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ABSTRACT

Any interstate comparison that does not take differences in the cost of education into account will give an incorrect impression of the relative levels at which different states support their schools. The lack of cost-adjusted statistics on state expenditures for elementary and secondary education interferes with policy analysis, resource allocation, and decision making in education. An examination of state cost data indicates that there is substantially more interstate variation in per-pupil spending than in the amounts of the main educational resource--instructional staff--that states provide for each pupil. In fact, the main conceptual and technical problems in constructing a cost-of-education index arise from the labor-intensive nature of education and the types of labor on which schools rely. This report evaluates some ways of constructing cost-of-education indices, focusing on existing approaches rather than proposing new ones. Conceptual advantages of econometric supply-demand modeling approach are noted, as are its practical disadvantages. Improvements in databases should make construction of a model-based cost-of-education index much more feasible in the near future. Chapters are: (1) "Introduction: Cost Differentials and Cost-of-Education Indices"; (2) "Conceptual Foundations of Cost-of-Education Indies": (3) "Alternative Index Construction Methods"; (4) "Demonstration and Assessment of Simple Cost Indices and Proxies"; and (5) "Conclusions: Current Capabilities and Promising Options." (Contains 19 tables and 48 references.) (SLD)

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Cost-of-Education Differentials Across the States

Working Paper No. 94-05

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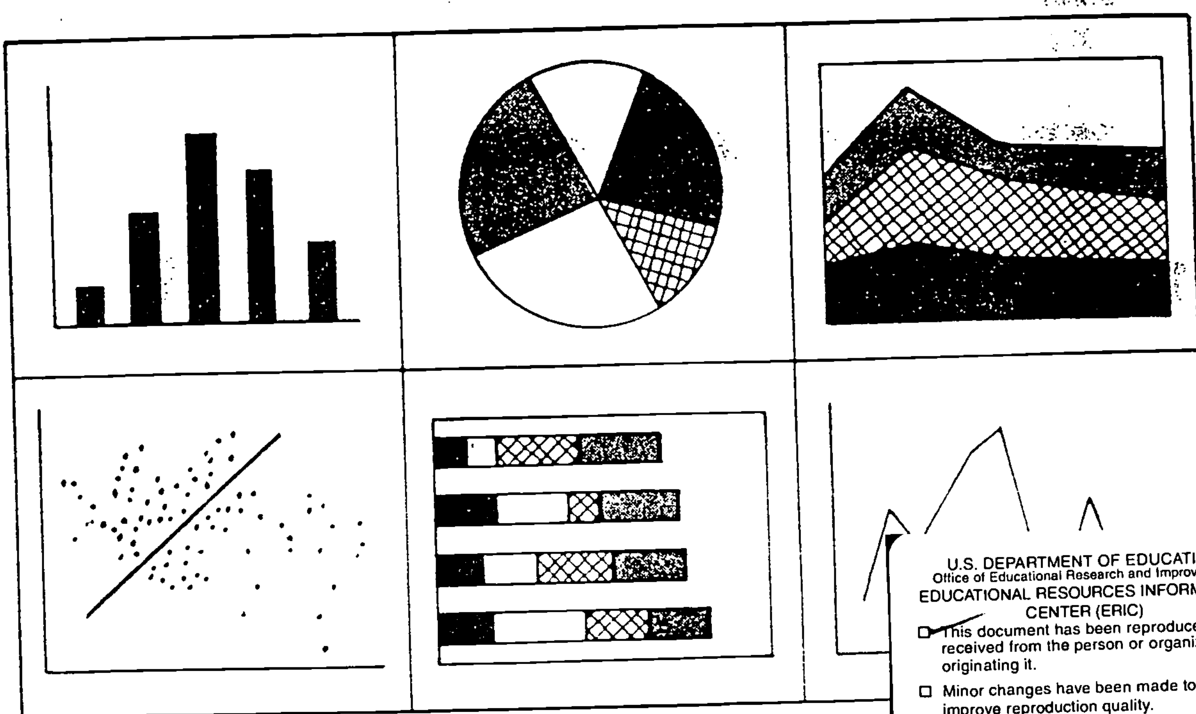

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Cost-of-Education Differentials

Across the States

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COST-OF-EDUCATION DIFFERENTIALS ACROSS THE STATES

Stephen M. Barro

November 1993

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1. INTRODUCTION: COST DIFFERENTIALS AND COST-OF-EDUCATION INDICES

Several organizations regularly publish statistics on expenditure for elementary and secondary education by state, but interstate comparisons of these unadjusted expenditure figures are misleading, and inferences or policies based upon them are likely to be misconceived.[1] The main problem is that the dollar is an inconstant measuring rod. Its educational purchasing power--the numbers of teachers, classrooms, and other educational resources that a given number of dollars can buy--varies significantly among the states. Equal outlays do not necessarily translate into equal educational services, and disparities in per pupil spending do not necessarily reflect disparities in the real educational resources that each state provides to its pupils. Any interstate comparison that does not take differences in the cost of education into account will give an incorrect impression of the relative levels at which different states support their schools.

The cost-differential problem has recently drawn renewed attention from researchers and policymakers, and calls to deal with it have become more urgent. One reason is that education reform efforts have stimulated interest in interstate comparisons of all kinds--comparisons of educational outcomes, programs, services, and curricula as well as comparisons of the fiscal and resource inputs into schooling. Interests that formerly resisted interstate comparisons now not only favor them but produce comparative statistics themselves--witness the "education indicator" reports issued by the National Governor's Association (NGA, 1990) and the Council of Chief State School Officers (CCSSO, 1991), not to mention the movement toward national standards and performance tests in which state governors have taken a leading role. Interstate comparisons have become more purposeful as well as more frequent. They figure frequently in debates over such issues as whether to raise teachers' salaries, to restructure state school finance systems, or to generate increased revenue for schools. As the importance of interstate comparisons has risen, the lack of satisfactory methods for taking cost differentials into account has grown from an irritant to a significant impediment to effective policymaking.

A second reason for increased interest in cost differentials is that the drive to improve schooling has focused attention on relationships between resource inputs and outcomes. Such relationships are likely to be obscured by comparisons that neglect geographical variations in costs. For example, the finding that a state spending $5,000 per pupil does no better educationally than a state spending $4,000 per pupil would have different implications if the outlay differential mainly reflected unequal staff salaries than if it reflected differences in the real resources provided to each student. Now that the National Assessment of Educational Progress (NAEP) has begun to produce state-by-state comparisons of educational achievement, the temptation will probably be irresistible, for better or worse, to see how average state test scores relate to levels of per-pupil spending, but any such analysis that fails to adjust the expenditure figures for interstate differences in cost is certain to yield faulty conclusions. In general, taking cost variations into account is necessary (though by no means sufficient) for determining how funds and resources are related to educational performance.

A third, more immediately practical reason for paying attention to cost differentials is that doing so could help to improve the distribution of federal education aid among the states. Current federal aid allocation formulas fall into two categories with respect to their treatment of cost differentials. In one group are formulas that take no account of cost differentials at all--for example, formulas that simply distribute funds according to the number of school-age children in each state. In the second group are formulas that link aid allocations to the level of education spending per pupil in each state--the rationale being that per-pupil spending is a "proxy" for the cost of education.[2] Formulas of the first type obviously provide greater real assistance per pupil, other things being equal, to low-cost than to high-cost states--a not necessarily intended result.[3] Formulas of the second type confound interstate differences in the cost of education with differences in the states' ability or willingness to support schools, skewing the distribution of aid in favor of the higher-spending states.[4] These particular shortcomings of the federal fund distribution process could be avoided if the technical tools were available to adjust aid amounts for interstate variations in costs.

In sum, the lack of cost-adjusted statistics on state expenditures for elementary and secondary education interferes in several ways with policy analysis, resource allocation, and decisionmaking in education. In each of these arenas, significant benefits could be realized by developing and applying appropriate cost-adjustment methods.

THE MAGNITUDES OF COST DIFFERENTIALS

Although the logical case for taking cost differentials into account are compelling, the question remains of whether interstate variations in the cost of elementary and secondary education are large enough to be important in practice. If prices of educational resources varied by only a few percentage points among states, the adverse effects of comparing unadjusted dollar amounts would be minor, and there would be little reason to invest much effort in quantifying cost variations. It appears, however, that interstate cost differentials are far from negligible (under reasonable sets of assumptions) and therefore that ignoring them in interstate comparisons does not have negligible consequences.

To demonstrate that the interstate differentials are substantial, I show below that differences in per-pupil spending across states are not proportional to differences in real resources (numbers of instructional staff per pupil) and, moreover, that the disproportionalities between staff per pupil and spending per pupil can be accounted for in large part by variations in instructional staff salaries. These findings provide a strong prima facie case that important interstate differentials in unit costs exist and hence that cost adjustments would change significantly the results of interstate funding comparisons. Although the evidence does not absolutely rule out the possibility that the disproportionalities might reflect other causes (specifically, very large interstate differences in the quality of personnel or in spending for resources other than instructional staff), the magnitudes are such that these alternative explanations have little credibility.

Some of the pertinent data are presented in Table 1-1, which arrays the states in order of descending current expenditure per pupil (all data are for school year 1987-88). The first three columns of the table show, respectively, current expenditure per pupil, the instructional staffing ratio (instructional staff per 1,000 pupils), and the average instructional staff salary.[5] The last three columns express the same variables as index numbers--that is, as percentages of the corresponding U.S. average values. Thus, for example, the table shows that Wyoming expended $4,742 per pupil in 1987-88, which placed it at 121 percent of the national average level of per-pupil spending; employed 75.9 instructional staff members per 1,000 pupils, or 117 percent of the U.S. average; and paid its instructional staff members $28,327 on average, or 97 percent of the average salary paid nationally.

It is evident from the table that there is substantially more interstate variation in per-pupil spending than in the amounts of the main educational resource--instructional staff--that different states provide for each pupil. The range of variation in expenditure per pupil (ratio of highest to lowest) is about 3.1 to 1 (2.7 to 1 excluding Alaska), whereas the range of

Table 1-1

Current Expenditure per Pupil, Instructional Staffing Ratio, and Average Instructional Staff Salary by State

State	Current Expenditure per Pupil ($) (1)	Instructional Staff per 1,000 Pupils (2)	Average Instructional Staff Salary ($) (3)	Indices (U.S. = 1.00) Current Expenditure per Pupil (4)	Instructional Staff per 1,000 Pupils (5)	Average Instructional Staff Salary (6)
Alaska	7,159	65.7	41,531	1.82	1.01	1.42
New York	6,196	78.1	35,400	1.58	1.20	1.21
New Jersey	6,059	83.5	32,110	1.54	1.29	1.10
Connecticut	5,905	87.3	34,802	1.50	1.34	1.19
District of Columbia	5,662	69.6	39,616	1.44	1.07	1.36
Massachusetts	4,965	80.5	31,756	1.26	1.24	1.09
Rhode Island	4,951	75.8	33,326	1.26	1.17	1.14
Vermont	4,927	84.7	25,525	1.25	1.30	0.87
Wyoming	4,742	75.9	28,327	1.21	1.17	0.97
Delaware	4,606	69.7	30,614	1.17	1.07	1.05
Pennsylvania	4,603	70.1	29,881	1.17	1.08	1.02
Maryland	4,575	67.1	31,932	1.17	1.03	1.09
Michigan	4,350	63.8	34,202	1.11	0.98	1.17
Wisconsin	4,296	68.9	30,958	1.09	1.06	1.06
Oregon	4,266	63.8	29,300	1.09	0.98	1.00
Minnesota	4,132	64.9	30,960	1.05	1.00	1.06
New Hampshire	4,080	74.4	24,690	1.04	1.14	0.85
Maine	3,965	76.1	24,161	1.01	1.17	0.83
Montana	3,878	72.7	25,318	0.99	1.12	0.87
Colorado	3,878	62.0	29,626	0.99	0.95	1.02
California	3,876	48.2	34,304	0.99	0.74	1.18
Washington	3,875	56.7	29,468	0.99	0.87	1.01
Virginia	3,873	71.0	27,705	0.99	1.09	0.95
Iowa	3,867	69.3	25,598	0.98	1.07	0.88
Illinois	3,822	64.2	30,673	0.97	0.99	1.05
Florida	3,778	66.3	27,052	0.96	1.02	0.93
Kansas	3,724	73.9	26,309	0.95	1.14	0.90
Nebraska	3,712	74.1	24,100	0.95	1.14	0.83
Hawaii	3,661	62.7	29,510	0.93	0.97	1.01
Ohio	3,595	63.1	29,322	0.92	0.97	1.00
West Virginia	3,579	74.6	22,711	0.91	1.15	0.78
Arizona	3,498	62.6	30,550	0.89	0.96	1.05
Indiana	3,454	62.1	27,794	0.88	0.96	0.95
Missouri	3,425	72.0	25,666	0.87	1.11	0.88
Texas	3,334	65.3	26,572	0.85	1.00	0.91
Nevada	3,298	57.6	28,860	0.84	0.89	0.99
North Dakota	3,239	70.1	22,370	0.82	1.08	0.77
Georgia	3,195	61.6	27,606	0.81	0.95	0.95
New Mexico	3,190	60.0	25,018	0.81	0.92	0.86
North Carolina	3,153	63.2	25,900	0.80	0.97	0.89
South Carolina	3,143	65.1	25,505	0.80	1.00	0.87
South Dakota	3,071	73.0	21,420	0.78	1.12	0.73
Oklahoma	2,897	65.6	22,400	0.74	1.01	0.77
Louisiana	2,886	61.2	21,802	0.73	0.94	0.75
Tennessee	2,855	59.5	24,536	0.73	0.92	0.84
Arkansas	2,771	66.5	21,097	0.71	1.02	0.72
Kentucky	2,710	61.8	25,327	0.69	0.95	0.87
Alabama	2,569	59.1	24,210	0.65	0.91	0.83
Idaho	2,505	54.0	23,105	0.64	0.83	0.79
Mississippi	2,416	59.0	21,175	0.62	0.91	0.73
Utah	2,302	47.0	23,655	0.59	0.72	0.81
United States	3,927	65.0	29,177	1.00	1.00	1.00

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variation in the instructional staff-to-pupil ratio is less than 1.9 to 1. Making the same comparison with a more comprehensive disparity statistic, the pupil-weighted coefficient of variation in expenditure per pupil among states is .242, whereas the similarly weighted coefficient of variation in instructional staff per pupil is only .138.[6] Only about 37 percent of the interstate variation in per-pupil expenditure can be accounted for by differences in instructional staff-to-pupil ratios.[7] Thus, the disparity statistics alone make it evident that differences in per pupil spending are not due mainly to differences in staff-pupil ratios, as they would be if the cost per staff member were about the same in all states.

