Maine Policy Review

Volume 12 | Issue 3

2003

Potential Efficiency Gains from Consolidation of Maine's Educational Resources

Philip A. Trostel
University of Maine, trostel@maine.edu

Follow this and additional works at: https://digitalcommons.library.umaine.edu/mpr

 Part of the Educational Administration and Supervision Commons, and the Education Policy Commons

Recommended Citation

Trostel, Philip A. . "Potential Efficiency Gains from Consolidation of Maine's Educational Resources." *Maine Policy Review* 12.3 (2003) : 64 -75, https://digitalcommons.library.umaine.edu/mpr/vol12/iss3/11.

This Article is brought to you for free and open access by DigitalCommons@UMaine.

Potential Efficiency Gains from Consolidation of Maine's Educational Resources

by Philip A. Trostel

Economist Philip Trostel analyzes the size of Maine's schools and school districts, and the costs and quality of education. He argues that some schools and districts may be too small to be cost-efficient, that on average education in Maine costs more per student than in the rest of the country, and that education quality may not be as high in smaller schools as in larger ones (at least based on some measures). While there may be some less-measurable benefits to small schools, Trostel suggests that declining school-age populations and increasing costs should lead policymakers to seriously consider consolidating schools and districts, not only to achieve cost-savings but also to enable more opportunities for Maine's children.

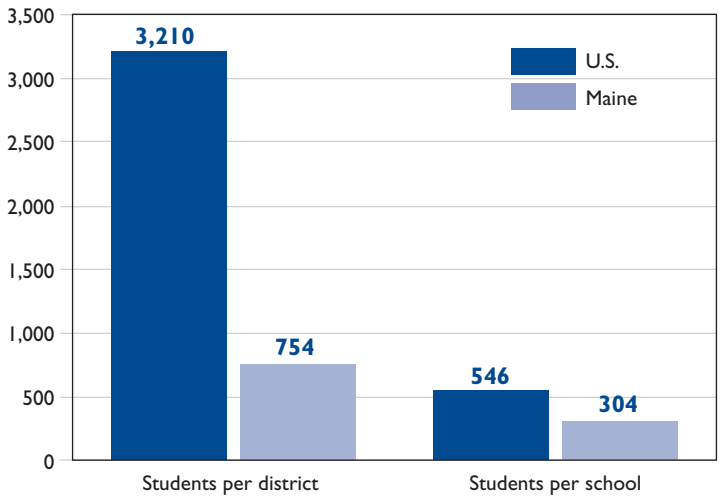
INTRODUCTION: ECONOMIES OF SCALE IN EDUCATION[1]

Economies of scale is a fundamental economic principle. When there are economies of scale, cost per unit decreases as more units are produced. To some extent there are economies of scale in just about every economic activity. Whether we are talking about building airplanes or baking cookies, it is almost always cost effective to produce more than one unit. However, economies of scale are also usually limited. At some point diseconomies of scale are encountered. At some level of output, production bottlenecks and supervisory problems become increasingly severe and cost per unit begins to rise. Thus, cost-effectiveness is a tricky balancing act. To borrow from *Goldilocks and the Three Bears*, some beds can be too large and some can be too small.

In the case of public provision of education in Maine, it appears that some of our beds (i.e., our school districts and schools) are too small. Certainly there are important benefits of small schools. Teachers and children generally get to know each other better, thus raising children's sense of belonging and security. Children's social experiences generally can be expected to improve with smaller school size. Parental and community involvement are likely to be greater in smaller schools. Moreover, many smaller schools as opposed to fewer larger schools potentially can save on transportation costs, and competition between school districts can be a healthy incentive for providing quality services.

However, small school districts and schools come with a high price. It is likely we are paying a high cost for too much duplication of education services. Moreover, it is not just that we may be paying more (i.e., through higher taxes) to educate our children, but that some of our children also may be missing out on some educational opportunities. That is, having very small schools and school districts may be costing us both in terms of taxes and in terms of quality. High-cost education might be an acceptable choice—if we were getting high-quality education in return. Similarly, "just-okay" educations might be an acceptable choice—if only the cost were okay. The data, however, suggest that the choice to have many very small schools and school districts is causing us to have just-okay public education and at a relatively high cost.[2]

FIGURE 1: **Average Number of Students in 2000-01**
(Data from the U.S. Department of Education)



It is important at the outset to stress three points. First, this article is not meant to condemn the effort and motivation of local school teachers and administrators. They are not the cause of the high-cost, average-quality problem. The problem is in our use of limited resources. That is, the issue is about using our resources more efficiently. Second, school size and school-district size are not the same as class size. I am not proposing increases in class sizes. I am proposing decreases in the number of schools, and especially in the number of school districts. Third, the trend of rapidly rising costs of education is going to continue. Thus, unless we use our resources more efficiently, the problem of rising mill rates is going to continue.[3] Furthermore, if we do not use our resources more efficiently, it is likely that the quality of education some of our young receive will lag further and further behind the rest of the country.

SCHOOL SIZE

On average, schools and school districts in Maine are much smaller than in the rest of country. This is shown in Figure 1. The average number of students in Maine school districts is less than one-quarter of the national average. Among the 50 states in 2000-01,

FIGURE 2: **Cost per Student in 1998-99**
(Data from the U.S. Department of Education)

