expenditure minima and the technical efficiency locus</u>

The estimated average expenditure curves can be used to

Table 4. OLS estimates of constant service average expenditure curves (t-values in parentheses)

Quality level 1

	Model 1	Model 2	Model 3
ADM	.44515 (4.12)	-2.6253 (-7.06)	
ADMI	285120 (11.8)		214190 (11.5)
ADMSQ		.00122 (6.05)	
Constant	2290.8 (19.3)	4207.7 (31.9)	2731.7 (47.9)
R^2	.70	.43	.63

Quality level 2

	Model 1	Model 2	Model 3
ADM	.49655 (6.30)	-2.1966 (-5.75)	
ADMI	337460 (19.1)		266470 (16.2)
ADMSQ		.00084 (4.80)	
Constant	2030.4 (22.6)	4076.3 (25.6)	2527.2 (48.6)
R^2	.83	.30	.75

Table 4 (continued)

Quality level 3	Model 1	Model 2	Model 3
ADM	.31863 (4.06)	-1.53 (-4.58)	
ADMI	285420 (11.6)		216290 (11.3)
ADMSQ		.00060 (3.75)	
Constant	2234.5 (21.6)	3715.9 (27.3)	2611.0 (53.7)
R^2	.66	.25	.59

Quality level 4	Model 1	Model 2	Model 3
ADM	.15450 (5.65)	-.49338 (-6.01)	
ADMI	184310 (11.0)		121000 (8.48)
ADMSQ		.000115 (5.73)	
Constant	2453.7 (39.0)	3278.2 (60.4)	2750.9 (69.2)
R^2	.58	.28	.43

Table 4 (continued)

Quality level 5	Model 1	Model 2	Model 3
ADM	.03403	.007137	
	(5.71)	(.42)	
ADMI	113280		71987
	(7.48)		(4.58)
ADMSQ		.000000	
		(.367)	
Constant	2665.2	2966.4	2838.0
	(54.9)	(72.8)	(63.3)
R^2	.44	.04	.21

make inferences about the nature of the technical efficiency locus. Because the technical efficiency locus behaves in the same way as a locus of average expenditure curve minima, finding the minimum of each of the estimated average expenditure curves will provide an estimate of the nature of the technical efficiency locus.

The minimum of each of the estimated average expenditure curves is simply the square root of the ratio of the coefficient on ADMI to the coefficient on ADM. This will be a minimum if the coefficient on ADMI is greater than zero. The minimum associated with each quality-constant average expenditure curve is presented in Table 5.

Table 5. Average expenditure curve minima by quality level

Quality level	Minimum (ADM)
1	800
2	866
3	946
4	1092
5	1824

Table 5 shows that as quality decreases the minimum of the average expenditure curve (in terms of ADM) increases. Likewise, the technical efficiency locus would behave in the same way. The implications of a downward sloping technical efficiency locus for school district consolidation is investigated in the next chapter.

CHAPTER 6

Once the location and slope of the technical efficiency locus is estimated, judgments may be made as to the potential for successful consolidation. In this chapter the implications for consolidation will first be considered within the framework of the "typical" efficiency argument found in most of the literature. Next, the theoretical model developed in the Chapters 2, 3, and 4 will be used to show the conditions when consolidation will be successful. Finally, areas for further research will be discussed.

School district consolidation for efficient production

As discussed earlier, research that supports school district consolidation generally presumes that consolidation should take place in order to capture available scale economies. Previous research, however, doesn't allow for the efficient scale to vary with quality level. One of the ways the empirical results from Chapter 5 can be used is to provide information on the availability of scale economies by quality level in Iowa.

Table 6 shows the predicted average expenditure (not including transportation) by school district ADM and quality level. These figures are the predicted expenditure levels calculated from the average expenditure functions (Model 1) estimated in Chapter 5.

Table 6. Predicted average expenditure (not including transportation) by ADM and quality level (Expenditure level in dollars per pupil.)