A more detailed examination of the data in Table 1-1 reveals numerous specific instances in which between-state differences in per pupil spending fail to correspond to differences in real educational resources (staff-pupil ratios). In some cases, the expenditure-staffing relationship even runs in the "wrong" direction--that is, a higher-spending state provides significantly *fewer* instructional staff members per 1,000 pupils than a lower-spending state. Consider the following examples extracted from the table:

- California and Virginia spent almost exactly the same amount per pupil in 1987-88, but Virginia's staff-to-pupil ratio was 47 percent greater than California's;
- Michigan spent 27 percent more per pupil than Missouri, but Missouri provided 13 percent more instructional staff per pupil than Michigan.
- Kentucky, Indiana, and Colorado all provided almost identical staffing ratios (62 instructional staff per 1,000 pupils), but their per-pupil expenditures were $2,710, $3,454, and $3,878, respectively.

Plainly, differences in staffing do not account for differences in spending, and equal outlays per pupil do not necessarily translate into approximately equal staffing ratios. Spending per member of the instructional staff varies widely among the states.

The proposition that these discrepancies between spending and staffing reflect interstate cost differentials gains support from the salary data in Table 1-1. The salary data indicate, first, that average instructional staff salary varies substantially among the states. The highest state-average salary is 1.7 times as great as the lowest (excluding the even higher salary figures for Alaska and the District of Columbia). More to the point, the variation in average salary accounts for much of the aforesaid disproportionality between spending and instructional staffing. The correlation between average salary and current expenditure per instructional staff member is strong (a correlation coefficient of .92). This means that about 85 percent of the variance in expenditure per instructional staff member is attributable to salary differentials, leaving only 15 percent to be accounted for by unequal spending on resources other than instructional personnel. The point is underscored by another set of examples taken from Table 1-1:

- The fact that Florida spends 36 percent more than Arkansas to provide virtually the same staff-to-pupil ratio is largely explained by Florida's 28 percent higher instructional staff salaries;

- That Connecticut spends more than twice as much per pupil as Oklahoma but provides only a 33 percent higher staffing ratio is almost entirely attributable to the 55 percent higher level of average salary in Connecticut;

- Missouri's ability to provide a 13 percent higher staffing ratio than Michigan while spending 27 percent less per pupil stems from the 33 percent difference between Michigan's average salary and Missouri's.

Clearly, much of the lack of correlation between levels of spending and levels of staffing among states is accounted for by differences in the salaries that different states pay their instructional personnel.

It would not be correct, however, to construe all the variation in instructional staff salaries as variation in the prices of equivalent instructional personnel; some reflects differences in staff characteristics. I show later, for example, that 10 to 15 percent of the variation in average teacher salary among states is attributable to interstate differences in average teacher experience and training. Other interstate differences in staff attributes may explain part of the remaining salary variation. Evidence is lacking, however, of differences in teacher attributes or teacher quality of sufficient magnitude to explain salary differentials as large as those shown in Table 1-1. The likely situation, therefore, is that part of the observed variation in salaries among states reflects differences in unit costs, and the rest reflects variations in the characteristics and quality of the resources (mainly personnel) on which the states spend their education dollars. Being able to distinguish between these two sources of interstate variations in salaries is a prerequisite for developing valid cost adjustments.

COST INDICES AND PROBLEMS OF INDEX CONSTRUCTION

Ideally, per-pupil expenditures and other dollar-denominated magnitudes to be compared among the states should be adjusted to compensate for interstate differences in cost. That is, instead of comparing the original, unadjusted, nominal-dollar figures, one should compare cost-adjusted, "real," or "constant dollar" magnitudes. The appropriate tools for making such adjustments are *cost-of-education (COE) indices*. An interstate cost-of-education index would represent the cost in each state, relative to the average cost in the nation, of procuring a standard array of educational services or a standard "market basket" of educational resources. To illustrate, if we knew how much has to be spent in each state to acquire equivalent teachers, classrooms, textbooks, etc., we would be able to determine how much each state would have to spend to obtain a package of, say, one teacher for every 20 pupils, one school principal for every 500 pupils, 5 textbooks per pupil, and so forth. The ratios of these hypothetical state outlays to the national average cost of the same package would constitute a cost-of-education index. The main tasks in constructing a COE index, as brought out by this simple example, include selecting an appropriate market basket, measuring the prices in different states of each item in the market basket, and calculating the overall multi-item index. The hard part is price measurement--quantifying what it would cost in each state to obtain *equivalent* personnel and nonpersonnel resources. The problems are discussed in detail later, but I note certain key points briefly at the outset.

The main conceptual and technical problems in constructing a cost-of-education index arise out of the labor-intensive nature of education and the particular types of labor on which the schools rely. The most important resources used in elementary-secondary education are the services of teachers and other professional educators, and the main costs incurred by school systems are costs of professional staff compensation. A COE index must consist, therefore, mainly of one or more measures of the relative salary in each state of teachers and other professionals. But teachers and other educators are not interchangeable or homogeneous commodities; they vary in characteristics and quality not only among schools and school systems but also among states. Consequently, variations in the actual salaries paid to educators in different states reflect not only differences in what is costs to hire an educator with *given* characteristics but also variations in the *types*, or *mixes*, of educators that the different states do, in fact, employ. One would not want to say, for example, that a state faces above-average teacher costs if the average salary of its teachers exceeds the national norm only the state employs more experienced and better-trained, hence more expensive, teachers than other states. The appropriate comparisons are not of the relative salaries that states *actually* pay but rather of the relative salaries that they *would have to pay, hypothetically*, to hire *equivalent* teachers and other staff. Estimating these hypothetical, unobservable salaries is simultaneously the most difficult and the most essential task in producing a valid COE index.

The problem of generating valid relative salary figures is further complicated by the important influence on educators' salaries of factors controlled by states and local school systems. For instance, a state that offers particularly unattractive working conditions to its teachers (large classes, poor facilities, meager supporting resources) may have to pay substantially higher salaries than other states to attract sufficient numbers of qualified teachers. Likewise, a state that imposes particularly stringent requirements for teacher certification may have reduced its supply of potential teachers and driven teacher salaries up. A cost-of-education index should not be influenced by this type of state action. It would be unreasonable, for example, to reward with extra federal aid a state that has driven up the prices it must pay for staff by adopting the types of policies just mentioned. The broad consensus among scholars in the field is that only external, or "exogenous," determinants of costs--not factors that the states or their school systems can control--should influence a cost-of-education index (see, e.g., Chambers, 1979; Barro, 1981). But distinguishing between external influences and the states' own influences on costs, and then constructing an index that reflects the former but not the latter, is a difficult analytical problem.

The serious conceptual problems of cost measurement are aggravated in practice by the limitations of currently available data on costs and characteristics of teachers and other educators and, for that matter, on all other resources that school systems buy. Until very recently, for example, data by state were unavailable on even such basic teacher attributes as experience and degree level. Data on these particular characteristics have now been provided (for the school years 1987-88 and 1990-91) by the NCES Schools and Staffing Survey (SASS), but data on other pertinent staff attributes are still lacking. In addition, data are unavailable on the prices and quantities of many other resources used by school systems and, equally important, on many of the fiscal, economic, and demographic factors that need to be taken into account in interpreting and adjusting the data on resource costs. This data shortage narrowly limits the methods that can be used to develop a COE index.

PURPOSE, SCOPE, AND LIMITATIONS

The general purposes of this report are to assess the state of the art in quantifying interstate differentials in the cost of education and to examine the prospects for developing a valid and usable state cost-of-education index in the future. More specifically, the report has four objectives:

1. To review and evaluate the assumptions, theories, and models underlying different methods of quantifying interstate differentials in the cost of education.

2. To evaluate alternative practical methods of constructing cost-of-education indices, taking into account both the conceptual soundness of the different approaches and the availability, quality, and timeliness of the required data,

3. To compare selected cost indices and proxies that can be constructed with existing data and to illustrate how adjustments based on such indices would affect interstate comparisons of per-pupil expenditures, and

4. To offer conclusions and recommendations regarding the feasibility of developing valid cost adjustments, the advantages and disadvantages of alternative approaches, and the most useful next steps for NCES to take to develop promising cost measurement methods.

The focus of the report is almost exclusively on methods of measuring differences in the cost of education among the states, but much of what is said applies also to cost differentials among the local school districts within a state, and some applies to changes in the cost of education over time. The same basic theoretical framework applies, for the most part, to all these dimensions of the cost measurement problem. Historically, in fact, the analytical framework for quantifying differences in the cost of education has been developed more fully through work on interdistrict rather than interstate cost differentials. Thus, although this paper emphasizes state-level cost-of-education indices, much of the discussion reflects thinking that originally focused on cost variations at the local level.

The purpose of this report is primarily to review and assess existing approaches to cost measurement rather than to offer new approaches or new cost-of-education indices. Accordingly, the analysis is mainly logical and conceptual rather than empirical. No new data have been collected specifically for this report, and no new econometric modeling efforts or large-scale statistical analyses have been undertaken. There is, however, one significant exception to the general characterization of the effort as conceptual and nonempirical. By an accident of timing, teacher salary data and other cost-related data from the first (1987-88) NCES Schools and Staffing Survey (SASS) became available at about the time work on this report commenced. The opportunity thus arose to use a richer set of data than had previously been available to analyze COE differences among the states. Through the good offices of the NCES National Data Resource Center, I was able to conduct certain limited statistical analyses with the SASS files. In particular, I have been able to determine--apparently for the first time--how an interstate comparison of average teacher salary is affected by adjusting for differences in teacher experience and teacher training (degree level) among the states. Thus, although no new empirical work was originally planned, this limited index development exercise based on the SASS data set has become an important feature of the report.

ORGANIZATION OF THE REPORT

The remaining chapters of the report correspond closely to the four objectives listed above. Chapter 2 examines the conceptual foundations of cost-of-education indices. It offers an economic analysis of the sources of cost variations among states and the implications for index construction. It explains why, from a theoretical perspective, the effects of certain factors should be reflected in a cost-of-education index, while the influences of other factors should be "held constant" or excluded. Where necessary, it presents alternative economic assumptions and models. Because most education funds are expended to compensate teachers and other professional educators, the discussion deals mainly with the problem of measuring interstate variations in professional staff compensation, including, more specifically, the problem of constructing an index of the "price" of equivalent teachers. The nonpersonnel components of the cost of education are considered only briefly.

Chapter 3 assesses alternative practical methods of constructing a state-level cost-of-education index. These include both methods that can be tested now, using existing data, and methods that should become testable in the not-too-distant future, as expected new data sets become available. The options considered range from using simple proxy indicators, such as indices of average teacher salary or private-sector wages, to deriving a COE index from a complex econometric model of teacher supply and demand. These alternatives are evaluated according to such criteria as theoretical validity, technical feasibility, availability of the required data, and acceptability to interested parties.

Chapter 4 presents and compares a number of simple COE indices and proxies. It examines differences in the statistical properties of the indicators and differences in the results concerning particular states. It shows how interstate comparisons of elementary-secondary expenditure per pupil would be affected if such indices were used to adjust for interstate differences in costs. In particular, the chapter presents indices based on the aforementioned SASS data set, including the new index of average teacher salary adjusted for interstate differences in average teacher experience and training.

Finally, Chapter 5 presents conclusions concerning the merits, limitations, and potential uses of the different cost measurement methods and offers recommendations regarding promising short-run and long-run index development strategies.

NOTES

1. Tabulations of per-pupil expenditure for elementary and secondary education by state appear in, among other places, the National Center for Education Statistics (NCES) *Digest of Education Statistics* (e.g., NCES, 1991); the Census Bureau's annual report, *Public Education Finances* (e.g., U.S. Bureau of the Census, 1991); the National Education Association (NEA) annual *Estimates of School Statistics* (e.g., NEA, 1991); the National Governors' Association (NGA) report, *Results in Education* (NGA, 1990); and the Council of Chief State School Officers (CCSSO) report, *State Education Indicators* (CCSSO, 1991).

2. Among the major federal aid programs whose formulas take no account of cost differentials are the Chapter 2 Block Grant program, the Vocational Education program, and the various programs of aid for education of handicapped children funded under the Individuals with Disabilities Education Act (formerly the Education of the Handicapped Act). The programs whose formulas use per-pupil expenditure as a proxy for cost are mainly those funded under Chapter 1 of Title I of the Elementary and Secondary Education Act, the most important of which is the multibillion dollar program of Chapter 1 Grants to LEAs for compensatory education of the disadvantaged. For detailed discussions of the formulas used to allocate aid under these formulas, see Barro (1991).

3. Some would consider the tilt in favor of low-cost states desirable, because it provides a roundabout method, in the absence of explicit adjustments for state fiscal capacity, of compensating for disparities in states' abilities to raise revenue for education. However, because low-cost states are not always low-capacity states (or vice versa), allocating extra amounts of real aid to the former is not equivalent to, or a good substitute for, explicitly skewing the aid distribution toward the latter.

4. See Barro (1991) for a discussion of the shortcomings of using an index based on state per-pupil expenditure as a proxy for the cost of education.

5. The data on expenditure per pupil are from the NCES Common Core of Data (CCD) for fiscal year (FY) 1988 (NCES, 1991); the data on numbers and salaries of instructional staff are from the National Education Association (NEA, 1990).

6. The significance of using pupil-weighted rather than unweighted coefficients of variation is that the weighted statistic accords each state importance proportionate to the number of pupils in its schools, whereas the unweighted statistic would attach the same importance to the smallest state's figures as to the largest's. For example, an unweighted coefficient of variation would be more influenced by the fact that Alaska and the District of Columbia, two of the smallest states, spend much more than the national-average amount per pupil.

7. The correlation coefficient between expenditure per pupil and instructional staff per pupil is about .61, which corresponds to a percentage of variation explained (R^2) of .37, or 37 percent.

2. CONCEPTUAL FOUNDATIONS OF COST-OF-EDUCATION INDICES

Were it not for the special problems of measuring the costs of teachers and other professional staff, producing an interstate cost-of-education (COE) index would be relatively straightforward. The major steps would be, first, to identify the different items that make up the education "market basket"; second, to determine the unit price of each item in each state; and third, to compute for each state an appropriately weighted average of these prices. But the need to deal with the complexities of professional compensation makes the job much more difficult and problematic. Instead of simply collecting data on the prices (salaries) of teachers and other staff, one must instead estimate the relative salaries that would have to be paid to attract hypothetical equivalent staffs under hypothetical uniform state policy regimes; or, alternatively, one must find suitable proxies for these unobservable hypothetical salaries. This alters the index construction process fundamentally, elevating it from a mainly mechanical task of data collection and computation to an exercise in inference and statistical estimation.