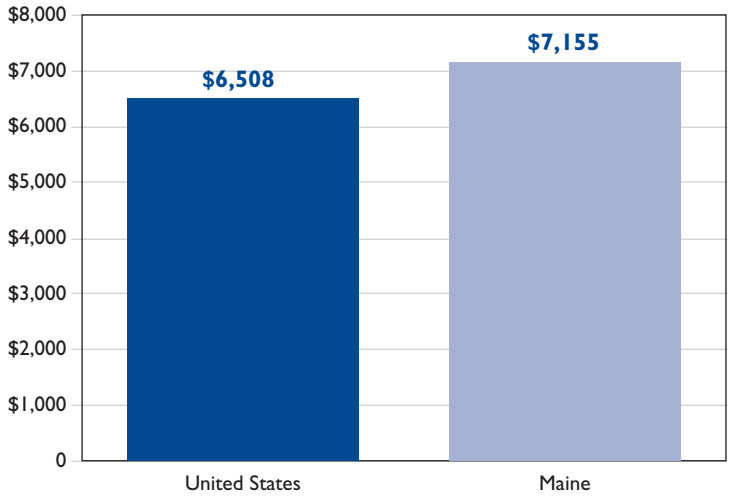
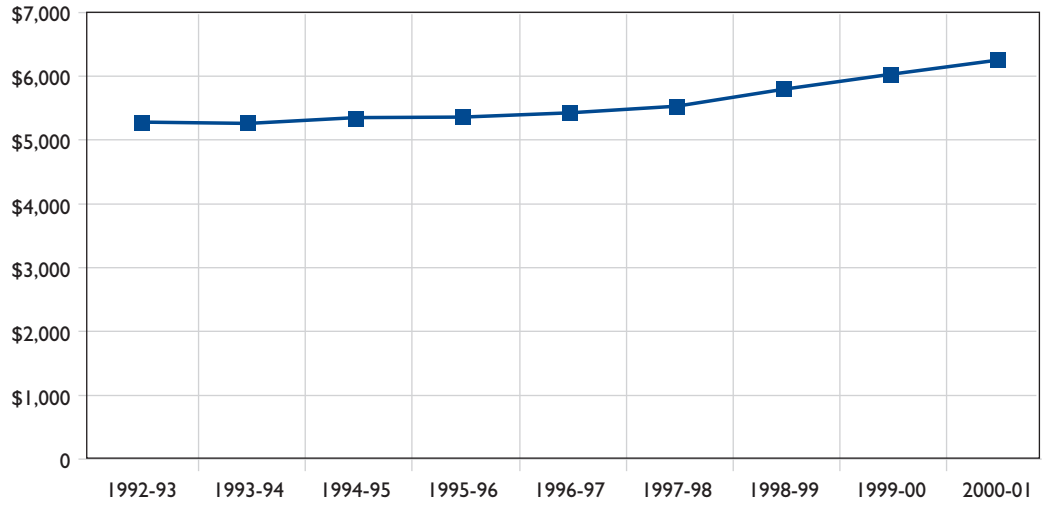


FIGURE 3: **Inflation-Adjusted Operating Cost per Student in Maine, 1992-93—2000-01**
(Data from the Maine Department of Education)



Maine had the sixth lowest number of students per school district. The average number of students in Maine's public schools is only about five-ninths of the national average. In 2000-01, Maine had the seventh lowest number of students per school.

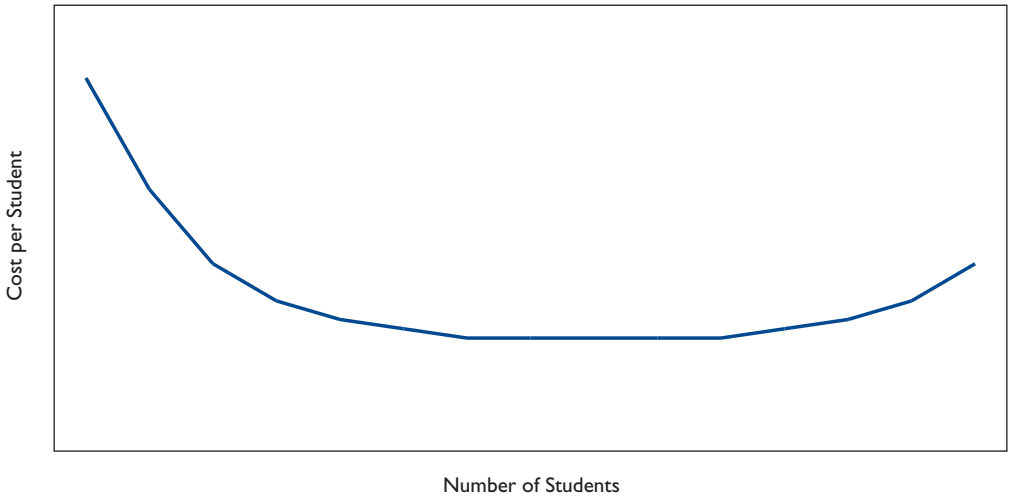
Moreover, future demographic changes recently forecasted by the Maine State Planning Office indicate that our schools and school districts will become even smaller without greater consolidation of educational resources. A rapid contraction of the school-aged population (ages five through 17) is expected in Maine. The school-age population is forecasted to shrink by almost 8% from 2000 to 2005, and by almost 13% over the 2000-10 decade. This forecast indicates that, unless there is significant consolidation, the fixed costs of providing education services (i.e., the costs of facilities operation, administration, etc.) will be spread over even fewer students in the near future.

COST PER STUDENT

On average, education in Maine costs more than in the rest of the country. As shown in Figure 2, current (in the sense of non-capital) cost per student in Maine is about 10% higher than for the country as a whole, according to the latest data available from the United States Department of Education. In 1998-99, Maine had the 13th highest cost per student.

Figure 3 illustrates the rising cost of providing K-12 education.[4] The cost of education rose significantly faster than the rate of inflation during the last decade. Even after removing the effect of inflation, per-student cost in Maine rose by an average of 2% per year over the nine academic years from 1992-93 to 2000-01. Moreover, public education costs rose particularly rapidly during

FIGURE 4: **Expected Relationship Between Cost per Student and School Size**



the last three years of that period. In the latter three years, per-student cost rose by an average of four percentage points per year more than the rate of inflation.

The primary reason for the rising costs is that education is labor intensive, and average wages rose faster than inflation, particularly at the end of the last decade. In a labor-intensive area like education, as opposed to a capital-intensive area such as microchip manufacturing, technological advances do not offset rising wage rates. The implication of this is that we should expect that education costs will continue to rise—unless significant cost savings are found. Indeed, a preliminary examination of the costs of providing public education in Maine reveals that there may be significant potential cost savings.