	Quality Level				
ADM	1	2	3	4	5
100	5186.52	5454.66	5120.56	4312.25	3801.40
200	3805.43	3817.01	3725.33	3406.15	3238.41
300	3374.75	3304.23	3281.49	3114.42	3053.01
400	3181.66	3072.67	3075.50	2976.27	2962.01
500	3083.62	2953.60	2964.66	2899.57	2908.78
600	3033.09	2890.76	2901.38	2853.58	2874.42
700	3009.72	2860.07	2865.28	2825.15	2850.85
800	3003.32	2849.47	2846.18	2807.69	2834.03
900	3008.24	2852.25	2838.40	2797.54	2821.70
1000	3021.07	2864.41	2838.55	2792.51	2812.51
1100	3039.67	2883.39	2844.47	2791.20	2805.62
1200	3062.58	2907.48	2854.71	2792.69	2800.44
1300	3088.82	2935.50	2868.27	2796.33	2796.58
1400	3117.67	2966.61	2884.45	2801.65	2793.76
1500	3148.61	3000.20	2902.73	2808.32	2791.77
1600	3181.24	3035.79	2922.70	2816.09	2790.45
1700	3215.27	3073.04	2944.07	2824.77	2789.69
1800	3250.47	3111.67	2966.60	2834.19	2789.39
1900	3286.65	3151.46	2990.12	2844.26	2789.49
2000	3323.66	3192.23	3014.47	2854.86	2789.91

The enrollment level at which all scale economies are exhausted would be where each average expenditure function reaches a minimum as described by Table 5 in Chapter 5. However, as Table 6 shows, the average expenditure functions tend to flatten out as the minimum occurs. Because of this, if using the availability of scale economies as the criterion for recommending consolidation, it may be that transportation and transition costs will eliminate some of the savings that accrue from consolidating to the minimum of the average expenditure function.

Of course, efficiency is not the only criterion that can be used to determine whether consolidation should take place. The theoretical model developed in Chapters 2, 3, and 4 may be used to determine when school district consolidation may be beneficial or harmful to the community.

School district consolidation within the club good framework

When considering school district consolidation within the previously described theoretical framework there are three general cases that may be of interest. First, the case where the school districts are so small that before consolidation and perhaps even after it they have not attained an enrollment level near the technical efficiency locus. Second, the case where the district's enrollment level is near the technical efficiency locus before and after consolidation. And finally, the case where the district's enrollment is at or above the relevant technical efficiency locus to begin with and consolidation would move them even farther from the locus.

The third case will not be considered in this study, not because it is uninteresting, but because it is not relevant to the situation in Iowa. It is not relevant because there are relatively few large districts and there has been no controversy about their consolidation (or deconsolidation). In addition, the conclusion that the technical efficiency locus is downward sloping is valid for Iowa but may not be generalizable to states that have a "bigness" problem.

The first case is probably the one most relevant to Iowa. Since the minima of the constant-service average expenditure curves (listed in Table 5) correspond to the technical efficiency locus, the technical efficiency locus is estimated to be downward sloping from quality level 1 at an enrollment level of 800 to quality level 5 at an enrollment level of 1824. As Table 1 shows, well over half the districts in Iowa are not nearly at an enrollment level this high. In addition, these are the districts that have the most pressure to consolidate because of the potential savings that might accrue through lowered average expenditure.

When will consolidation be optimal for these small school districts? The process of consolidation is the movement from one constrained opportunity set to another. When the district has an enrollment level smaller than the one associated with any points on the technical efficiency locus, consolidation moves the district to an opportunity set higher than the previous one everywhere except at the vertical intercept. This situation is illustrated in Figure 14. The district described in this diagram is clearly better off than it was before consolidation provided it can attain the utility maximizing combination of private goods and school services. This is not guaranteed, however. Because it takes two districts to form a consolidation the characteristics of the other district are important in determining whether consolidation, will be beneficial.