The preponderant share of professional staff compensation in education budgets makes the treatment of such costs the dominant practical consideration as well as the central conceptual and methodological issue in constructing a COE index. A COE index based on a sound teacher or professional salary index is likely to be reasonably accurate even if other costs are measured crudely, but even the most refined treatment of other costs will count for little if the indicator of professional staff salary is unsatisfactory. Accordingly, this discussion focuses mainly on how interstate differences in the costs of teachers and other professionals can and should be quantified.

Before turning to the professional salary issue, however, it is important to set the stage by addressing certain general issues of cost measurement. The immediately following section reviews different concepts of the scope and coverage of a cost-of-education index and identifies the cost categories corresponding to each concept. The next section examines the composition of the education market basket--that is, the mix of staff and other resources that school systems buy--and draws implications for the structure of a COE index. I then turn to the core conceptual issue of how, in theory, an index of the price of teachers (and similar indices of the prices of other educators) should be constructed. The discussion summarizes pertinent theories of teacher supply, demand, and salary determination and identifies the factors that need to be taken into account and the adjustments that must be made, in principle, to measure the price of teachers correctly. The last part of the chapter deals--much more briefly--with the problem of quantifying interstate variations in costs of the other resources used by school systems, including costs of other personnel and costs of the various nonpersonnel resources used in providing educational services.

TYPES OF COST-OF-EDUCATION INDICES

A cost of education (COE) index consists, in general, of a set of numbers representing the relative amounts that would have to be spent per pupil in different places or at different times to provide a specified standard array of educational resources or services. One can distinguish among types of COE indices on the basis of (1) the places and/or the time periods across which costs are to be compared, (2) the range of education costs that the index covers, and (3) the way in which the "standard array" of educational resources or services is defined.

Units of Comparison: States, Districts, and Time Periods

This report focuses on cross-sectional, state-level cost-of-education indices--that is, indices of the relative cost of providing equivalent, standard educational resources or services in different states in a particular school year. An interstate cost index consists of a set of 51 numbers (one for each of the 50 states plus the District of Columbia), each representing the average cost of education in a particular state relative to the average cost of education in the nation. If the COE index value for the nation is set at 1.00, states with above-average and below-average costs of education have COE index values greater than 1.00 and less than 1.00, respectively. Each state's *real*, or *constant dollar*, education expenditure per pupil--meaning expenditure measured in units of U.S.-average purchasing power--is computed by deflating the state's nominal (unadjusted) expenditure per pupil by the state's COE index value; that is,

$$\text{Real expenditure per pupil} = \frac{\text{Nominal expenditure per pupil}}{\text{COE index value}}.$$

For instance, a state spending $6,000 per pupil per year but with costs of personnel and other resources averaging 20 percent higher than for the nation as a whole (COE index value = 1.20) would be said to have a real, or constant-dollar, expenditure of $5,000 per pupil ($6,000/1.20), while a state spending only $4,000 per year but with costs 10 percent below the national average (COE index value = 0.90) would have a real expenditure level, measured in the same constant dollars, of $4,444 per pupil ($4,000/0.90). In this example, the first state's nominal outlay per pupil exceeds the second state's by 50 percent before the cost adjustment ($6,000 compared with $4,000) but by only 12.5 percent after the adjustment ($5,000 versus $4,444). Assuming that the cost differentials have been measured correctly, the latter percentage is the true measure of the interstate differential in the real resources devoted to each pupil's education.

An intrastate, or interdistrict, COE index would have the same basic structure as an interstate index, except that it represents the cost of education in each locality or school district in a state relative to the statewide average cost of education. More effort has been devoted to developing district-level than state-level COE indices, and the bulk of the research literature in the field pertains to cost differentials among local school districts. Some of the district-level studies are reviewed in Chapter 3[1] A few states now include cost indices of various types in their formulas for distributing state education aid to local school districts. Although interdistrict COE indices fall outside the scope of this report, I have drawn extensively on district-level studies for concepts, theoretical models, and methods that apply to the state-level analysis.

An intertemporal COE index would express the cost of education in different years relative to the cost in some specified base year; that is, it would represent the relative cost in each year of procuring a specified, fixed package of educational resources for each pupil. Such an index could be produced for any geographical unit or jurisdiction. For example, one could construct an index (in principle) showing the time trend in the relative cost of education in different years in the Los Angeles Unified School District, the State of California, or the whole United States. The need for an intertemporal COE index has been obscured by the all-too-common practice of using a general price indicator, such as the Consumer Price Index (CPI) to adjust data on per-pupil education expenditure over time, but such adjustments are misleading because prices of the resources used in education generally do not change from year to year at the same rate as the prices of consumer goods. NCES has recently conducted some research on intertemporal changes in the cost of higher education but has not, to my knowledge, undertaken similar work on elementary and secondary education. A national index of trends in the prices of elementary-secondary resources or services would be a valuable tool for policymakers and would complement the cross-sectional, interstate indices discussed here. The problems of measuring differences in the COE over time are similar in some respects and different in other respects from the problems of measuring COE differences across the states. The intertemporal measurement problem deserves serious attention but falls outside the scope of the present report.

The Range of Education Costs

An important question concerning the structure of a COE index is how broad a range of education costs it should cover, or, equivalently, to what expenditure aggregate should it apply? An index could be designed to cover total education expenditure (current plus capital outlay), current expenditure only, current instructional expenditure only, or perhaps what used to be called "core current expenditure," meaning expenditure for instruction and closely related support functions but not for such peripheral functions as plant operation and maintenance, pupil transportation, and food service. Also, a state-level COE index might or might not be designed to cover preschool and adult education and might either be limited to public education or extended to private schooling as well.

The issue of coverage hinges partly on what is technically feasible and partly on the intended research or policy applications of the COE index. For such purposes as analyzing fiscal inequality among states, studying the relationship between education expenditures and results, and distributing funds on a cost-adjusted basis, indices of current operating cost (and perhaps the aforementioned components of operating cost) are probably the most useful. Although it would be desirable in principle to cover capital as well as current costs, the obstacles to measuring the capital cost component validly are so severe that an attempt to include them could detract from, rather than enhance, the validity of interstate comparisons.[2] An index of combined public and private education costs might be useful for specialized purposes, such as distributing federal aid that is supposed to benefit both public and private pupils, but the available data on private school finances are too limited to make cost measurement feasible. Henceforth, except where otherwise stated, the term cost-of-education index means an index of current operating costs in public elementary and secondary education.

The Definition of Standard Resources or Services

A more complex attribute of a COE index than the ones just discussed is the definition of the *standard array of educational resources or services* (education "market basket") whose costs are to be compared across states. This definition plays a major role in determining which factors should be taken into account in a cost index and which factors should be controlled for (held constant) when the index is constructed. Indices based on different conceptions of the education market basket may yield significantly different state COE scores. The distinctions among definitions may seem technical, but they are important parts of the conceptual foundation for valid cost measurement.

Consider, first, the general implications of defining a COE index in terms of the cost of a standard array of resources or services. One is that a sharp distinction must be drawn between a state's cost of education and its level of education expenditure per pupil. Suppose, for example, that one state spends more per pupil than another state only because it provides a higher teacher-pupil ratio. That expenditure difference does not result from or reflect any interstate difference in the price of educational resources or services. Rather, it indicates merely that one state has chosen to buy more resources for its pupils. Such a difference should not be reflected in a COE index. Similarly, if one state spends more than another because it chooses to employ more highly qualified and hence more expensive teachers, the resulting difference in per-pupil outlay does not indicate a difference in the cost of standard resources; rather, it reflects a difference in resource quality.[3] A valid COE index measures not what each state spends on its actual education programs and resources but what it would have to spend, hypothetically, to provide the specified standard array of resources or services to each pupil.

The second implication is that a COE index takes the form of a weighted average of relative prices. The value of the index for each state is a ratio, the numerator of which is the cost of the standard package of resources or services calculated at the state's own prices, and the denominator of which is the cost of the same standard package calculated at national-average prices. This ratio is mathematically equivalent to a weighted average of the relative prices of all the different types of resources in the education market basket, where the relative price of each resource is defined as the ratio of its price in the state to its average price in the nation, and the weights are the average shares of national education expenditure devoted to each type of resource. The implication of this equivalence is that it is possible to develop separate indices of the relative prices of particular resources or services--a teacher price index, a support staff price index, a supplies and materials price index, etc.--and then to calculate the complete COE index as an appropriately weighted sum of the separate components.

It remains necessary to define the "standard array" of resources or services. Indices corresponding to at least three different definitions have been discussed and demonstrated in the literature. I characterize these as (1) the resource-input definition, (2) the service-level definition, and (3) the service-relative-to-need definition.[4] The differences among the three and the reasons that one might favor one or another are as follows.

The Resource-Input Definition. Defining a COE index strictly in terms of a standard package of resource inputs into education is the simplest option but also the narrowest. According to this definition, the COE index value for each state is the relative cost of providing a fixed quantity per pupil of each type of educational resource. Normally, one would set these fixed amounts at national average values (e.g., the national average teacher-pupil ratio and the national average principal-pupil ratio), in which case the index would represent the relative cost in each state of providing a national average market basket of resources for each pupil.[5]

An index based on the resource-input definition is more accurately called an index of educational resource prices than an index of education costs. The value of such an index varies among states to the extent, and only to the extent, that prices of resources differ. Nonprice factors that require one state to spend more than another to provide equivalent services are not taken into account. Consider, for instance, the cost of pupil transportation. If a standard package of pupil transportation resources were defined in terms of fixed quantities of resources per pupil, the corresponding index of pupil transportation costs would reflect interstate variations in the price of school buses, the price of gasoline, and the wages of school bus drivers but would not take into account the undoubtedly more important disparities in transportation outlay per pupil attributable to variations in the distances over which pupils must be transported. Thus, a state that has to transport each pupil one mile (on average) and a state that must transport each pupil ten miles would be assigned equal scores on the transportation cost index if they faced equal resource prices--a result that, if not nonsensical, is surely not what most policymakers would expect or want from a cross-state comparison of the cost of pupil transportation. Recognizing that an index of resource prices is too restrictive for many applications, analysts have developed the alternative, broader cost concepts outlined below.

The Service-Level Definition. According to this formulation, the standard resource package on which cost calculations are based is not identical for all states but varies when unequal quantities of resources are *technologically* necessary to produce equivalent services for pupils. Thus, the COE index reflects both interstate variations in resource prices and interstate variations in the pertinent technological cost factors.[6] Referring again to the example of pupil transportation, the index would take into account interstate differences in miles driven per pupil as well as in bus and gasoline prices and the wages of bus drivers. If one state had to drive its buses ten times as many miles per pupil as another to transport its more widely dispersed pupils, that state would be credited with correspondingly higher transportation costs, even if there were no difference in resource prices. Similarly, if one state must spend three times as much per pupil as another to heat its schools, not because of higher fuel prices but because it has colder winters, the difference in cost attributable to the technological factor--in this case, climate--would be reflected in the COE index. The essential distinction between the service-level definition and the resource-input definition is that the latter measures the relative cost of performing certain functions for each pupil, while the former measures only the cost of buying each pupil a specified basket of resources.

Although the pupil transportation and school heating examples are instructive, the most important consequence of taking technological cost factors into account is not that these relatively minor components of a COE index would be affected but rather that technological factors affecting the cost of instruction would also have to be considered. The most important such factor is *scale*--the size of the schools and/or the school systems in each state. The proposition that small schools or districts must spend more per pupil than larger districts to provide comparable education programs is both empirically well established and logical on its face. Resource indivisibilities alone (e.g., the difficulty of employing, say, three-fifths of a chemistry teacher) often necessitate higher staff-to-pupil ratios in small districts and schools than in larger units. It follows that states with above-average percentages of their pupils in small districts or schools (e.g., states with many sparsely populated rural districts) must incur higher per-pupil costs, other things being equal, to provide comparable instructional services to their pupils. To capture this scale effect in a COE index, we would have to define the standard package of instructional resources in such a way that it varies according to school or district enrollment. For instance, the standard teacher-to-pupil ratio used in calculating relative costs might be made an increasing function of the percentage of a state's pupils enrolled in small schools.[7] The need to work out the details of the scale factor adds to the complexity of the index construction task.

The Service-Relative-to-Need Definition. Recognizing that some pupils are harder and costlier to educate than others, some analysts have suggested that a COE index should take into account pupil characteristics related to educational needs. States with above-average concentrations of handicapped, disadvantaged, or limited-English-proficient (LEP) pupils would be deemed to face higher unit costs of education, other things being equal, than states with smaller percentages of such pupils. The list of cost factors would expand under this approach to include not only relative prices and technological cost factors but also the percentages of each state's pupils in the various high-cost categories.

The issue raised by this option is not whether concentrations of special-need pupils make it more costly to provide equivalent services--they unquestionably do!--but whether differences in pupil needs should be treated separately or in combination with differences in prices and other cost factors. On one hand, the idea of a combined, comprehensive cost and need index is attractive. With such a tool, one could compare directly how much states actually spend with how much they would have to spend to provide equivalent services to their diverse pupil populations.[8] On the other hand, there are strong reasons not to intermingle pupil-need factors with resource costs. No objective method is available for determining the extra cost of providing special-need pupils with services equivalent to the services provided to "regular" pupils (however "equivalent" might be defined). We cannot now quantify, for example, the resource or expenditure increment required, on average, to bring the achievement level of children from below-poverty families up to that of children from above-poverty families. Attempting to incorporate pupil-need differentials into a COE index in the absence of objective measures of relative need would confound cost questions with questions of educational productivity and budget allocation policy.

A proposed method of circumventing the lack of objective need measures is to infer the differential costs of serving different types of pupils from prevailing typical budget allocation patterns in the country. If it could be shown, for example, that the average disadvantaged pupil in the United States receives, say, 15 percent more resources than the average advantaged pupil, this could be reflected in a comprehensive need/cost index by weighting each disadvantaged pupil in a state 1.15 times as heavily as each advantaged pupil. Although this procedure could be viewed as a logical extension of the principle of comparing costs of a national-average array of resources per pupil, it is problematical in several respects:[9] First, data are not available on the incremental resources, if any, devoted nationally to special-need pupils other than the handicapped, leaving no basis at this time for determining the appropriate need weights for disadvantaged and LEP pupils.[10] Second, the results might well come out "wrong"; they might show, for example, that economically disadvantaged pupils receive fewer resources rather than more resources, on average, than other pupils, simply because they are more often enrolled in low-spending school systems. Third, merging the essentially political need weights derivable from budget data with the more objective price and technology factors in a COE index would detract from the technical validity, hence the credibility, of the index as a whole.