A FIRST LOOK AT SCHOOL SIZE AND COST PER STUDENT

Economies of scale exist when cost per student declines as the number of students increases. Economies of scale are expected to occur at low numbers of students because the spreading of fixed costs over more students outweighs the additional costs from more students. Diseconomies of scale exist when cost per student rises as the number of students rises. This is expected to occur at high numbers of students because the additional costs of more students outweigh spreading the fixed cost over more students. In other words, going from very low levels of students (imagine the cost per student of having a school for each student) to very high levels of students (imagine the cost per student of having only one school in the state), we can expect a U-shaped relationship between cost per student and the number of students (this assumes that the quality of educational services remains constant). This expected relationship between school size and per-student cost is shown in Figure 4.

However, it is not immediately clear where our schools and school districts are in this relationship. Ideally our schools would be on the flat middle region of this relationship, where cost per student is minimized (again, for some fixed level of education quality). The data, however, suggest that our schools are on the declining portion of the relationship.

Figure 5 (page 68) plots average cost per student in each state in 1998-99 against its average number of students per school district (comparable cost figures are only available for school districts rather than for schools).[5] Although there is a considerable amount of variation in average per-student cost (i.e., there are obviously other factors that affect states' costs), the curve of best fit indicates a U-shaped relationship. Moreover, Maine appears to be on the declining portion. The data shown in this figure are highly aggregated, though. It would be better to look at data from individual school districts to infer economies of scale and potential cost reductions from consolidation of school resources. Data of this sort are shown in Figure 6.

Figure 6 (page 68) also suggests a U-shaped relationship between cost per student and the number of students in Maine, although there again is considerable variation in cost per student across the districts (i.e., the number of students is obviously not the only factor that affects districts' costs). All of the 25 highest-cost districts (above $7,800 per student) are relatively small (all but

FIGURE 5: **Current Cost per Student and Average School District Size in Each State, 1998-99**
(Data from the U.S. Department of Education)

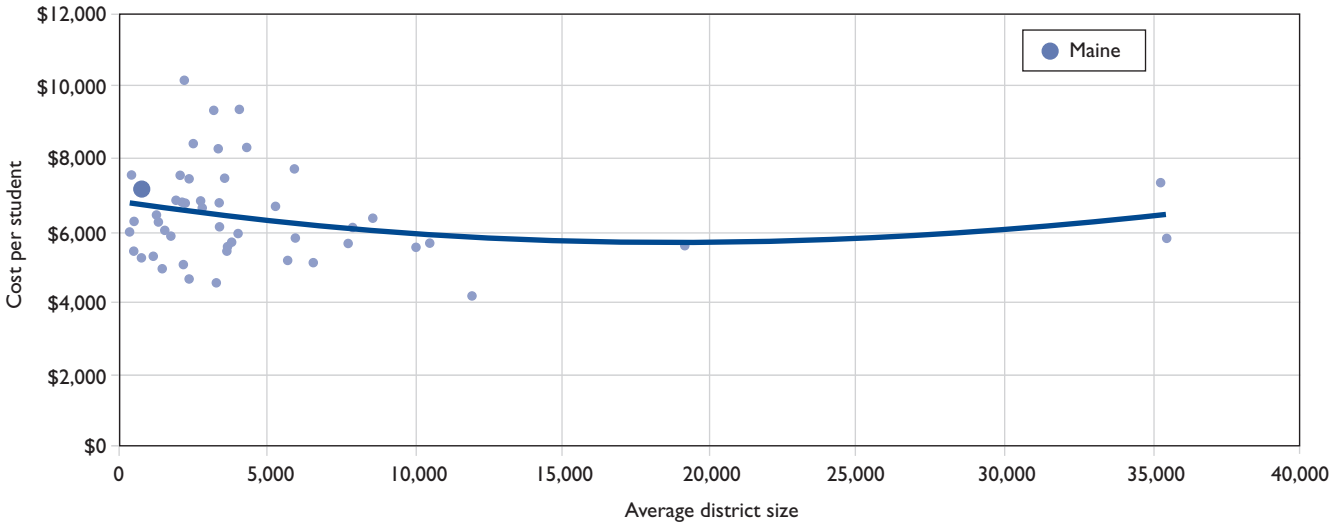
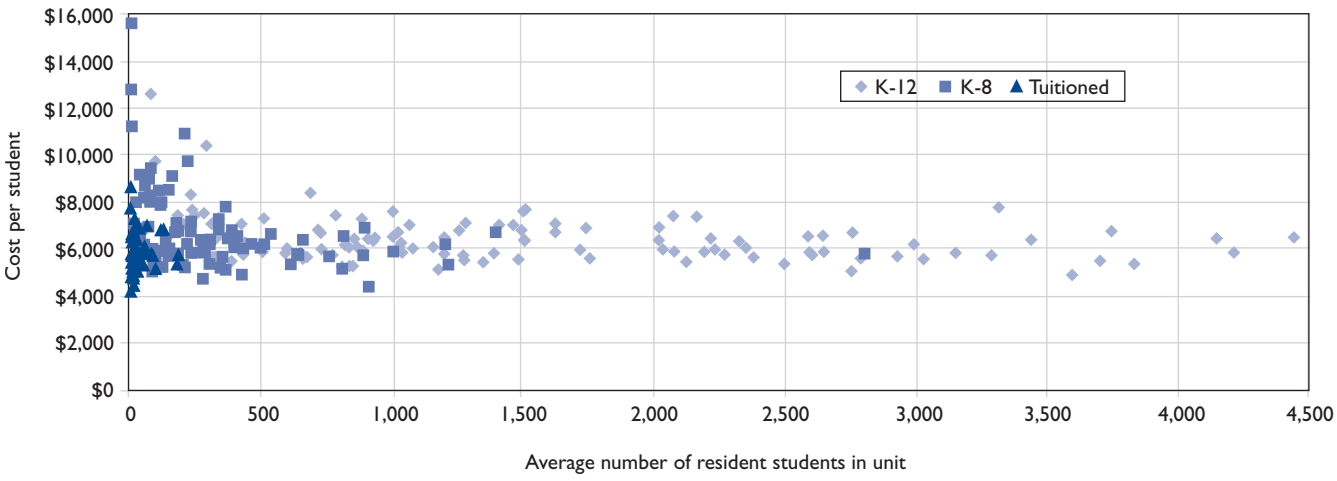