The simplest situation to consider is when the two districts are identical in every way. If the two districts are identical, Figure 14 shows how consolidation would not only make both districts better off but would result in a bundle of private goods and school services that both districts would consider optimal subject to the new enrollment constraint. On the other hand, if the districts differ in terms of income, property valuation per pupil, or state aid each district would face a different constrained opportunity set. It would be merely coincidence if the districts, through their own utility maximization, desired the same level of service after the consolidation takes place. Therefore, some compromise must take place.

Figure 15 shows an example of this situation. The lower

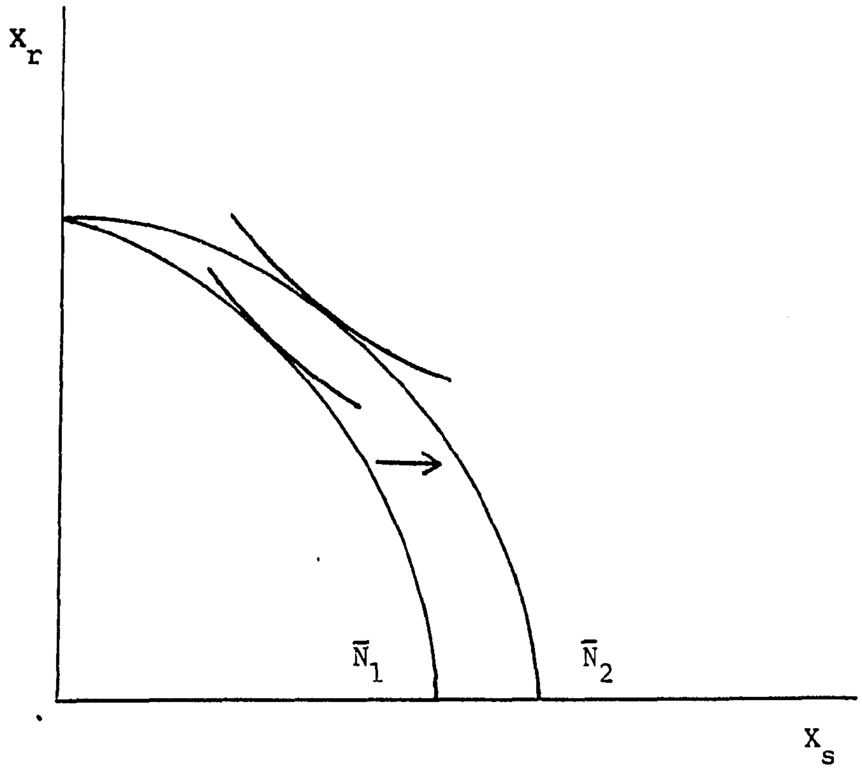

Figure 14. Consolidation of identical small districts

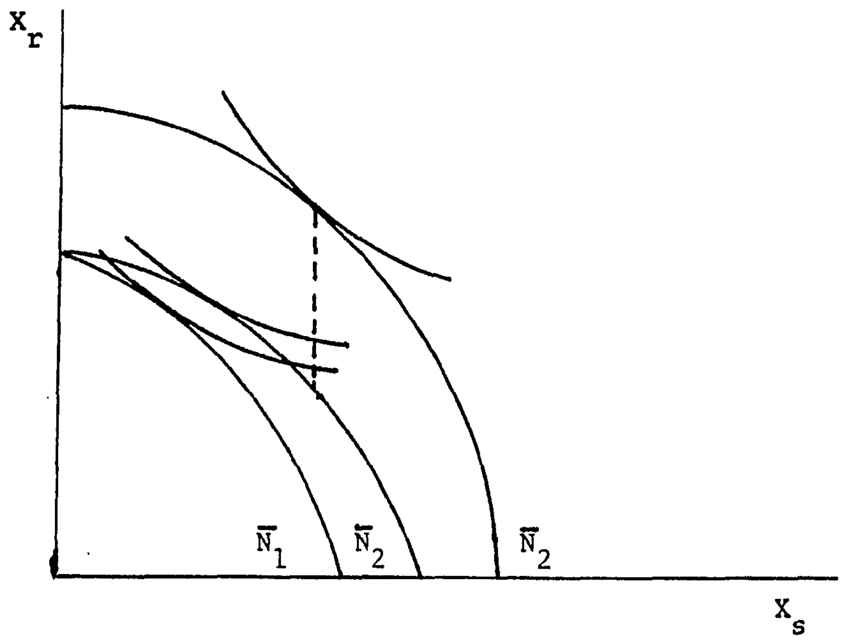

Figure 15. Consolidation of differing small districts

opportunity boundary is the before-consolidation boundary for the relatively poorer district. The next higher opportunity boundary is the after-consolidation boundary for that same district. The highest boundary is the after-consolidation opportunity boundary for a district with a higher income than the poorer district. If consolidation occurs between these two districts each district would prefer a level of educational service that maximizes their utility. However, only one community can attain their utility maximizing level of service. In a "majority rules" world the district with the most voters could choose its optimal level of service and impose that level on the other district. The smaller district would not be at its utility maximum in terms of level of service or spending on education. In fact, because the smaller district cannot choose its level of education it is possible that the consolidation could make it worse off.