It seems preferable, therefore, to deal with cost differentials and pupil-need differentials separately, and that is the approach I take in this report. Accordingly, it should be understood henceforth that references to COE indices and cost adjustments *exclude* adjustments for any resource or cost differentials among states arising from the need to serve different concentrations of special-need pupils.

THE EDUCATION MARKET BASKET AND THE STRUCTURE OF A COST-OF-EDUCATION INDEX

No matter how the broad definitional issues are resolved, a COE index will consist of a weighted average of relative prices, in which most of the weight is assigned to teacher and other professional staff compensation. Several aspects of the structure and composition of such an index need to be considered: How finely should cost categories be disaggregated? Should professional staff compensation (including teacher compensation) be one immense cost category, dominating the index, or should it be decomposed into subcategories with separate indices, and if so, along what lines? How many resource categories, and which ones, should be recognized outside the professional staff cluster? The alternatives range from a COE index with only two components--professional staff compensation and "other"--to indices that disaggregate teachers by training and experience, recognize multiple categories of other professionals, and deal with several classes of nonpersonnel resources.

Assuming that the COE index will represent the cost to each state of a national average market basket of educational resources, a look at the composition of that market basket is the logical first step in deciding how the index should be structured. Unfortunately, comprehensive data on the full range of resources used by school systems are not available. NCES did collect such information for a brief period in the mid-1970s but has not done so more recently.[11] Although some pertinent information can be extracted from various NCES data sets, it is necessary at this time to piece together a picture of the education market basket from multiple sources, including material compiled by nongovernmental agencies.

The closest thing now available to a breakdown of the national elementary-secondary education budget by resource category seems to be the "local school budget profile" produced by the Educational Research Service (ERS, 1990). This profile, for the school year 1988-89, is based on an ERS survey of a large sample of local school districts. Although the sample of districts is not fully representative (the districts covered are apparently larger and higher-spending, on average, than districts in general), the results provide at least a rough breakdown of expenditures by the major personnel and other resource categories.

According to the ERS data, teacher compensation accounts for 51.9 percent of total current expenditure (41.9 percent of which is for salaries and the other 10.0 percent for fringe benefits). Other professional compensation makes up 12.5 percent of expenditure, bringing the percentage for teachers and other professionals combined to 64.4 percent. Expenditure for nonprofessional compensation constitutes another 13.2 percent of total outlay. All types of personnel compensation combined, therefore, consume 77.6 percent of the education budget, leaving 22.4 percent for all nonpersonnel costs.[12]

Another source of information on budget shares is the NCES National Public Education Finance Survey (NPEFS) for 1988-89. This survey provides state-level data on education spending by function (instruction, support services, administration, etc.) and object (salaries, fringe benefits, purchased services, materials, etc.). Although the NPEFS does not provide data on teacher compensation explicitly, one can infer from the data on salaries and benefits for instruction that spending on teachers is about 52.8 percent of total current expenditure.[13] The NPEFS data also imply that all personnel compensation costs combined account for 79.7 percent of total current expenditure. The fact that these percentages are slightly higher than those based on the ERS data is accounted for by the inclusion in NPEFS, but not in the ERS data, of retirement contributions and fringe benefits paid directly by states rather than by local districts.

The NPEFS survey also includes a category of expenditures called "purchased services," which is not, strictly speaking, a component of personnel cost but consists mainly of payments (under contract) for the services of personnel who are not school system employees. Assuming, conservatively, that 80 percent of purchased services for instruction and 60 percent of purchased support services are, in effect, payments for personnel compensation, the estimated share of total personnel cost in the national education budget rises by another 5 percentage points to a total of almost 85 percent.

Using the aforesaid NPEFS figures, but assuming also that the division between costs of "other professional" and "nonprofessional" staff compensation is as estimated by ERS, I arrive at the set of "best guess" estimates of the composition of the national elementary-secondary education budget presented in Table 2-1. Especially significant for the development of cost indices are the estimates that teacher compensation (including fringe benefits) accounts

Table 2-1

Estimated Composition of the National Education Budget

Cost Category	Percentage of Total Current Expenditure	
	Purchased Services Excluded from Personnel	Purchased Services Included in Personnel
Teacher compensation	52.8	52.8
Other professional staff compensation	13.1	15.1
Total professional compensation	65.9	67.9
Nonprofessional compensation	13.8	16.9
All personnel compensation	79.7	84.8
Nonpersonnel costs	20.3	15.2

for about 53 percent of total current spending, total professional staff compensation accounts for about two-thirds of all education outlay (68 percent including purchased services), and all nonpersonnel outlays combined consume only about 15 percent of the education budget.

The Structure of the Professional Staff Component

Because professional staff compensation accounts for over two-thirds of all education spending, whether or how professional staff should be disaggregated is the main issue concerning the structure of a COE index. Several alternatives merit consideration, as follows:

Option 1. Use a single teacher salary index to represent all costs of teacher and other professional staff compensation. This is the simplest approach and the one most commonly used by analysts seeking a quick and easy proxy for the cost of education. The validity of the resulting index depends on the accuracy of each of several underlying assumptions: (1) either the salaries of different types of teachers vary in about the same proportions among states, or the composition of the teaching force (e.g., with respect to experience) is similar in all states, or both; (2) ratios of other professional salaries to teacher salaries are roughly constant across the states; and (3) variations in the cost of fringe benefits are proportional to variations in salaries. In fact, there appear to be substantial deviations from these sorts of proportionality, some of which are discussed later. To the extent that the aforesaid assumptions are violated, using a single teacher salary index to represent professional staff compensation will yield incorrect results.

Option 2. Construct a single teacher compensation index plus separate indices for other categories of professional staff. This approach allows for the possibility that prices of nonteaching professionals, such as principals, counselors, and librarians, do not vary among states in proportion to the price of teachers. Although certain institutional factors (related, e.g., to career paths for educators) may foster a certain degree of proportionality, interstate differences in supply and demand for different classes of professionals could cause the ratios between salaries in different occupations to vary substantially. The cost of nonteaching professionals could be represented by a single "other professional" index or by separate indices for several occupational subgroups. The appropriate degree of disaggregation depends on how closely the salaries of different types of professionals correlate with one another and, of course, on how much detail is available on professional staff salaries.

Option 3. Construct the teacher salary index as a weighted sum of indices for different categories of teachers. This option allows for the fact that the salaries of different types of teachers--for instance, teachers with more and less experience and teachers with and without advanced degrees--do not necessarily vary in fixed proportions among states (data confirming this nonproportionality are presented in chapter 4). Teachers could be differentiated, for the purpose of constructing a COE index, by experience, training, level at which they teach (elementary or secondary), and perhaps subject specialty. For example, an education price index developed several years ago in Canada treated teachers with each experience and training combination recognized in local salary scales as a separate category for the purpose of calculating a salary index (Statistics Canada, 1985). Although this Canadian index was developed to measure changes in salaries over time, the same approach could be used to compare the cost of a standard mix of teachers across states.

Option 4. Construct separate indices of the costs of starting teachers, increments in experience, and increments in training. This approach focuses on teacher attributes rather than teacher categories. It reflects the theory that school systems, in hiring teachers, are, in effect, purchasing three different goods simultaneously: "basic teachers," years of teaching experience, and increments in training. Each good has its own price. Because the three prices do not necessarily vary in fixed proportions among states, an index made up of the three separate components may yield a more accurate representation of interstate teacher price variations than an index that reflects only variations in average salaries.

Option 5. Develop separate indices for salaries and fringe benefits. This option, which is compatible with any of the options already mentioned, allows for the possibility that the cost of a standard package of fringe benefits is not necessarily proportional to the salary of a standard teacher. Some possible sources of disproportionality are that (1) the costs of standard retirement plans might not be proportional to salary because of interstate differences in life expectancy, (2) costs of medical insurance might not be proportional to salaries because of differences in health care costs and the frequency of claims, and (3) unemployment insurance costs might be disproportional because of different state unemployment histories. Treating fringe benefits separately is a long-term rather than an immediate option because state-level data on fringe benefits and their costs are not now available and might prove very difficult to collect.

The Structure of the Remainder of the Index

The one-third of the education market basket not composed of professional staff consists of two clusters of resources: the services of nonprofessional or support staff (operation and maintenance personnel, clerical personnel, bus drivers, food service personnel, etc.) and an array of nonpersonnel resources (materials and supplies, books, energy, insurance, rents, travel expenses, etc.). The degree to which these clusters can or should be disaggregated for the purpose of constructing a COE index depends largely on data availability. With extant data, even a breakdown into three categories--nonprofessional compensation, supplies, and miscellaneous--pushes at the bounds of feasibility. The aforementioned ERS "budget profile" data shed some light on the shares of the education budget devoted to books and materials and utilities but not on other categories. Apart from data limitations, the returns to analyzing additional tiny slices of the education budget diminish rapidly. Even if detailed data were available, a breakdown into five categories--nonprofessional staff, instructional supplies and equipment, noninstructional supplies and equipment, utilities, and all other--would seem to be adequate.

THEORETICAL FRAMEWORK FOR MEASURING COSTS OF TEACHERS

I now turn to the central conceptual issue in developing a COE index: What method should be used, in principle, to quantify interstate variations in the prices of teachers? In contrast to the simple but conceptually flawed solutions that are sometimes offered, such as using actual state-average teacher salaries or starting salaries as proxies for prices, the answer turns out to be highly complex. In theory, numerous influences on salary must be taken into account and relatively sophisticated methods must be used to adjust the available salary data to ensure that only the appropriate sources of price variation are reflected in the COE index. Although the following account explores these complexities, it is not offered with the idea that theory can be translated fully or directly in practice. Both data limitations and technical problems of statistical estimation preclude taking into account many theoretically relevant factors. I hope, nevertheless, that this exposition will serve two purposes: first, in the short run, to provide the framework for assessing the simple indices and proxies that are often offered as rough-and ready substitutes for indices grounded in theory; second, in the longer run, to provide a foundation for constructing the more elaborate and technically sophisticated indices needed to approximate the theoretical ideal.

The Problem

An ideal interstate teacher price index would measure variations in the prices that different states must pay, because of factors outside their own control, to provide equivalent teachers to their pupils. The problem is that such prices cannot be observed directly. The actual salaries prevailing in different states are not salaries of equivalent teachers because the makeup of the teaching force varies from one state to another. The observed salaries reflect the combined effects of state policies and factors outside state control.[14] Consequently, one cannot simply "measure" teacher prices but must instead infer, or estimate, what teachers of specified types would cost in each state under specified hypothetical conditions.

To appreciate the difficulties, consider, first, what it means to compare salaries of equivalent teachers and, second, what it would take to quantify salary variations attributable to factors not under state control. Specifying that the salaries to be compared are those of equivalent teachers implies a sharp distinction between the interstate salary differentials due to differences in teacher attributes and differences in the prices of teachers with *given* attributes. Only the latter count as price variations, and only they should be reflected in a teacher price index. To avoid confounding differences in teacher prices with differences in teacher attributes, one must control for, or hold constant, variations in the attributes when a price index is computed.

But controlling for differences in teacher attributes is no easy matter. In principle, the task could be accomplished by (1) estimating statistically the effects of the pertinent attributes on salary and then (2) using these estimates, together with information on the characteristics of each state's teachers, to infer what each state would pay teachers with standard, or national average, characteristics. In practice, this strategy cannot be carried out completely because some important teacher characteristics--notably, aspects of teacher quality--are not directly measurable. Although it is feasible to control directly for teacher experience and degree level, the same is not true of more elusive attributes such as quality of training, ability, and teaching skill--all of which may be associated with differences in pay. The latter must be handled, if at all, by roundabout methods of inferring what teachers of standard quality would be paid in each state.

The stipulation that a teacher price index should reflect only salary variations due to factors not under state control depends on a distinction between exogenous and endogenous determinants of salaries. The exogenous (externally determined) influences include such things as a state's cost of living, its employment opportunities and wages outside teaching, and other state characteristics that determine how attractive a state is to teachers. A teacher price index should reflect the salary variations due to such factors. The endogenous influences on salary (factors controlled by states or local school systems) include class size, quality of facilities, other working conditions, and state rules governing such things as teacher training, certification, and tenure. In principle, these factors should not be reflected in the teacher price index but rather should be held constant when salaries are compared.

Unfortunately, holding the controllable factors constant is not easy. Just deciding whether a factor belongs in the state-controlled category can be a problem. For instance, are state laws pertaining to teachers' unions policy variables to be excluded from the index, or are they features of state labor markets whose effects on salaries should be taken into account? Even where it is clear that a factor should be held constant, quantifying the factor's effects on teachers' salaries may be very difficult. To take account of interstate variations in teacher certification requirements, for example, means estimating how much teachers would be paid in each state if the state had "typical" or "average" certification rules instead of the rules it actually has. Although some adjustments are less troublesome (e.g., correcting for different lengths of the school day and year), controlling for the whole range of state-controlled factors would be a formidable analytical task.

The aforementioned complexities (and others yet to be discussed) make it essential to approach the teacher price issue from a sound theoretical perspective. The history of efforts to construct district-level COE indices provides ample evidence that ad hoc approaches will not suffice. An effort to construct an index (or even to evaluate a proposed index) is unlikely to succeed unless it is guided by a reasonably comprehensive economic theory of how the salaries of teachers are determined. Within such a theoretical framework, one can sort out the numerous and diverse influences on teachers' salaries, distinguish between factors that should and should not be reflected in a price index, and identify appropriate statistical techniques. Fortunately, considerable research has been done on the economics of teacher supply, teacher demand, and salary determination, and there is a body of work from which to draw assumptions, findings, and theoretical formulations. In the following pages, I summarize elements of the theory and examine the implications for state-level teacher price indices.

Supply, Demand, and the Determinants of Teachers' Salaries

Teachers' salaries, like other wages and salaries, are determined by the interplay between supply and demand in the labor market. On the supply side, individuals decide whether to offer their services as teachers and, if so, to which states or school systems. In doing so, they presumably take into account, among other things, the salaries (and other compensation) that school systems are offering. On the demand side, employers (school systems) decide how many teachers to employ and what traits to seek in their teachers, taking into account, among other things, the salaries they must pay to attract teachers with the desired characteristics in the desired numbers. Out of the interaction between individuals' supply behavior and employers' demand behavior emerge not only salary levels and salary structures but also the size and makeup of the teaching force.