FIGURE 6: **Operating Cost per Student and Number of Students in Maine's School Administrative Units, 2000-01** *(Data from the Maine Department of Education)*



one have less than 300 students). But there also are many small districts (so small that they appear very near the zero vertical axis) that have low per-student costs, which appears to contradict the hypothesis that there are significant increasing returns to scale in K-12 education. Closer inspection of the data, however, reveals that these

data points do not contradict the hypothesis. Indeed, these cases provide further support for the hypothesis of increasing returns at low numbers of students.

All of the seven lowest-cost districts (below $4,850 per student), and 20 out of the 23 lowest-cost districts (below $5,225 per student) pay other districts to educate at least some of their students. That is, by sending all or some (i.e., just the high schoolers) of their students to other districts, many of the very small districts are able to benefit from the economies of scale found in the larger school districts. One might initially think that tuitioning students to other districts would be relatively costly for these school districts. However, on average this is not the case. For the small districts, tuitioning their students is not only cheaper than educating their students themselves, it is even cheaper than the average cost per student in the state. The average operating cost per student in Maine in 2000-01 was $6,233. The weighted average cost per student in school districts that tuition all of their students to other districts was only $5,889—5.5% less than the state average.

Why do these tuitioning districts get such a good deal? Are the receiving school districts being benevolent to the smaller districts? Perhaps, but probably not. The larger districts have their own children and taxpayers to consider. More likely, the larger districts benefit by accepting students from other districts at a tuition rate below their average cost per student. How is this possible? Economies of scale. The cost of the *additional* students is less than their overall average cost per student. These districts benefit from having more students share their costly infrastructure. In other words, both the sending and receiving districts can share in the cost savings from moving from points on the downward-sloping part of the curve shown in Figure 4 to a point on or nearer the flat part of the curve.[6]

Comparing the points in the tuitioning districts to those in the teaching districts in Figure 6 clearly shows the benefit from tuitioning students out of the smallest districts.[7] The complete-tuitioning districts generally lie below and to the left of the K-8 districts, which generally lie below and to the left of the K-12 districts. Tuitioning students out of very small districts reduces the cost per student. Thus, the state already benefits from some consolidation of school resources. Indeed, consolidation of school resources has been occurring in the state for decades. Still, there does appear to be room for more consolidation. Many of Maine's schools appear to be on the downward-sloping part of the relationship between cost per student and school district size. Moreover, one cannot help wondering if there is any reasonable justification for having the extra bureaucracy from 56 school districts that do not operate any schools and tuition all of their students (with an average of 38 students per district).

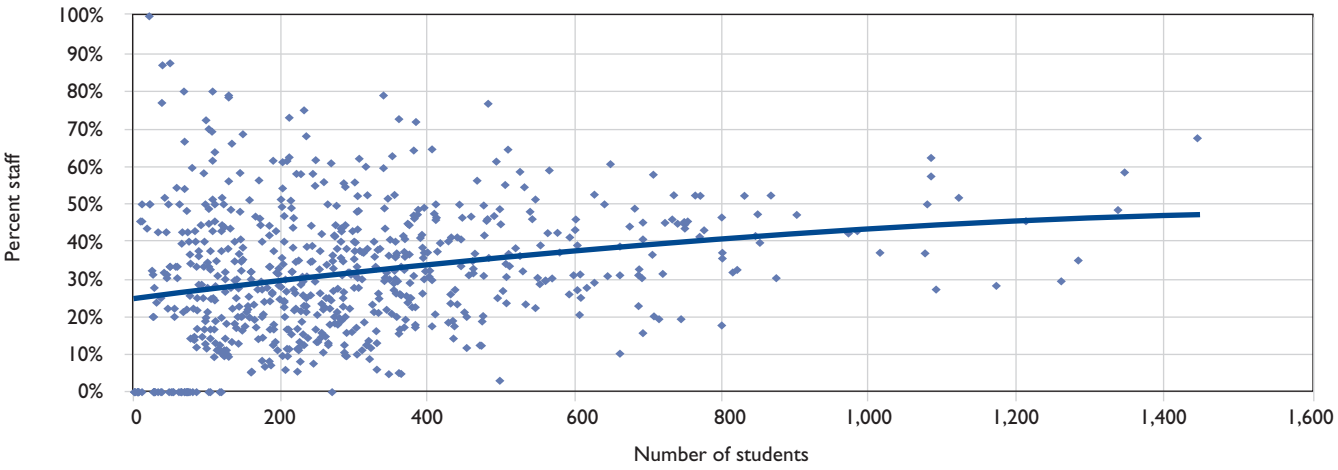
SCHOOL QUALITY

It is possible that the cost savings from larger schools and schools districts come from a reduction in quality. However, casual observation suggests this is not likely the case. For instance, students in larger schools tend to have more educational choices, such as advanced placement (AP), vocational, language, music, and drama courses. Although the quality of educational services cannot be quantified with any degree of precision, it is worth examining some crude measures. The readily available crude measures are for individual schools (as opposed to school districts as examined earlier).

Figure 7 (page 70) plots the percentage of the school staff with graduate degrees against school size. Staff with greater credentials can presumably provide better services on average. Although there is a great deal of variation in the ratio across schools, the curve of best fit shows that there is a clear positive correlation between the percentage of graduate staff and the number of students. Of the 82 schools with less than 80 students (and without missing data), 36 do not have any staff with graduate degrees (which explains the overlap of many data points near the origin on the horizontal axis). Perhaps larger schools do indeed use some of their cost savings from economies of scale to hire relatively more staff with higher qualifications.