In Iowa, before consolidation can occur, each district must approve it. If it is approved, over the long run the decisions of the consolidated district are made jointly. In other words, the smaller district can exercise its veto power only once and that is at the time of the "consolidate-or-not-consolidate" decision. This could be one reason so many districts are resistant to consolidation.

The second case of interest is the case where the districts are reasonably close in enrollment to the location of the technical efficiency locus. In this case the consolidation is again a movement from one constrained level of enrollment to another. Figure 16 illustrates the two constrained opportunity boundaries. In Chapter 3 it was noted that the boundary that was associated with the larger enrollment constraint was ambiguous. However, since the technical efficiency locus has been estimated to be downward sloping, the constrained boundary associated with N_2 must represent a higher enrollment level than the one associated with N_1.

If this is the case, even if the two districts are identical in every way consolidation may not be beneficial. In general, consolidation would be more likely to be beneficial when the districts are providing relatively low levels of service and harmful when the districts are providing high levels of service; because, at low levels of service, the constrained opportunity boundary associated with the higher level of enrollment is above the boundary associated with smaller districts and below the small district's boundary at high levels of service. In addition, this seems reasonable since moving from a small size to a larger size is more likely to move a high-service district away from the technical efficiency locus and a low-service district toward it.

If the districts differ in terms of income, property valuation, state aid, or preferences it becomes even more