The supply behavior of teachers is more directly relevant to the development of a teacher price index than is the demand behavior of school systems, but both must be taken into account to measure prices correctly. The key variable is what is called the *supply price of teachers*--defined as the price that a school system must pay--or, in the present context, the average price that a state must pay--to attract a given number of teachers of given characteristics or quality. This supply price rises in relation to factors that make teaching in a state (or district) unattractive and falls in relation to factors that make teaching more desirable. The price required to attract teachers is likely to be higher, for example (other things being equal), in states with a high cost of living, high wages in nonteaching occupations, stringent certification requirements, less pleasant physical and social environments, and poor working conditions in the schools than in states with the opposite characteristics. The importance of each such factor depends on how much weight teachers (and potential teachers) assign to it in deciding whether and where to teach. Note that the listed influences on the supply price include both external factors and factors under state or local control. If it were possible actually to quantify the influence of each factor on the supply price, it would also be possible to estimate what each state would have to pay for teachers with national average characteristics and with the state-controlled factors held constant. These are precisely the estimates needed to generate a teacher price index.

An understanding of influences on the demand for teachers is also needed to sort out the influences on teacher prices, but the relevance of the demand-side information is less direct. Such information is needed for technical rather than substantive reasons. In principle, knowledge of the supply relationship alone would permit estimation of prices of teachers under specified hypothetical conditions, but because numbers of teachers, teacher attributes, and teacher prices are all jointly and simultaneously determined by supply and demand factors, it is not feasible technically (econometrically) to derive the supply relationship without analyzing the demand for teachers at the same time. Therefore, although the supply behavior of teachers is of primary interest, both the supply and demand sides of the teacher market must be considered to measure teacher prices correctly.

Specific Influences on Teacher Supply

I have already cited more than a few examples of factors that may cause the salaries of equivalent teachers to vary among states. In this section, I offer a more systematic survey of these determinants of teacher supply. The list of potentially relevant factors includes virtually anything likely to influence the choices of current and potential teachers between teaching in a particular state and pursuing such alternatives as teaching in another state, working in a nonteaching occupation, or leaving the labor force. To help sort out these factors, I have grouped them under the following headings (which are more or less standard in the literature on teacher supply): (1) cost of living, (2) locational amenities and disamenities, (3) alternative wages and employment opportunities, (4) working conditions, (5) unions and collective bargaining, and (6) the relationship between quantity and price. I consider how the factors in each category are likely to influence state-average teacher salaries and how, in light of that influence, the different factors should be dealt with in constructing a teacher salary index.

Cost of Living. The value of a given salary is inversely related to the cost of living (level of consumer prices) in the area where the teacher resides. Consequently, the salary required to attract teachers (of given characteristics and quality) should be related positively to the cost of living (COL) in a state. The strength of this positive relationship logically depends on the interstate mobility of labor. If teachers were highly mobile, one would expect COL and salary to be highly correlated. The real purchasing power of teachers' salaries (nominal salary relative to the state cost of living) would tend, other things being equal, toward equality across states. Even if teachers themselves were unable or unwilling to cross state lines, COL differences would remain important as long as other types of labor were mobile. The reason is that such mobility would cause wages in occupations other than teaching to vary with the cost of living, and salaries in teaching would have to vary more or less proportionately to make teaching competitive with other economic sectors. Only under the implausible assumption that all labor is immobile would one not expect to see interstate differences in the cost of living reflected in teachers' pay.[15]

The present lack of satisfactory cost-of-living indicators for states is an important practical obstacle to explaining variations in teacher prices. Attempts have been made to circumvent the problem by using the price of housing or other proxies for the cost of living as variables in empirical teacher supply studies. In a more elaborate attempt to fill this major data gap, the American Federation of Teachers (AFT) has constructed a rough cost-of-living index for states from consumer price data for selected metropolitan areas (this index is discussed further in Chapter 3). It seems fair to say, however, that the problem of measuring the cost of living accurately at the state level has not yet been solved.

Locational Amenities and Disamenities. Other things being equal, teachers, like any other workers, would choose places with attractive rather than unattractive living and working environments (referred to as "amenities" and "disamenities," respectively). Given the choice, they may accept somewhat lower compensation in exchange for the nonmonetary benefits of more pleasant, healthier, and safer surroundings. In labor economics, such trade-offs provide the basis for a general theoretical model of geographical differentials in employee compensation known as the "theory of compensating variations". Examples of local community characteristics cited as amenities and disamenities in previous research on teacher supply include:

- *Geographical location, size, and type of place*--whether the community is a central city, suburb, or rural area; large or small; and near to or far from a major city;

- *"Quality of life" variables*, such as availability of cultural and recreational facilities, environmental pollution, congestion, climate, and the local crime rate;

- *Adequacy of public services and infrastructure*, including the quality of local schools (for the teachers' own children) and the availability and quality of public transportation; and

- *The demographic makeup of the local community*, with respect to income, occupational and educational level, and race and ethnicity.

Although these variables have been discussed mainly in connection with the supply of teachers to local school districts, the same kinds of variables should also affect the supply to whole states. It seems plausible, for example, that states with comfortable climates, clean air, relatively little congestion, and above-average public services would have advantages in attracting teachers that could translate, other things being equal, into lower salaries for teachers (of given characteristics) than those offered by less favorably endowed states.

But although the theoretical arguments about amenities apply to states as well as to localities, quantifying statewide amenities is problematic. There is likely to be more variation in amenities within than among states. The same state may contain both highly attractive suburbs and decaying, crime-ridden central cities--school systems where teachers eagerly seek work and systems where they work only as a last resort.[16] Indicators of state-average amenities may prove misleading. If, for example, the central-city districts in a state were reducing staffs in response to declining enrollment while the suburban districts were doing most of the teacher hiring, an analysis of the state average teacher salary in relation to the statewide average level of amenities would yield incorrect results. For this reason (among others), it is probably not feasible to measure the amenity effect using state-aggregate data.

The inclusion of population composition on the list of amenities or disamenities requires special comment. The rationale for including this factor is that the willingness of prospective teachers to work and live in particular localities (or states) may depend partly on who else lives there. For example, if teachers tended to favor middle-class communities, such places would have an advantage in the teacher market: other things being equal, they would be able to attract teachers at lower prices than other communities. Conversely, places with, large concentrations of poor or, especially, "underclass" households might face disadvantages in the teacher market similar to those faced by places with remote locations, high taxes, or polluted air. From an economic standpoint, therefore, population composition may warrant the same analytical treatment as other amenities and disamenities.[17] Whether such treatment is *politically* acceptable is, of course, an entirely different matter.

Wages and Employment Opportunities Outside Teaching. Whether an individual chooses to become or remain a teacher is likely to be influenced by opportunities in occupations other than teaching--specifically, other fields that employ college graduates. In general, the higher the wages and the more abundant the job opportunities outside teaching, the greater the salaries that school systems must pay to compete. Consequently, wage rates and labor market conditions in related professional and white collar sectors of employment are likely to figure prominently in any empirical explanation of salary levels in teaching.[18]

But whether wages and employment opportunities outside teaching affect *interstate* differences in teacher pay is a somewhat different question. The answer seems to hinge on the degree to which the teacher labor market is national rather than state-specific in scope. We can picture, on one hand, a college graduate in, say, Ohio trying to choose between teaching in Ohio and becoming a junior executive in Ohio or, on the other hand, the same graduate trying to choose between the same two career lines with no geographical constraints. In the first case, interstate variations in nonteaching wages should be reflected in variations in teachers' salaries. That is, if Ohio has relatively high professional salaries in general, it will probably have to pay high teacher salaries as well. But if the realm of occupational choice is national, interstate variations in nonteaching wages should be of less consequence. The relevant consideration for our prospective Ohio teacher should be the level of nonteaching salaries in the nation, not in one particular state. Once again, mobility is the key, but in this case, it is not willingness to teach out of state that counts but rather willingness to consider out-of-state nonteaching alternatives.

Working Conditions. Differences in working conditions should affect teachers' salaries in much the same way as the aforementioned amenities. Where teaching conditions are poor, teaching jobs will be relatively unattractive, and school systems will have to offer higher salaries to attract and retain teaching staff (once again, "compensating variations"). The relationship between working conditions and salary is likely to be much the same in teaching as in other fields of employment. One would expect salaries to be higher (other things being equal), in states that have longer school years or school days or that impose heavier work loads in the form of larger classes or more nonteaching duties. Class size is likely to be an important factor. Teaching a class of 30 is not as satisfying to most teachers as teaching a class of 20, and states or school systems that offer smaller classes should have an advantage in recruiting and retaining staff. Other pertinent working conditions may include the availability of teaching aides, specialists, and other support personnel; the adequacy of classrooms, equipment, and materials; and, less tangibly, such aspects of "school climate" as the level of discipline, the quality of school leadership, and the emphasis placed on teaching and learning. Some of the latter, admittedly, would be hard to measure even at the individual school level, much less for whole states.

Although differences in working conditions and differences in amenities should have similar effects on the supply price of teachers, an essential difference between the two is that the amenities are externally determined, whereas most working conditions reflect the policies of states or local school systems. If a state has large class sizes, it is because state and local authorities have chosen, through their budgetary and resource allocation decisions, to make them large. If the same state must then pay high salaries to induce teachers to teach the large classes, the resulting salary increments are attributable to the state's own actions. Therefore, although differences in endogenous working conditions must be taken into account in explaining salaries, the salary differentials attributable to those conditions should not be allowed to influence the teacher price index.

Some working conditions reflect the characteristics of the pupil population. Whether schools are secure, conducive to learning, and rewarding work places for teachers may depend to a large extent on the backgrounds and characteristics of the enrollees. States with large percentages of pupils in "difficult to teach" categories (pupils unprepared to learn, disruptive pupils, pupils from dysfunctional families) are likely to face greater difficulty in attracting teachers and to have to pay correspondingly higher salaries.[19] Proposals to give extra pay to teachers in inner-city schools can be viewed as testimony from the field that such concentrations do raise the price of "good" teachers. Moreover, demographic characteristics of pupils per se (as distinguished from education-related pupil behavior) may also affect teacher supply. If significant numbers of teachers consider it less desirable to teach poor or minority children than middle-class, majority children, then poverty and minority status become cost factors in their own right.[20]

The implications of this last point are politically troubling. A COE index that designates some states (or localities) as "high cost" partly because they have high concentrations of poor and minority pupils might be deemed objectionable, especially when the explanation for these factors is that they reflect educators' preferences for teaching some types of children rather than others. On the other hand, omitting such factors for political reasons would mean ignoring the high costs and, perhaps, denying such areas corresponding extra funds. (Note that this discussion has nothing to do with allowing for the extra educational needs of poor or disadvantaged pupils. The question here is whether it costs more to hire *equivalent* staffs in states where such pupils are concentrated. Whether such states should provide *more-than-equivalent* staffs to meet the special needs of the poor and disadvantaged is an entirely separate issue.)

Unions and Collective Bargaining. One of the main reasons for the existence of teachers' unions is to obtain improved compensation for their members. Where unions are successful, they raise the supply price of teachers. If the strength and effectiveness of unions varies among states, such variations should be taken into account in explaining interstate differences in salaries. But teachers' unions operate within collective bargaining frameworks defined by state labor laws. These frameworks, therefore, are themselves supply factors that may either reinforce or weaken the unions' effects on prices.

Considerable research has been conducted (mainly during the 1970s) on the effects of teachers' unions on compensation, working conditions, and other aspects of resource allocation in education. The empirical studies, most of which take the school district as the unit of analysis, have (1) demonstrated that unions do affect salaries significantly and (2) identified specific aspects of collective bargaining that seem to account for these effects.[21] Among the factors shown to be associated with interdistrict salary differentials are the percentage of teachers who are union members, whether the union has a contract with the school district, whether strikes have occurred, and whether the union contract contains an agency shop provision or a provision for binding arbitration.

Some of these factors have direct state-level counterparts--e.g., the percentage of teachers statewide who belong to unions and the percentage of districts with union contracts. In addition, certain state-level variables would logically be relevant, such as whether state law authorizes collective bargaining, allows for agency shop agreements, or prohibits teacher strikes or other job actions. Insofar as such factors can be shown to affect salaries, they belong on the list of influences on the supply price of teachers.

A special analytical problem in this area is the difficulty of disentangling the effects of union activity per se from the effects of state collective bargaining frameworks. For example, the percentage of a state's teachers covered by union contracts may influence teachers' salaries, but whether districts are even allowed to enter into such contracts is a function of state law. Because of such interactions, it would be very difficult to distinguish between the effects of the state's policies and those of teachers' own (collective) supply behavior. A further complication is that unions do not merely work within the existing legal framework to obtain benefits for their members but also seek to shape that framework by engaging in political activity. Thus, the interactions run in two directions: Favorable legal frameworks foster stronger unions; stronger unions help to produce favorable legal environments. Even if it were feasible to quantify the overall union/collective bargaining effect on salaries, sorting out these different channels of influence might not be possible.

Relationships between Quantity and Price. Finally, an important determinant of each state's supply price of teachers is the number of teachers employed. Other things being equal, the larger that number, the higher the salary that must be offered to attract teachers of any given level of quality. To see why, think of all members of the pool of potential teachers in a state (all who meet some minimum standard of qualification, even if it is nothing more than being a college graduate) as being ranked according to the price that would have to be paid to bring them into teaching. People who would teach for only $10,000 per year would be placed at one end of the scale; then people who would teach for $20,000, $30,000, $40,000, and so forth, extending out to people who would not become teachers even if the salary reached $100,000. The further along this supply curve a state must go to fill its teaching positions, the higher the salary it must pay. What counts is the salary required to attract the *marginal* teacher. Thus, a state that employs, say, 20 percent more teachers than another, otherwise identical state would probably have to pay higher salaries, for that reason alone, to attract an equally qualified staff.

Numbers of teachers can be compared meaningfully among states only if they are expressed relative to the potential teacher supply. Suppose, for instance, that State A would have to enlist 25 percent of all its resident college graduates in teaching to provide one teacher for every 15 pupils, while State B would have to employ only 10 percent of its college graduates in teaching to support the same teacher-pupil ratio. Because State A must go much further out along its supply curve to staff its schools, it is likely to have to pay a higher price for teachers.