Figures 8, 9, and 10 (page 71) plot average scores from the Maine Education Assessment against the number of students in the school.[8] Again there is a lot of variation across schools (clearly, there are other important factors affecting test scores), but the curves of best fit show positive correlations between average

FIGURE 7: **Percentage of Staff with Graduate Degrees, by School Size in Maine Public Schools, 2000-01** *(Data from the Maine Education Policy Research Institute)*



test scores and the number of students. In the case of high school MEA scores, though, the correlation is nonlinear. The correlation between average 11th grade MEA scores and high school size is positive only up to a little over 1,000 students. But almost 90% of the high schools in the state are below this level. Overall, the evidence again suggests that economies of scale enable the larger schools to provide higher quality instruction (as well as at a lower cost), although there are limits to these economies of scale.

Figure 11 (page 72) plots the percentage of graduating seniors that intend to further their education against school size. Perhaps surprisingly, there is essentially no correlation between these variables.

Figure 12 (page 72) shows the high school dropout rate and high school size. The relationship between these variables is clearly nonlinear. The curve of best fit shows that the dropout rate improves up to a high school size of a little over 650 students. About two-thirds of Maine's high schools have less than 650 students.

Thus, the evidence, albeit crude, does not indicate that cost reductions from larger schools come at the expense of education quality.[9] Indeed, the evidence suggests that, up to a point, larger schools are able to use some of their cost savings to provide better instruction. And most of Maine's schools are below this point. An important implication of this is that expenditures per student are not the whole story for judging the fairness of educational opportunities. Equality of spending per student does not necessarily imply equality of education quality and opportunity when there are significant differences in economies of scale across school districts. The evidence suggests that, even if spending per student were the same across every school district, students in smaller school districts still may have less educational resources and opportunities.

Naturally, it is possible that larger schools have lower levels of some unmeasured—yet important—aspects of education quality. To the extent that this is the case, then the loss of these benefits from smaller schools needs to be weighed against the estimated cost savings presented below.

STATISTICAL ANALYSIS

The previous charts showing correlations suggest significant potential cost savings from greater consolidation of educational resources. To obtain a rough idea of the extent of these cost savings, an average cost curve was estimated using multivariate regression analysis on the per-student cost data shown in Figure 6. That is, a curve of best fit was estimated.

Three variables were included in the regression equation. Obviously, one of these is the number of students in the district. The square of the number of students was included to capture the nonlinearity in its relationship with per-student cost. A variable indicating the K-8 districts was also included to measure the cost savings K-8 school districts gain through the tuitioning of their

FIGURE 8: **Average 4th Grade MEA Scores, by School Size, 2000-01**

(Data from the Maine Education Policy Research Institute)

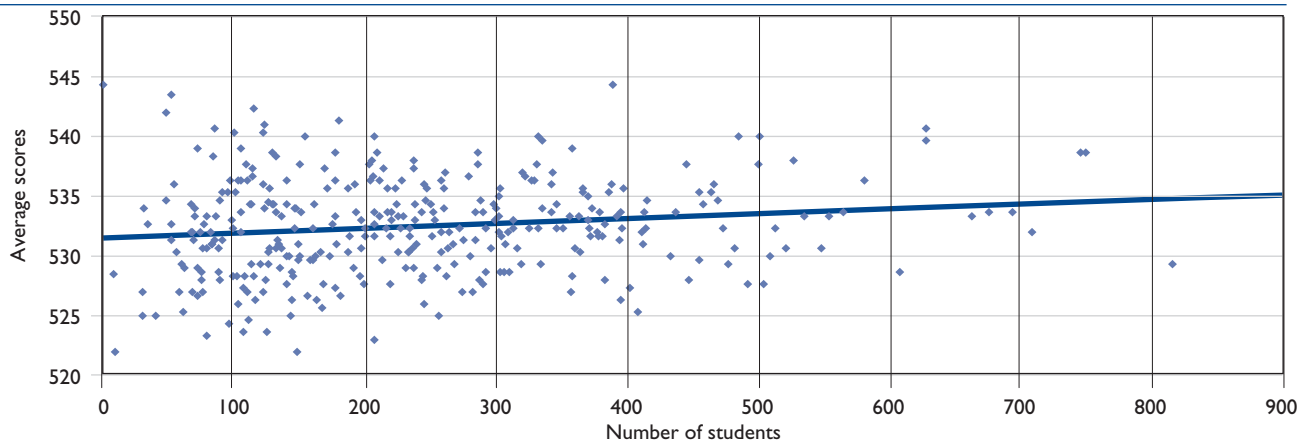


FIGURE 9: **Average 8th Grade MEA Scores, by School Size, 2000-01**

(Data from the Maine Education Policy Research Institute)

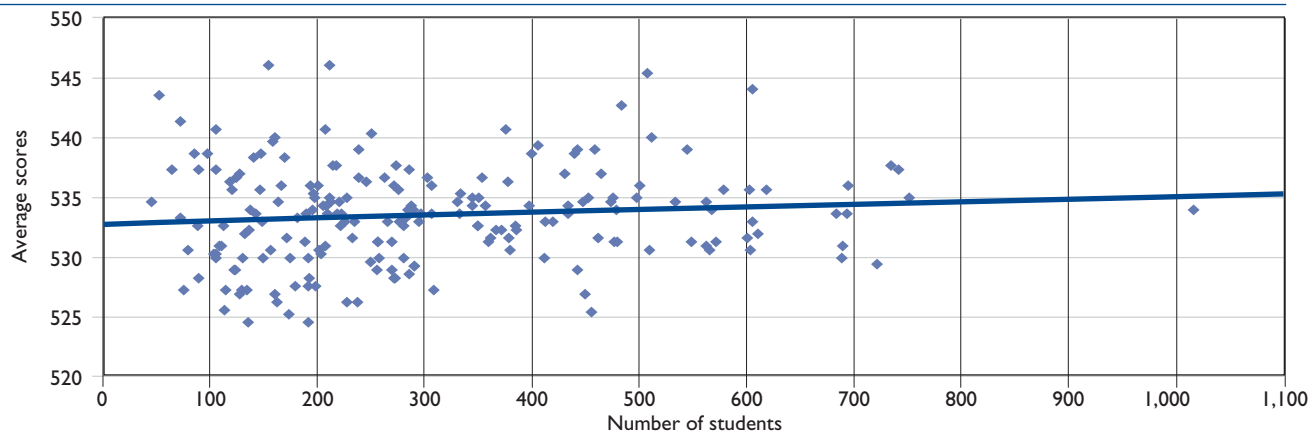


FIGURE 10: **Average 11th Grade MEA Scores, by School Size, 2000-01**

(Data from the Maine Education Policy Research Institute)