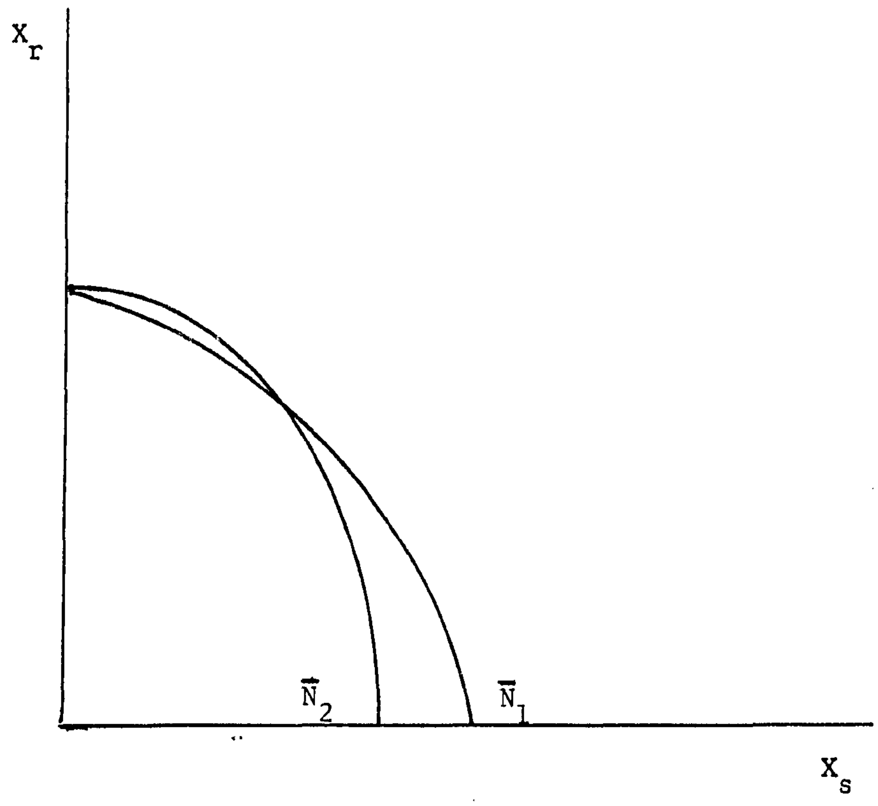

Figure 16. Consolidation of identical near-TEL districts

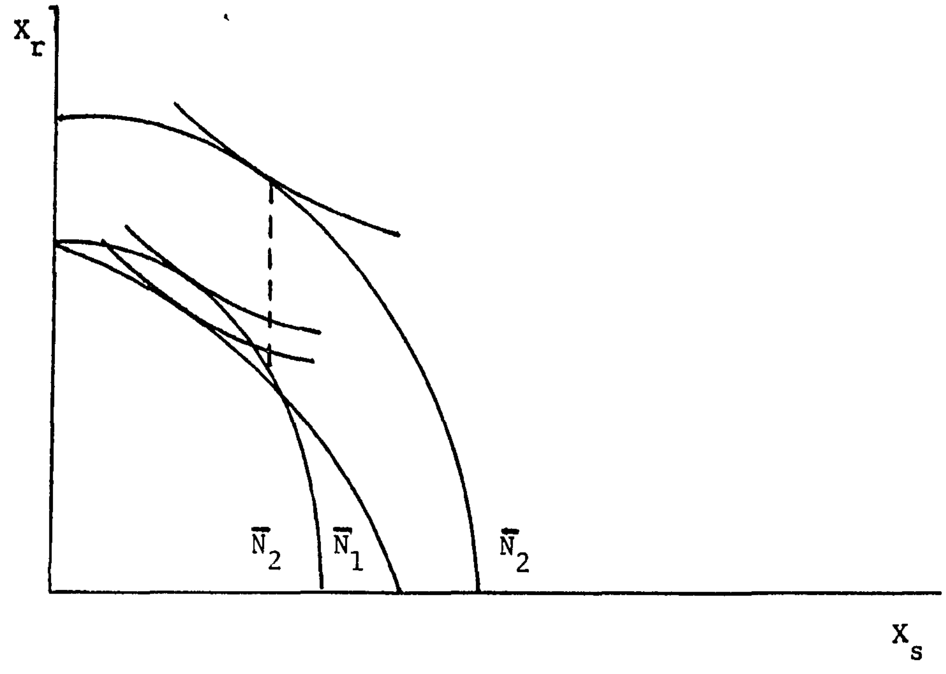

Figure 17. Consolidation of differing near-TEL districts

likely that consolidation is not optimal. Figure 17 illustrates this situation.

In Figure 17 three opportunity boundaries are illustrated. The lower two illustrate the same two boundaries as in Figure 16; in addition, an after-consolidation boundary for a higher income district is added to show the potential for harm from consolidation. If the higher income district is the one with the majority of voters, consolidation could make the smaller, poorer district worse off.

<u>Conclusions and areas for further research</u>

What is the value of this study? This study has provided a theoretical framework for the examination of school district service provision. In addition, a new technique for determining school district quality has been explored and used to determine the nature of the interaction of quality and the structure of school district expenditures.