The significance of relative teacher scarcity logically depends, once again, on the degree to which the teacher market is national rather than state-specific. It would make no sense to speak of relative scarcity in a truly national market, because every state would draw from the same national pool of potential teachers. But although some teachers do seek and find employment across state lines, the market is far from being national in the sense just described. Partly because of individual inertia and partly because of state policies that limit mobility (such as different state requirements for certification), most teachers work in the states where they resided or were trained. Consequently, it is meaningful (albeit with qualifications) to speak of the supplies of potential teachers available to particular states and hence of interstate differences in relative abundance or scarcity.[22]

In practice, quantifying the salary effects of relative scarcity could be difficult, partly because of measurement problems. The indicator already mentioned, the number of teachers relative to the number of college graduates in a state, is probably too broad. Another possibility, the ratio of teachers to persons with teaching certificates, may be too narrow, both because certification may follow rather than precede recruitment into teaching and because opportunities to teach are often not limited to certificated persons. Also, certification rules and standards vary too widely for this ratio to be comparable across states. Although the concept of adjusting for relative scarcity seems reasonable, its empirical feasibility remains to be demonstrated.[23]

If relative scarcity were taken into account, the question would arise of whether it should be reflected in a teacher price index or held constant when the index is constructed. The answer is not clear-cut. The size of the pool of persons qualified to teach in a state depends partly on factors outside state control, namely, demographics and individual decisions to pursue postsecondary education. On the other hand, the size of the pool also depends partly on state policies regarding, e.g., teacher qualifications and certification, out-of-state recruitment, and state support for teacher training institutions. Consequently, even if it were feasible to quantify the effects of relative scarcity on the supply price of teachers, it would be unclear how to use the results in constructing a price index.

The Relevance of, and the Determinants of, the Demand for Teachers

Although only knowledge of the determinants of teacher supply is needed to construct a teacher price index, it is generally not possible to quantify influences on supply without simultaneously considering influences on demand. The reason is that the relationships between the number or quality of teachers and the price of teachers are *bidirectional*. On one hand, the supply price of teachers depends on the number of teachers supplied; on the other hand, the number of teachers demanded depends on how much teachers must be paid. Both sides of the relationship must be taken into account to estimate what teachers would be paid in each state if the state employed the national average number of teachers per pupil. The same applies to teacher characteristics or quality. If the demand for quality (teacher attributes) is price-sensitive, salaries cannot simply be adjusted for interstate differences in quality as if quality were predetermined. Both the supply-side influence of quality on price and the demand-side influence of price on quality must be taken into account. Neglecting the demand side would be acceptable only under the implausible assumption that the demand for teachers is completely price-inelastic--i.e., that states and school systems decide how many teachers and what types of teacher to hire without regard to what teachers cost.

In contrast to analyses of teacher supply, which deal with the behavior of individual teachers and potential teachers, an analysis of teacher demand focuses on the behavior of *employers*--local school systems or statewide aggregations thereof. The objective of the demand-size analysis would be to quantify influences on the numbers of teachers and the types of teachers that districts wish to employ. These influences have been investigated extensively not only in studies of teacher supply and demand but also in the research on determinants of education spending.[24] According to the latter body of literature, the main determinants of the demand for teachers include (1) fiscal and economic indicators of the ability of school systems or states to pay for ("afford") teachers, (2) demographic and socioeconomic influences on willingness to support education, (3) educational considerations that affect the numbers and types of teachers demanded, such as percentages of special-need pupils, and (4) the prices, or, more generally, the "tax prices" of teachers and other resources used in the schools (the concept of tax price is explained below). Because influences on demand are less centrally related to cost-of-education indices than are influences on teacher supply, I discuss them only briefly. The following remarks concentrate on identifying some of the main specific demand factors and pointing out, where applicable, their relationships to influences on teacher supply.

Ability to Pay. The ability of a state or school system to pay for education, and hence to hire teachers, has two components: internal ("own source") revenue-raising ability and the availability of outside aid. Taking the state as the unit of analysis, the appropriate measure of own-source revenue-raising ability is the fiscal capacity of the state as a whole (that is, the combined revenue-raising ability of the state and all its local districts), and the relevant aid variable is education aid from the federal government. (In a district-level analysis of the demand for teachers, the relevant measure of own-source revenue-raising ability would be the local tax base, and outside aid would include aid from both state and federal sources.)

State per capita income is often used to represent fiscal capacity, but there are reasons to prefer such alternative indicators as gross state product (GSP) per capita or the representative tax system (RTS) index produced by the Advisory Commission on Intergovernmental Relations (ACIR). The measurement issues are much too complex to discuss here.[25] For the present purpose, the main point is simply that differences in state fiscal capacity undoubtedly account for much of the variation in the teacher-pupil ratios that different states are willing to support.

An important reason to take account explicitly of interstate differences in fiscal capacity and their effects on demand is that state fiscal capacity is correlated with certain influences on teacher supply. For instance, states with relatively high fiscal capacity are also likely to have relatively high percentages of pupils from prosperous, well-educated families (a factor negatively related to the supply price of teachers) and relatively high living costs (a factor positively associated with the supply price). In the absence of adequate statistical controls, confounding of demand-side and supply-side influences could result in misestimation of the effects of the supply factors on teachers' salaries.

Demographic and Socioeconomic Influences. The generic term "taste variables" is used to describe demographic and socioeconomic characteristics that influence state and local decisions about how much to spend on education. For instance, states in which larger percentages of the population have school-age children, are well educated, or are employed in high-level occupations are likely, other things being equal, to exert greater financial effort to support education. A significant consideration in developing a teacher price index is that some of these same variables also figure among the amenities that influence the supply price of teachers. The level of educational attainment of a state's population, for example, may influence both the state's willingness to raise revenue for education (a demand effect) and the attractiveness to teachers of living and working in the state (a supply effect). It is important to separate the demand-side and supply-side effects to avoid misestimation of the latter and consequent mismeasurement of price differentials among the states.

Educational Considerations. The number of teachers demanded is likely to be greater, other things being equal, in states with high concentrations of pupils deemed to require more intensive services. States with relatively large percentages of pupils enrolled at the secondary level fall into this category, as do states with relatively large concentrations of disadvantaged pupils. As noted earlier, the concentration of disadvantaged pupils may also influence the supply of teachers if, and to the extent that, teachers view a high concentration of disadvantaged children as an undesirable working condition. In principle, only the supply-side effect of the percentage of disadvantaged pupils should be reflected in a teacher price index; the demand-side effect should be held constant. This makes it imperative to identify and separate the two effects--which is precisely why both the demand for teachers and the supply of teachers must be analyzed.

Prices and Tax Prices. Districts facing higher prices for teachers are likely, other things being equal, to hire either fewer teachers or teachers with less expensive characteristics. Thus, the supply price of teachers, which is the variable to be explained in the analysis of teacher supply, becomes an explanatory variable itself in the analysis of teacher demand. It was established long ago in research on the determinants of education spending that the key price variable in an analysis of the demand for education is not the price of educational resources per se but rather the so-called *tax price* of the resources. It is convenient, for the purpose at hand, to define the tax price of teachers as the cost to an average state resident or taxpayer of a unit increase in the number of teacher hours per pupil per year. For example, if the price of a teacher hour is $30 and there is 1 pupil for every 6 state residents, the cost to each resident of adding one teacher hour per pupil is one-sixth of $30, or $5. The significance of the tax price is that it measures how much each taxpayer must sacrifice to acquire the item in question, which, as the example shows, depends on the state's pupil-to-population ratio as well as on the item's price tag. The implication is that states with higher pupil-to-population ratios face higher tax prices and consequently can be expected, other things being equal, to demand fewer teachers per pupil.

Summary and Implications for Teacher Price Indices

To summarize, interstate variations in the prices of teachers are due to many factors, some of which should, and some of which should not, be reflected in a teacher price index. The factors that *should* be reflected in the index are those that (1) cause the salaries of teachers with given attributes to vary among states and (2) are not themselves determined by state or local policies. These include the cost of living, various amenities and disamenities, wages and employment opportunities outside teaching, and aspects of working conditions not controlled by state and local authorities, including the types of pupils to be served. A high cost of living, favorable employment opportunities outside teaching, an unpleasant environment, and a concentration of difficult-to-teach pupils should all be associated (other things being equal) with relatively high salaries, while the opposite characteristics should be associated with relatively low salaries.

The factors that *should not* be permitted to affect a price index include interstate differences in experience, training, and other characteristics of teachers that school systems value; factors that influence the demand for teachers rather than the supply; and state and local policies and their consequences. Because certain factors may influence both demand and supply, both sides of the teacher market must be analyzed, so that the demand effects can be separated and held constant. Among the policy variables that should not influence the index are state- or locally determined conditions of teaching, such as class size and the length of the school year, and state rules governing teacher certification, collective bargaining, and other aspects of teachers' employment. In principle, all these factors should be held constant--that is, their effects on salaries should be controlled for statistically--when the price of teachers are compared across states.

Ideally, the process of constructing a teacher price index would proceed as follows: The first step would be to use multivariate statistical techniques to derive teacher supply and demand functions. The supply function would represent the effects on the supply price of teachers of the whole array of supply factors. The demand function would represent the effects on the number of teachers and the characteristics of teachers of the whole array of demand factors. Step two would be to hold constant all the factors the *should not* influence the price index, namely, all the demand factors and all the supply factors subject to state or local control, by setting each such factor at its national average value. Step three, which has to be carried out separately for each state, would be to set all the remaining factors (those that *should* influence the price index) at their actual values for a particular state and then to calculate the corresponding estimated salary for that state. This estimate would represent the hypothetical average salary that would be paid in the state if the demand factors and controllable supply factors were held constant at the national average values. Finally, step four would be to construct the teacher price index by calculating the ratio of each estimated salary from step three to the actual average teacher salary in the nation.

The probability is not high that this elaborate scheme for comparing the prices of teachers across states can be fully implemented empirically. The practical difficulties include severe data limitations, technical obstacles to estimating the simultaneous supply and demand functions, and more basic ambiguities concerning the appropriate roles and representations of certain supply and demand factors. Nevertheless, establishing a theoretical foundation for cost measurement is useful in its own right. It provides the framework within which a variety of proposed approaches to cost measurement can be evaluated and compared. This application of theory is demonstrated both in Chapter 3, where alternative practical methods of constructing a COE index are considered, and in Chapter 4, where assorted simple cost indices and proxies are evaluated.

OTHER COMPONENTS OF THE COST OF EDUCATION

This section deals briefly with issues concerning indices of the prices of resources other than teachers. As was shown earlier, such indices could represent anywhere from 32 percent to 58 percent of total current education expenditure, depending on whether the teacher salary index is applied to fringe benefits and compensation of other educators as well as to teacher salary itself. I comment in turn on indices of the salaries of other professional staff, fringe benefits, costs of nonprofessional staff, and costs of nonpersonnel resources.

Salaries of Other Professional Staff

The same theoretical framework as applies to teachers' salaries applies equally well to the salaries of such other professionals as school principals, supervisors, psychologists, counselors, and librarians. In principle, one could construct a supply and demand model for each such category, distinguish between factors that should and should not be reflected in a price index, control for the latter, and estimate interstate variations in the supply price of each category of personnel. Many supply factors would be the same or similar for other educators as for teachers; however, some differences can be expected, as the following examples suggest:

- The opportunity wage variables that influence the supply of nonteaching staff may be different from the corresponding variables for teachers. The relevant indicator for psychologists, for example, may be the average compensation of psychologists, or mental health professionals in general, in each state. The relevant indicator for school and district administrators may be the level of compensation for administrators in other economic sectors.
- The working conditions that influence other professionals may also be different from those that influence teachers. Class size is unlikely to be an important consideration for nonteaching professionals, for example, although other work-load factors may play similar roles.
- School size and district size should be important determinants of the salaries of building-level and district-level administrators. These variables are relevant not only as indicators of working conditions but also as proxies for the levels of skill, or professional stature, required to administer organizations of different scale. Data compiled by the Educational Research Service (ERS) demonstrate a strong relationship between salary and district enrollment (ERS, 1990).

In practice, it would probably be harder to compare the salaries of other professionals across states than to compare the salaries of teachers, not only because the data on nonteaching staff are very sparse but also because of the greater diversity of staff roles in nonteaching fields and the difficulty of defining job categories uniformly across states. The data limitations are severe. Although there have been a few empirical analyses of the salaries of nonteaching staff (see Chapter 3), these were done with data sets for individual states for which there are no national counterparts. Although an analysis of the salaries of school principals could be carried out with data from the school administrator questionnaire of the NCES Schools and Staffing Survey (SASS), the same is not true for other categories of education staff. State-by-state data on salaries in other professional categories apparently do not exist.

It is not entirely clear, however, that separate price indices for nonteaching professionals are really needed. The proposition is at least worth testing that interstate variations in the salaries of other educators are similar enough to variations in the salaries of teachers that a teacher price index may adequately represent both. Whether this is so is mainly an empirical question hinging on the degree of proportionality between salaries of teachers and salaries of other educators. Despite the general scarcity of salary data, at least two data sets exist from which the degree of proportionality may be determined. First, the SASS data on school principals could be used to compare teachers' and principals' salaries (controlling in both cases for staff qualifications). Second, salary data for a large sample of school districts compiled by the Educational Research Service could be used to determine how strongly the salaries of classroom teachers correlate with the salaries of 20 or so other categories of education personnel. Such analyses could help to settle the question of whether an index of teacher salaries can reasonably be extended to other professional educators.

Fringe Benefits

Ideally, one would deal with fringe benefits by constructing an index of the cost in each state of providing a standard fringe benefit package to each major class of employee. Standard benefits might include, for example, a retirement program that pays each retired teacher a certain fraction of what the teacher formerly earned, a health insurance program that provides specified levels of coverage, standard amounts of sick leave, maternity leave, disability insurance, and so forth. In principle, one could measure the cost of providing such a package in each state. The costs of such a package might vary because of such things as differing morbidity and mortality rates, health insurance claim histories, and costs of medical services. Adjustments could be made (again, in principle) for the effects on fringe benefit costs of differences in pertinent state policies, such as the regulations imposed on insurance carriers and restrictions on pension fund investments.

Again, however, the question arises of whether a separate analysis or separate index of fringe benefit costs is really necessary. The cost of a standard fringe benefit package could turn out to be so nearly proportional to the salary of a standard teacher that a teacher price index can reasonably represent both. Unfortunately, too little information is now available on the cost of fringe benefits to test this hypothesis. A special study may be needed, therefore, just to determine whether a separate index of fringe benefit costs is required.

Services of Nonprofessional Staff

Although the same theory of supply and demand for labor applies, in principle, to nonprofessional personnel as to teachers, there would be little point to developing special models of nonprofessional salaries. The reason is that the nonprofessional work force in education is composed largely of workers in occupational categories that are common in other economic sectors. These include, for example, secretaries and other clerical workers, white collar workers responsible for nonpedagogic functions (bookkeeping, purchasing, personnel, etc.), building maintenance personnel, food service workers, and school bus drivers. Absent any reason to believe that the salaries of such workers employed by school systems vary differently among states than salaries of similar workers employed in other sectors, it would be reasonable to rely on general indicators of wages in the pertinent occupations to represent the relative wages of nonprofessional personnel in education.