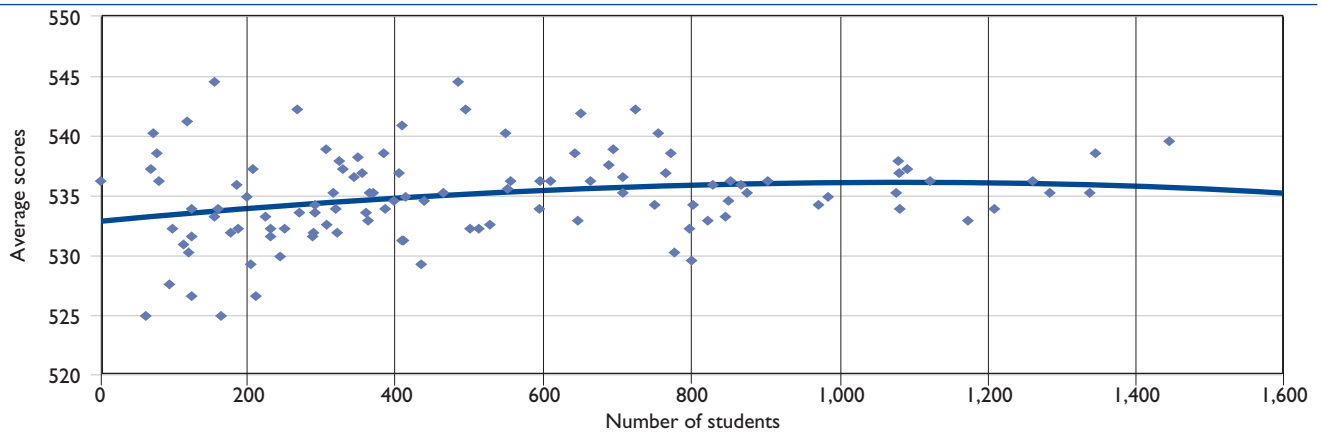


FIGURE 11: **Intent to Enroll in Higher Education, by School Size**
(Data from the Maine Education Policy Research Institute)

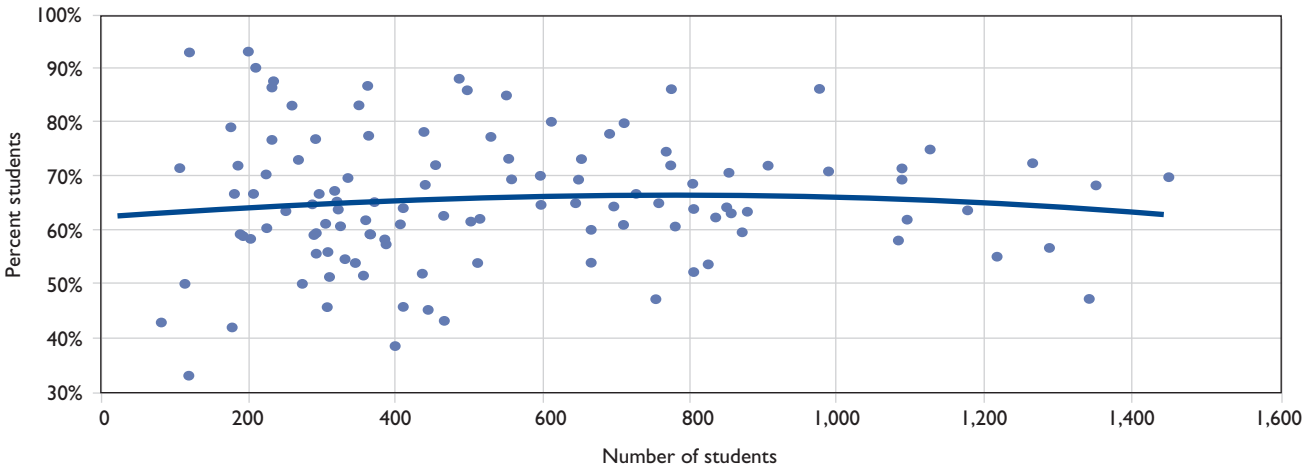
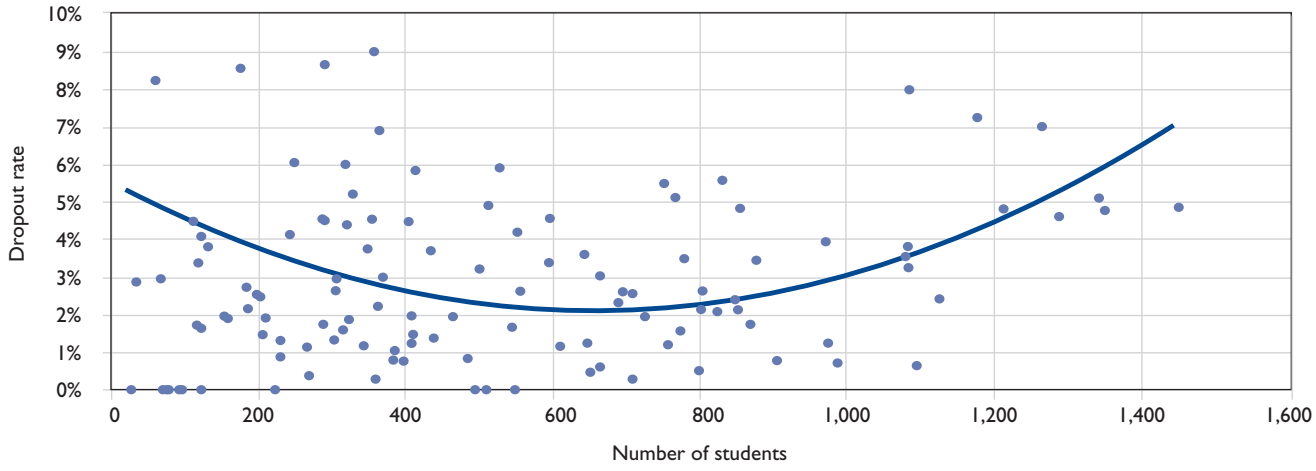