More importantly, it may provide some guidance for policy makers in determining the potential for beneficial consolidation. It's been shown that consolidation is not necessarily beneficial even when both districts are far from technically efficient. In any case, consolidation is more likely to be beneficial the more the districts are alike. If consolidation is to be encouraged, changes in the rules for consolidating, in particular, letting the districts bargain for long-term guarantees may make it more likely that consolidations will occur.

More research could be done in this area. One new educational policy that has been recently employed by a number of states, including Iowa, is open enrollment. With open enrollment, school districts could recruit students in order to receive the state aid and property tax revenue associated with them. Under this law, the school districts have some ability to get new students or to lose some they currently have. The model developed in Chapter 2 could be modified to include this possibility.

Also, much more research could be done in the area of quantifying school district quality. While the index developed here is certainly different and hopefully better than what came before, it could be improved upon, especially if better data were collected by the agencies concerned with education.

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APPENDIX

Descriptive statistics by quality level

Table A1 presents the mean, standard deviation, and range for average daily membership, average expenditure, and quality index for each of the five quality levels. As quality level decreases, the mean average daily membership increases and the mean average expenditure decreases. Also, while the smallest district in each quality level is about 100 in ADM, the largest district increases as quality level decreases, except between quality level 2 and quality level 3.

Estimation of average expenditure curves--a more general model

A fourth more general model was used to estimate average expenditure curves by quality level. The results of this estimation are presented in Table A2. The minima of the average expenditure curves increases as the quality level decreases from level 2 to level 5. The minimum for quality level 1 is slightly larger than level 2 or 3 but is smaller than that of quality level 4 or 5.

Compared to Model 1 in Chapter 5 the minima have the same general trend. However, the minima seem to occur at somewhat smaller levels of ADM in the more general model. Given the flatness of both sets of average expenditure curve estimates near their minima, the difference in minima is neither surprising nor of much consequence. In addition, the explanatory power of the fourth model is not much greater, as signified by R^2, than the first model. The coefficient on the quadratic term is not significantly greater than zero, at the .05 level, for quality level 1 and 4.

Finally, the conclusions drawn in Chapter 6 remain the same regardless of the functional form used. Model 4 does, however, indicate that the technical efficiency locus might lie a bit further to the left than indicated by Model 1.

Table A1. Descriptive statistics by quality level

Quality level 1	Mean	Standard Deviation	Range
ADM	589	392	99-2019
Average Expenditure	3272	472	2618-5887
Quality Index	42.54	.40	42.01-43.78
Quality level 2			
ADM	653	457	76-2558
Average Expenditure	3174	625	2597-6963
Quality Index	41.74	.14	41.51-41.99
Quality level 3			
ADM	740	480	85-2139
Average Expenditure	3051	432	2534-6373
Quality Index	41.26	.14	41.01-41.49
Quality level 4			
ADM	1032	1070	103-4865
Average Expenditure	3014	323	2610-4417
Quality Index	40.78	.15	40.50-40.99
Quality level 5			
ADM	2483	4820	101-30132
Average Expenditure	2992	300	2485-4148
Quality Index	39.52	4.22	25.61-40.49

Table A2. OLS estimates of average expenditure curves for a general model (t-values in parentheses)

Variable	Quality Level 1	2	3	4	5
ADM	.90	1.42	1.30	.12	.08
	(1.80)	(5.29)	(3.92)	(1.25)	(5.24)
ADMI	311500	387740	348950	179670	134860
	(8.37)	(17.83)	(11.14)	(8.09)	(8.49)
ADMSQ	-.00021	-.00038	-.00042	-.00001	-.00001
	(-.93)	(-3.58)	(-3.05)	(-.32)	(-3.18)
Constant	2061	1545	1700	2481	2565
	(7.53)	(9.67)	(8.45)	(23.18)	(46.04)
R^2	.70	.85	.69	.58	.50
Minimum	722	645	695	1139	1366