Unfortunately, salary data by state for the pertinent occupational categories are not generally available. The Bureau of Labor Statistics (BLS) does publish state-level data by industry, which makes it possible to construct wage indicators for the private sector as a whole and for broad subsectors such as service industries. These general indices can be used as proxies for nonprofessional salaries in the absence of more specific data, but they are not very good substitutes for indices of wages in specific occupations. They are problematic in that they reflect the wages of workers in occupations not represented in education, and they are distorted by the varying occupational mixes of the work forces of different states.

An alternative approach to measuring the cost of nonprofessional personnel is to construct an index from decennial Census data on earnings by occupation. Rafuse (1990) has demonstrated a method of adjusting such data to reflect the varying age, gender, and educational attainment mixes of different states' labor forces. The resulting adjusted figures should yield indices more valid than those based on unadjusted average wage figures. (Rafuse's approach is discussed in more detail in Chapter 3.) Thus, although the preferred occupationally specific wage figures are not available, it seems feasible to produce at least some rough proxies for the nonprofessional wage component of education cost.

Resources Other than Personnel

The 15 percent share of the education budget made up of expenditures for resources other than personnel is composed of relatively small outlays for diverse categories of goods and services. These fall into several categories for which different approaches to price estimation seem to be appropriate:

First, there is probably little interstate variation in the prices paid by school systems for standard manufactured items, such as books, paper products, instructional materials, instructional and other equipment, and operation and maintenance supplies. These products tend to be marketed nationally. Although there undoubtedly are some regional price differentials related to varying transportation costs, differences in market scale, and, perhaps, differences in the degree of competition among vendors in different parts of the country, it seems likely that only relatively minor errors would be introduced into a COE index by treating the prices of such items as nationally uniform.

Second, prices of services utilized by school systems, such as insurance, accounting, financial, and legal services, probably do vary geographically but in essentially the same proportions as the prices of similar services consumed by households and businesses. There are no special conceptual problems to be addressed in dealing with these items: the main issue is whether suitable general price indicators or proxy measures can be identified.

Third, the most troublesome cost category within the nonpersonnel cluster is undoubtedly the cost of energy. Although the unit prices of fuel and electricity vary geographically, this variation alone poses no special difficulties: all that needs to be done is to find appropriate state-level or regional price indicators. The more difficult problem is that the amounts of fuel and power required for heating, cooling, and transportation depend on climate, geography, and population distribution and consequently vary widely among the states. It has been shown that the relationship between energy requirements and such factors as climate can be represented mathematically, but doing so requires detailed technical information and fairly elaborate models. Whether the required analytical effort is worthwhile for a category that makes up only about three percent of the elementary-secondary budget is not at all clear.

* * * * *

As the foregoing discussion has indicated, there is a large gap between the cost measurement methods that are appropriate in theory and those that can be implemented with existing data and analytical tools. The following chapter examines the practical possibilities and evaluates them in light of the foregoing conceptual framework.

NOTES

1. The literature on district-level cost-of-education indices has been reviewed in papers by Barro (1981) and Chambers (1979).

2. The main problem is not that it is difficult to develop price indices for such capital goods as buildings or equipment; in fact, indices of geographical variations in building construction costs are available. Such indices would be useful for translating into constant dollars the capital outlays made by different states in a given year. However, it would not be possible, even with such indices, to make interstate comparisons of costs of the accumulated stock of education capital. Accomplishing the latter would require, among other things, data on asset values and rates of capital consumption (depreciation) that do not exist for the education sector (or for the public sector in general). The difficulty, in other words, is not in developing an index of capital cost per se but rather in measuring the flow of services from the capital stock to which such an index should be applied.

3. It has been argued, to the contrary, that the salary differentials associated with differences in teacher experience and training should be treated as cost rather than quality variations, at least in some circumstances. The premise is that school systems sometimes do not want highly experienced teachers or teachers with advanced degrees and extra course credits and would not pay for such teachers voluntarily but are forced to do so under established seniority and tenure rules. The added expense, therefore, can be viewed as an unavoidable cost burden. The problem with this line of argument is that it is hard to reconcile the claim that seniority and advanced degrees are undesired attributes with the fact that they are almost universally rewarded in district salary schedules. A district that did not value master's degrees, for example, would presumably not offer salary premiums to teachers who earn them. For this reason, I adhere to the proposition that experience and training are voluntarily purchased attributes of teachers and, consequently, that pay differentials associated with higher qualifications do not constitute differences in costs.

4. In theory, there is a fourth possibility, defining the COE index in terms of the expenditure per pupil required in each state to produce standard, or national-average, educational outcomes, but this definition is not considered here for two reasons: First, although such a definition is attractive in some respects, it is completely unworkable in practice. No one knows, or has any reasonable basis for estimating, what it would cost in each state to produce any specified level of educational performance. Second, even apart from workability, it seems desirable to maintain the logical distinction between (1) the outlay required to provide specified educational services, and (2) the quantity of services required to produced specified educational results. The distinction is between the cost of services, on one hand, and the productivity of services in producing student learning, on the other. By rejecting the outcome-based definition of cost in favor of a resource-based or service-based definition, we effectively set aside the educational productivity issue for separate treatment in its own right.

5. Possible alternatives to basing a cost-of-education index on a national average market basket of educational resources include basing it on the cost to each state of either (1) providing specified "minimum adequate" educational services or (2) implementing someone's design for an "exemplary" educational program.

6. The concept of technological cost factors is discussed extensively by Chambers (1980).

7. In principle, one might want to distinguish between "necessary" and "unnecessary" small schools, as has long been done, for example, in distributing state education funds in California. "Necessary" small schools are those required by such external conditions as poor access or sparsity of population; "unnecessary" small schools are those that districts or states choose to retain. even though there is no physical imperative to do so. In theory. only the former should be considered in adjusting for the diseconomies of small scale operation; however. it is unlikely that the distinction could be made in practice on a national scale.

8. Robert Rafuse, of the Advisory Commission on Intergovernmental Relations (ACIR). has attempted to make this comparison for the whole range of state and local public services (Rafuse. 1990) by developing a "representative expenditure" index that reflects both need and cost differentials across states.

9. That is to say, the notion of a national-average package of resources per pupil could be expanded into the broader concept of a specified package of resources per pupil in each of a number of pupil categories. This broadened concept is embodied in the resource-cost model (RCM) approach to cost analysis, developed by Jay Chambers and his associates. in which costs are compared by pricing specified programs for each type of pupil and then comparing the resulting average cost per pupil among places (see, e.g., Chambers, 1982).

10. Estimates of the incremental, or excess, costs of special education for the handicapped have been developed recently in Moore et al. (1988), but no such estimates of recent vintage are available for other major groups, such as the educationally or economically disadvantaged or limited-English proficient.

11. Halstead (1983) presents data on the resource mix in elementary-secondary education in 1973-74 and 1975-76--the last years, he says, for which the National Center for Education Statistics collected such information.

12. Within the nonpersonnel category, ERS reports shares of 2.7 percent for books and materials, 2.9 percent for utilities, and 16.8 percent for all other items (ERS, 1990). The "other" category presumably includes expenditure for contracted services, much of which can be construed as a form of personnel outlay. See the following remarks on the contracted services category in the NCES expenditure data.

13. The only salary and fringe benefit expenditures included under "instruction" in the NPEFS appear to be expenditures for teachers and teacher aides. Estimates for teachers only were developed from data on numbers of teachers and aides reported in NCES (1990) and data on the average salaries of teachers and aides reported in ERS (1990). These estimates are probably fairly accurate, because the expenditure for aides amounts to only about 7 percent of the expenditure for teachers and aides combined.

14. Note that "salary" is used here, for expository convenience, as if it were synonymous with price. Strictly speaking. the price of a teacher should include the teacher's total compensation, including salary, the value of current fringe benefits, and the present value of deferred compensation.

15. If labor were immobile, the main choice facing teachers would be to teach or to work in some other occupation in the same state. Because the real values of salaries in both teaching and other occupations would depend only on that single state's cost of living, interstate differences in the cost of living would not influence choices between teaching and alternative occupations.

16. An additional complicating factor is that locational preferences are likely to vary among individual teachers. Some may treat as amenities characteristics that others see as disamenities. For example, some teachers may favor central cities for diversity, excitement, and cultural resources, while others would flee them because of crowds, noise, congestion, and crime. Because these preferences are likely to be related to such demographic factors as age and marital status, it may be important to take interactions between the amenities and personal characteristics into account.

17. This is not to imply that salaries in high-poverty places would actually be higher than those in lower-poverty places. The key phrase is "other things being equal." The positive effects on salaries of the presence of "less desirable" population groups might be offset by the negative effects of lower living costs (especially housing costs) in high-poverty areas.

18. Chambers (1980) has argued that because the same amenities and other fixed locational factors as influence teachers' salaries also influence salaries in other occupations, there is no need to take salaries (or conditions) in other occupations explicitly into account in a model of the determinants of teacher salary. However, this conclusion rests on some very strong and implausible assumptions regarding competition, equilibrium, and mobility in the labor market and similarity of preferences between teachers and other workers. If the assumptions are not satisfied, as is highly likely, then there is an independent role in the model for wages and conditions of employment outside teaching (Barro, 1981).

19. Again, it should be noted that preferences in these matters vary among individual teachers. Some teachers may feel a "calling" to work with hard-to-teach pupils or may welcome it as a challenge. For them, the presence of such pupils could even be an attraction rather than a disamenity. But the issue is how pupil characteristics affect the teacher at the margin. Unless there is an ample supply of teachers with positive preferences for the more difficult assignments, the disamenity affect will be the marginal one and will predominate.

20. Again, although many teachers may have the opposite attitudes--namely, positive preferences for working with poor or minority pupils, what counts are the preferences prevailing at the margin. Unless the teachers with positive preferences are numerous enough to staff heavily poor and minority schools, the school systems will have to fill out the school staffs with teachers who would prefer to be elsewhere, which means that the salaries and other terms of employment will have to be attractive enough to compensate for the perceived disadvantages of working with the less-preferred populations.

21. For a review of the 1970s literature on the effects of teacher collective bargaining on salaries, see Victor (1978).

22. The situation varies regionally, however, and depends strongly on state policies. In the New England region, for example, an interstate compact has helped to standardize certification requirements and facilitated movements of teachers across state lines.

23. Relative scarcity factors of the kind suggested here have not appeared in earlier empirical models of teacher supply, but that is to be expected because all the earlier models were of teacher supply at the local district level, where the scarcity concept is not applicable.

24. The two bodies of literature are related because the variables one would look to for an explanation of interdistrict variations in teacher-pupil ratios are the same, for the most part, as those that account for variations in expenditure per pupil. A useful review of the expenditure determinants literature is Tsang and Levin (1983).

25. For reviews of the literature and detailed discussions of alternative indicators of state fiscal capacity, see Barro (1985) and the collection of papers on fiscal capacity in U.S. Department of the Treasury (1986).

3. ALTERNATIVE INDEX CONSTRUCTION METHODS

The methods available (now or prospectively) for constructing an interstate cost of education index can be arrayed along a continuum from simple to complex. The simplest approach is to use a readily available proxy indicator, such as average teacher salary or the average private-sector wage, as a rough-and-ready COE index. The most complex is to derive a cost index from a fully elaborated, simultaneous-equation econometric model of the supply and demand for teachers and other education personnel. But neither polar approach is satisfactory in practice. The simple proxies do not yield valid cost indicators, and interstate comparisons based upon them are likely to be distorted. The supply-demand modeling approach is preferable in principle, but developing the complex econometric model called for in theory is infeasible because of both data limitations and technical problems of model estimation. The optimal practical solution, therefore, involves a compromise between a quick and easy but indefensible index and a conceptually ideal but impracticable index.

The search for a workable but valid index can be initiated at either end of the complexity spectrum. One strategy, starting from the complex end, is to begin with a full theoretical model of supply and demand for teachers and other personnel but then to pare the model down until it can be implemented empirically. This entails reducing the number of supply and demand factors to those that can be handled with the available data and simplifying the model structures by dropping the less central relationships and interactions. Ideally, the less important influences on salaries would be the ones eliminated in this paring down process, but in practice, unfortunately, data availability may become the decisive consideration, and some important factors are likely to be sacrificed.

The opposite strategy, starting at the simple end of the complexity spectrum, is to select a readily available indicator, such as state-average teacher salary, and then to adjust, augment, and embellish it in an effort to correct for some of its deficiencies. For instance, the problem that an index of average teacher salary fails to allow for variations in the makeup of the teaching force can be dealt with in part by adjusting the average salary data to reflect interstate differences in teacher experience and training. (This adjustment is demonstrated in Chapter 4.) Going further, it may be feasible to adjust an index of average teacher salary for such other quality-related characteristics of teachers as certification status, major field, and type of college attended. It may even be possible to control for differences in teacher certification rules, collective bargaining arrangements, and other aspects of state policy. The resulting adjusted salary indices, though far from theoretically pure, might be sufficiently improved (relative to the available alternatives) to be suitable for practical applications.

This chapter examines immediately and potentially practical index construction methods reflecting both strategies. (Potentially practical means not implementable immediately but implementable with data that could be assembled in the not-too-distant future.) I begin with methods that involve econometric modeling and that are grounded in the theory of supply and demand for teachers--all of which, however, involve simpler, more manageable models than those suggested by the theoretical exposition in Chapter 2. I then examine methods that use available simple indicators and proxies, adjusted and augmented in various ways, to represent interstate variations in education costs.

METHODS BASED ON SUPPLY-DEMAND MODELS

The education finance literature includes a dozen or more studies in which attempts are made to derive cost-of-education indices from teacher supply and demand models, but all focus on cost variations among local school districts rather than among states. Nevertheless, the same models and methods, or variants or analogs thereof, may be applicable to the state level as well. The models in question (most dating from the mid-1970s or early 1980s) are of three kinds: (1) district-level models featuring separate supply and demand equations (simultaneous-equation models), (2) simpler models featuring single salary equations (reduced-form models), also based on district-level data, and (3) single-equation models of salary determination based on individual-teacher data (also known as "hedonic" price-index models). After a brief review, I comment on whether or how each type of model might be used to construct a state-level COE index.[1]

Simultaneous-Equation Models Based on District-Level Data

These simultaneous-equation supply-demand models come closest to reflecting the theoretical framework laid out in Chapter 2; however, they are "stripped down" versions of the complex model called for in theory, because they incorporate only a few of the presumed influences on salaries and leave out important interactions and feedback effects. The principal models in this category are those of Brazer and Anderson (1975), Boardman, Darling-Hammond, and Mullin (1979), Wentzler (1979), Loatman (1980), and Rosenthal, Moskowitz, and Barro (1981). Each such model includes at least one teacher supply equation and one teacher demand equation, but the models presented in the last two studies mentioned are more elaborate in that each includes three pairs of equations--one pair pertaining to teachers' base salaries, one to the salary increments paid for experience, and one to the salary increments paid to teachers with a master's or higher degree.