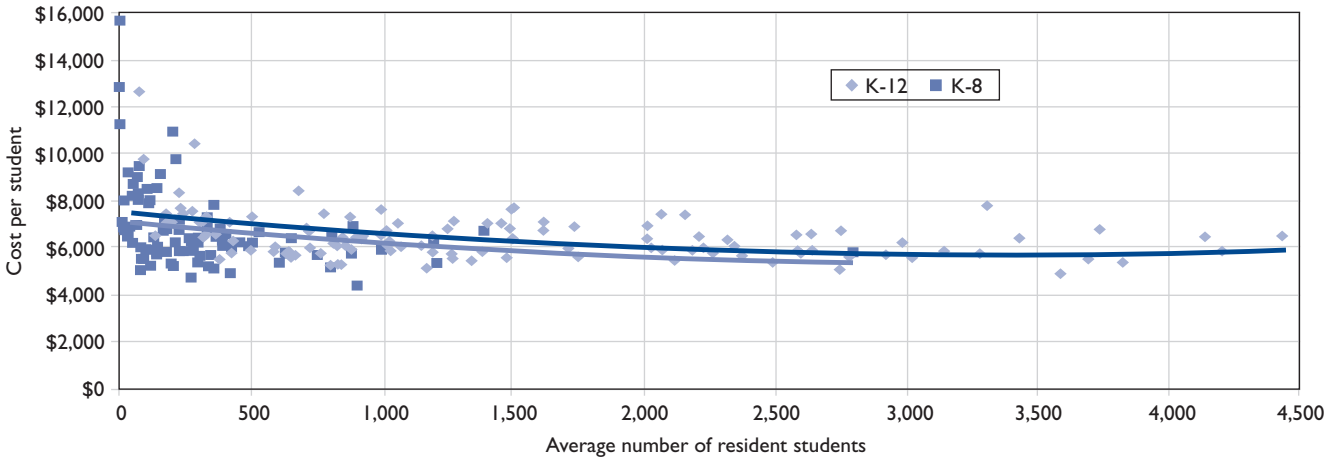
FIGURE 12: **Dropout Rates, by School Size, 2000-01** *(Data from the Maine Department of Education)*



high school students. As discussed above, the number of students in school districts that tuition all their students is a misleading indication of the school sizes where the students attend. Thus, the regression equation was estimated using data from the school districts where teaching occurs (i.e., for the K-8 and K-12 districts only).[10]

The equations that best match the K-8 and K-12 data are shown in Figure 13. The estimated average cost curves are clearly downward-sloping over the range of most school district sizes in Maine. The average cost per student in K-8 school districts is $409 lower than in the K-12 districts after controlling for the number of students (although their per-student cost is $242 higher than for K-12 schools when not controlling for district size). Clearly, there is a considerable amount of unexplained variation across districts in cost per student (due to differences in efficiencies, quality of instruction, etc.). But 12.7% of all the variation in cost per student is explained by only three variables (the number of students, its square, and the

FIGURE 13: **Operating Cost per Student and Number of Students in Maine's School Administrative Units that Operated Schools in 2000-01**
(Data from the Maine Department of Education)



tuitioning of 9-12 students). School district size clearly affects per-student cost. This suggests significant cost savings from moving to more cost-effective sizes.

The estimated school district size that achieves minimum cost per student is 3,378 students (260 students in each grade, K-12). Only nine of the state's school districts are this large. Thus, there appears to be substantial potential cost savings from greater consolidation of educational resources in Maine.

SOME ILLUSTRATIVE ESTIMATES OF COST SAVINGS

The estimated per-student cost curves shown in Figure 13 are nonlinear. Therefore, the implied potential cost savings from consolidation depend on levels of consolidation. The likely cost savings are clearly greater when going from, say, 500 to 1,000 students per school district, than from, say, 2,500 to 3,000 students per district. The average cost curve is relatively steep at low numbers of students, but is flat near 3,378 students. Thus, a few illustrative examples of cost savings from reducing duplication of educational services are calculated below.

Four points are worth making before turning to these illustrative cases. First, the estimated regression equations indicate average potential cost savings. We cannot expect the same cost savings in every case (even if the level of consolidation were the same). The actual cost savings would probably be smaller in some circumstances, but larger in others. Second, there are at least some physical limits to the potential cost savings. To take an extreme example, according to the estimates Augusta and Orono could merge to form a school district with 3,358 students, which is very close to the cost-minimizing size. The 85-mile distance between the towns, though, obviously makes such a merger absurd. It is equally absurd to think that the state's island schools could consolidate. To the extent that there are severe physical limits, the estimated cost savings shown below overstate the likely actual cost savings. Third, the estimated cost savings are implicitly long-run cost savings. Clearly, there would be some adjustment costs from school and school-district realignment. The estimates below do not account for these costs; hence there is another reason why the estimated cost savings overstate likely actual cost savings to some extent. Fourth, the estimates do not take differences in educational quality into account. If some of the cost savings from economies of scale are used to increase school quality, then the estimates below understate the true cost savings from consolidation.

The weighted-average school district size in Maine in 2000-01 is 2,238 students. The average school district size is 754 (1,018 when excluding the districts that tuition all their students), but most of the students

in Maine are in the larger districts. Thus, the average school size for Maine's public school students is the weighted average. The estimated long-run annual cost saving of moving from a school district of this size to a cost-minimizing size is $207 per student. This is 3.5% of the average cost per student at 2,238 students. Moreover, because the cost-size relationship is non-linear, this understates the potential cost savings of moving all of Maine's school districts to the cost-minimizing size (subject to the caveats above). This estimate would be the potential cost savings for the state if all school districts in Maine had 2,238 students. Obviously some districts have more, and many have less, but, because of the nonlinearity, the greater cost savings from the smaller districts more than offsets the lower cost savings from the larger districts.

As noted above, the average teaching school district in Maine has 1,018 students. The estimated cost saving of moving the average teaching school district to the cost-minimizing size is $886 per student. This is 13.5% of the average cost per student at 1,018 students.

Brewer, Dedham, Orrington, and the communities in S.A.D. 63 (Clifton, Eddington, and Holden) recently considered, but rejected, merging into a single school district that would have had 3,347 students (remarkably close to the cost-minimizing size) in 2000-01. The estimated long-run cost of that decision is $647 per student per year, which is 10.2% of the estimated weighted-average cost per student in these school districts. Evidently the decision not to consolidate these districts is very costly.

CONCLUSION

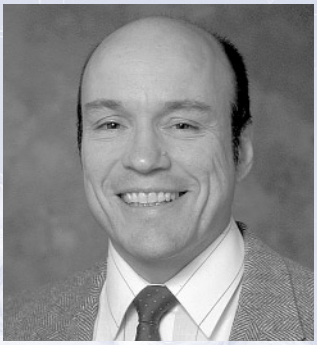
The rough estimates presented here are just that—rough estimates. They should not be interpreted as any more than that. This initial examination of the data cries out for more in-depth analysis. The primary reason why further study is warranted is that this initial study suggests that the stakes are very high.

For example, the estimated potential long-run cost savings from one proposed consolidation of educational resources is about 10%. In 2000-01, 72.8% of local property taxes in Maine were used for K-12 education (and this ratio has been rising). The average was 72.5% in 1999 in the six towns affected by the proposed consolidation. Thus, if education costs can be reduced by 10%, then property tax rates can potentially be reduced by about 7%. That is, potentially the average mill rate in the six towns could be reduced from 15.4 (in 1999) to 14.3. This means about $110 of potential taxpayer savings per year per $100,000 of property tax valuation.

However, these potential tax savings are probably significantly less than the actual tax savings that these towns would see. Much of the cost savings would probably be passed on to the state rather than kept within the district. The state's school funding formula appears to subsidize the small districts, and hence unintentionally subsidies sprawl. That is, the data show that, despite the fact that small school districts generally have significantly higher per-student costs, small districts also generally have significantly lower property tax rates for education. This unintentional subsidy to sprawl from the school funding formula is an issue that merits further research.

Although costs have received the lion's share of the emphasis in the study (for the simple reason that they are quantifiable), it is important to keep in mind that costs are only part of the story. The quality of the instruction that our children receive also is at issue here. It is quite possible that by reducing unnecessary duplication of infrastructure, we will enable more opportunities for our children. Larger schools and school districts may be better able to offer a wider and richer array of curricular and extracurricular opportunities. They also, through exposure to a greater diversity of people and cultures, may better prepare our children to fully participate in a global society.

View current & previous issues of MPR *at: www.umaine.edu/mcsc/mpr.htm*



Philip Trostel is an associate professor of economics and public policy at the University of Maine, with a joint appointment at the Margaret Chase Smith Center for Public Policy and in the Department of Economics. He has previously taught at North Carolina State University, Hong Kong University of Science & Technology, University of Warwick (England) and Dartmouth College. He has published numerous articles in academic journals on issues about human capital and education.

ENDNOTES

1. This research was funded by the Eastern Maine Development Corporation as part of their PV PILOT project, and the TCSP Pilot Program of the Federal Highway Administration. I would like to thank Walter Harris, Judith Lucarelli, David Silvernail, and participants of the School Administrative Unit Study Group for sharing their knowledge on the subject, and Ewa Kleczyk for research assistance.

2. This evaluation may seem rather harsh to some readers familiar with assessments such as Maine having "the highest performing K-12 education system" (National Education Goals Panel 1999) and the "biggest bang for its education buck" (*Forbes* 1997). These studies (as well the widely publicized high average scores of Maine students on national standardized exams), however, fail to account for Maine being the least ethnically diverse state in the country. After accounting for this fact, the performance of Maine schools is only about average. For further discussion on this issue, see Philip A. Trostel, "Workforce Development in Maine: Held Back by the Lack of Higher Education." Margaret Chase Smith Center for Public Policy Technical Report, 2002.
3. Moreover, this problem is compounded by Maine's current budget problems and already high level of state and local taxes.
4. Maine's operating cost per student shown in Figures 2 and 3 are not directly comparable because of differences in the way that the Maine and U.S. Departments of Education calculate cost per student. The U.S. Department of Education figure includes all state spending on public education, not just that which can be attributed to individual school districts.
5. Hawaii, with a single school district of 185,860 students, is omitted to avoid distorting its scale.
6. There are also legal caps on the tuition rates that school districts can charge other school districts. It seems highly unlikely, however, that the receiving districts would tolerate a situation where they are heavily subsidizing the sending districts.
7. The largest school district (Portland) is omitted to make this chart easier to read by substantially reducing its scale.
8. To streamline the discussion, these test scores are the average of the average scores on the reading, writing, and mathematics tests.
9. It would have been interesting to examine the relationship between course offerings, such as advanced-placement and vocational courses, and school size, but compiling this data was beyond the scope of this study.
10. For details of the regression analysis, see Chapter 2 of Thomas Allen, Kathleen P. Bell, and Philip Trostel, "Regional Cooperation in the Greater Bangor Region: Educational, Housing, and Capital Planning." Margaret Chase Smith Center for Public Policy Technical Report, 2002.