Consider, first, the models based on a single pair of supply and demand equations. The supply equation of each such model has district-average teacher salary as its dependent variable. The explanatory variables (influences on teacher salary) in the supply equation vary greatly from study to study but generally include teacher characteristics (mainly experience and training); some proxy for the cost of living (often the price of housing or land); selected community characteristics intended to represent amenities (e.g., population density, distance to center city, crime rate); an indicator of the local wage level outside teaching and/or other local labor market characteristics; and such indicators of teachers' working conditions as the teacher-pupil ratio and the percentages of pupils who are poor or minority or who have special educational needs. The dependent variable in the demand equation is usually the number of teachers demanded (employed), and the explanatory variables include such fiscal variables as tax base, income, and state aid; indicators of local preferences, or "tastes," for education, such as the ethnic composition and educational attainment of the district's population; and the price or "tax price" of teachers.[2] All these models have been estimated from data pertaining to the local school districts within a single state, usually by the standard method of two-stage least-squares (2SLS).

Once the supply and demand equations of such a model have been estimated, the following steps are taken to compute a teacher salary index: First, the pair of simultaneous supply and demand equations is solved for teacher salary. Second, the demand factors and the "controllable" supply factors are held constant by setting them at their statewide average values. (The demand factors are the fiscal and "taste" variables mentioned above; the controllable supply factors are variables determined by the district's own policies, such as class size.) Third, the salary equation is used to compute the average teacher salary that would be paid in each district with the aforesaid variables held constant. Fourth and finally, the index value for each district is computed as the ratio of the hypothetical salary calculated for that district to the actual statewide average salary.

The more complicated models presented by Loatman (1980) and Rosenthal, Moskowitz, and Barro (1981) contain supply and demand equations for base teacher salary similar to the equations described just above, but in addition, each contains additional pairs of equations pertaining to salary premiums for increments in experience and training. Loatman (1980) links the salary increment that Michigan districts pay for teacher experience to the wage level outside teaching, the teacher-pupil ratio, several characteristics of district enrollment (percent poor, percent minority, etc.), and the actual average experience and average level of training of each district's teaching force.[3] He models the demand for experience as a function of local wealth, the availability of outside financial aid, local fiscal effort to support education, and the salary premium associated with each experience increment. Similarly, in the Rosenthal, Moskowitz, and Barro (1981) study of Maryland, the salary increment per year of teaching experience is expressed as a function of the teacher-pupil ratio, average teacher experience, suburban location, and several characteristics of the pupil population. On the demand side, average experience is related to district per capita income and tax base, the availability of state and federal aid, the pupil-population ratio, certain locational and demographic characteristics, and a price variable that reflects the salary increment associated with each year of experience. Similar sets of equations are used to represent the supply and demand for master's or higher degrees.

The procedure for computing a teacher salary index from these more complex models is basically the same as for a model with a single pair of equations, but with the following additions: (1) the simultaneous equations are solved for three salary variables rather than just one--that is, for base salary, the experience increment, and the training increment; (2) demand factors and controllable supply factors are held constant in all three salary equations; (3)

estimates are calculated for each district of the hypothetical base salaries, experience increments, and training increments that would prevail with the aforesaid factors held constant; and (4) the resulting estimates are aggregated into an overall estimate of the average salary for the district. The index is then constructed as described earlier.

A feature of the Rosenthal, Moskowitz, and Barro (1981) Maryland model that may apply to future state models is that it includes supply-demand equations not only for teachers but also for four other types of personnel: administrators, pupil personnel staff, paraprofessionals, and plant operation and maintenance workers. The overall cost-of-education index is constructed as an expenditure-weighted sum of salary indices for all the personnel categories, plus a constant factor that represents the costs of nonpersonnel resources. Note, however, that the teacher component receives twice the combined weight of the other four personnel components and accounts for almost 60 percent of the whole COE index.

Single-Equation Models Based on District-Level Data

The models in this group are precursors (methodologically, if not chronologically) of the previously described simultaneous-equation supply-demand models. They appear in studies by Brazer (1974), Grubb and Hyman (1975), Kenny, Denslow, and Goffman (1975), Frey (1975), Loatman (1977), and Adams (1980). Each such study presents a single ("reduced form") regression equation in which the dependent variable is either average teacher salary or some other measure of salary and the explanatory factors include both supply-side and demand-side influences on teachers' pay. These regression equations are estimated from data on all districts or a sample of districts within a state, usually by the standard ordinary-least-squares (OLS) method.[4] The procedure for deriving a teacher salary index from such an equation is to hold constant (i.e., set at statewide average values) all the explanatory variables assumed to be demand factors or controllable supply factors and then to calculate the index values in the same manner as with the previously described simultaneous-equation models.

Although these reduced-form models may include the same explanatory variables and require essentially the same data as the simultaneous-equation models, they have less capacity (by definition) to distinguish between supply-side and demand-side influences on salary; consequently, they do not allow for clear distinctions between factors that should and should not influence a teacher salary index. Specifically, the single-equation approach fails to take into account that certain variables may affect *both* the supply of, and the demand for, teachers and that certain influences on demand may be closely correlated with influences on supply.

An example of a variable that influences both supply and demand is the average educational level of a district's population, which may, on the demand side, affect the district's willingness to support education and, on the supply side, help to determine the district's attractiveness to teachers. In principle, the demand-side effect of this variable should be held constant in constructing a salary index, while the supply-side effect should be taken into account in the index calculations; but this distinction cannot be made in the reduced-form framework, because the variable in question enters the model only once. The estimated coefficient of "educational level of the district's population" in the reduced-form regression equation represents neither the supply-side nor the demand-side effect of the variable but only an amalgam of the two.

An example of correlation between supply-side and demand-side influences is that district per capita income (an influence on the demand for teachers) is likely to be positively correlated with certain local amenities but negatively correlated with such influences on teacher supply as the percentages of poor, minority, and special-need children in the district's pupil population. Where such correlations are strong, the likelihood of being able to estimate the effects of particular supply and demand factors accurately diminishes, and hence the attempt to isolate and hold constant the effects of the demand factors may not succeed. Thus the danger is great that a teacher salary index derived from a reduced-form salary equation will be distorted.

This is a case in which one analytical strategy dominates the other. Holding other things constant (e.g., the unit of analysis, the number of observations, and the availability of data), a single-equation model of teacher supply and demand is less suitable than a simultaneous-equation model as the basis for constructing a teacher salary index. Therefore, if a state-level COE index is to be derived from a supply-demand model, it should be a model with separate supply and demand equations.

Single-Equation Models Based on Individual-Teacher Data (the Hedonic Price Index Approach)

The main model-based alternative to the district-level supply-demand method is the hedonic price index method developed by Jay Chambers and his colleagues (Chambers, 1978a, 1978b, 1980; Chambers, Odden, and Vincent, 1976; Augenblick and Adams, 1979; and Wendling, 1980). In principle, the hedonic method derives from the same theory of the teacher labor market as the district-level method. That is, teachers' choices among districts are assumed to be influenced by district amenities and working conditions as well as by salaries; while districts' decisions about how many teachers and which teachers to hire are assumed to be determined by local fiscal capacity, other district attributes, and the teachers' personal and professional characteristics. The hedonic method also resembles the district-level supply-demand method in that it depends on a multiple regression analysis of influences on teacher salaries and seeks to derive district-level teacher salary indices by isolating the salary variations due to uncontrollable supply-side factors. Yet the two approaches differ substantially in statistical methodology, in the type of data used, in certain underlying assumptions about the market for teachers, in the variables "controlled for" in the statistical analysis, and, most important, in the variables used to calculate the salary indices (Barro, 1981). Therefore, the choice of method substantially affects the results.

The distinguishing characteristics of the hedonic approach to modeling the determinants of teacher salaries are the following:

- The models are based on data on *individual* teachers and other staff members. Wendling's 1980 analysis of districts in New York State, for example, is based on a sample of nearly 19,000 teachers. In the studies by Chambers and his colleagues, these data were obtained from special sample surveys; in other studies, they were extracted from state administrative records.

- The models use single multiple regression equations fitted to the individual-teacher data to estimate the effects on salaries of both characteristics of teachers and characteristics of school districts.

- The models do not deal explicitly with the demand side of the teacher market, under the assumption that teacher salaries (adjusted for personal characteristics of teachers) are wholly supply-determined.

Operationally, the process of constructing a teacher salary index from such a model involves two main steps: The first is to fit a regression equation in which individual teachers are the units of observation; salary is the dependent variable; and the explanatory variables include (1) teacher education, experience, field of teaching, and other individual characteristics and (2) such exogenous (uncontrollable) characteristics of the districts in which teachers are employed as size, location, and the makeup of the student body. The second is to construct the teacher salary index by holding constant all the individual teacher characteristics in the regression equation (i.e., setting them at their statewide average values) and then calculating the interdistrict salary variations attributable to the uncontrollable district characteristics.

The teacher salary indices based on these hedonic models--especially those produced by Chambers--are notable for being based on very sparse sets of supply factors. For example, in Chambers' 1980 study of California, the only factors taken into account in calculating index values are enrollment, percent urban population, area population, and population of the nearest central city, rate of population change, and the cost of new homes (the last intended as a proxy for the cost of living). Conspicuously missing are opportunity wages or employment opportunities outside teaching and characteristics of the district's pupil population.

The absence of these factors is no accident. Chambers has argued against including opportunity wages on the grounds that variations in such wages are already accounted for, under conditions of labor market equilibrium, by the amenity and disamenity variables in the salary model.[5] He has asserted that pupil characteristics should be excluded because the characteristics of the pupils assigned to a particular teacher (even their achievement levels) are controllable by districts.[6] In addition, his models generally do not take explicit account of variables usually considered endogenous in supply-demand theory. For instance, he assumes that the supply price of teachers is independent of the number of teachers to be hired (i.e., that the supply of teachers to a district is infinitely elastic) and omits such controllable factors as the teacher-pupil ratio from his salary equations.

Not all developers of hedonic models have adhered to the same specifications, however. Both Wendling (1980) and Augenblick and Adams (1979) include various pupil characteristics and the teacher-pupil ratio in their models (the latter without any allowance for endogeneity). Even so, the hedonic models generally allow for the influence of fewer variables, and less diverse variables, on the teacher salary index than do the district-level supply-demand models. It seems clear, therefore, that even though the district-level supply-demand models and the hedonic models share the same conceptual underpinnings, they are not merely two routes to the same destination. The nature of the product--the salary index itself--depends on which approach is chosen.

Applicability to State-Level Price Indices

At least in principle, the same basic supply-demand modeling techniques as have been applied at the district level could be used to construct a state-level cost-of-education index. However, there are two obvious major differences between the models needed to quantify interstate and interdistrict cost differentials: First, the model underlying a state-level index must take account of variations in the salaries of teachers (and in other salaries and prices) across the nation, not just within an individual state. Second, the same model must represent the influence of state characteristics and state policies, not just district-level variables, on teacher salaries and the other prices. Most details of modeling methodology would depend strongly on the level of aggregation of the data on which the model is based. I 20 consider three possibilities: a model based on state-aggregate data (statewide averages), a model based on district-level data (as in the previously described district-level supply-demand studies), and a model based on observations of individuals (as in the hedonic index approach).

Models Based on State-Aggregate Data. Although it might seem feasible to develop an interstate cost model with state-level data in much the same way as earlier researchers developed interdistrict models with district-level data, it is questionable whether this approach can yield a satisfactory COE index. One reason that state-level modeling may not work is that the effects of only a handful of variables can be estimated with models fitted to just 51 data points (the 50 states plus the District of Columbia). Many variables that have appeared earlier district-level models and that figure importantly in the theory of teacher supply and demand would have to be omitted. This need to limit the number of variables is particularly troubling because a state-level model logically needs to include *more* variables--not fewer variables--than a district-level model to deal with factors that are constant within but not across states. For example, differences in state teacher certification standards are irrelevant to an analysis of salary variations among a single state's school districts but could be important in explaining interstate salary differentials. Although the option exists of enlarging the state-level data base by pooling observations for multiple years, this tactic might not do much to solve the problem because, first, certain key data items are not available for multiple years (notably, state-level data on teacher experience and training) and, second, the models would then have to be made correspondingly more complex to represent changes in supply and demand over time.[7]

Another reason to doubt the value of models fitted to state-level data is that a great deal of information would be lost by dealing only with state aggregates. Much of the variation of interest occurs within states. It seems unlikely, for instance, that the effects of community and pupil demographics on the supply price of teachers could be captured adequately with models based on state-average data. To see why, consider a state whose overall pupil population mix is similar to that of the nation as a whole, but in which most of the enrollment growth, and hence most of the teacher hiring, has been occurring in areas with large poor and minority populations. The average teacher salary in that state is likely to have been elevated by the need to attract teachers to heavily poor and minority schools, but this relationship would be missed entirely with a model that takes account only of the statewide-average concentration of poor and minority pupils. Consequently, the model would probably underestimate the effects of poverty percentage and minority percentage on salaries. Thus, overaggregation could detract substantially from the validity of the results.

Limitations notwithstanding, an analysis based on state-aggregate data may be useful for determining (1) whether variables identified as salary determinants in theory play their expected roles and (2) how much of the interstate salary variation is explained by a few basic variables and how much remains to be explained by other factors. The simplest analytical approach based on state-level data would be to develop a single-equation state-level model directly analogous to the single-equation district-level models described earlier. The dependent variable in such a model could be either state-average teacher salary or the salary of a teacher with specified experience and training (e.g., a master's degree and 15 years of teaching experience). The independent variables would include state averages of teacher attributes and selected state characteristics. Prior to the development of NCES's SASS data base, such models could not have been constructed because data on certain key variables were missing. In particular, there were no data on average teacher experience and training by state or on the average salaries paid in each state to teachers with specific experience-training combinations. Now SASS provides this information for both 1987-88 and 1990-91, with further rounds of similar data to follow.[8] Thus, the advent of SASS has made this line of modeling feasible.

The possibility of constructing a simultaneous-equation supply-demand model with state-aggregate data might also be explored. In a two-equation model, the supply equation would relate state-average teacher salary to state averages of key supply factors, and the demand equation would relate the number of teachers demanded to state-level fiscal capacity, price, and taste variables. In a more elaborate version, separate sets of equations pertaining to base teacher salary, the average salary increment per unit of experience, and the average salary increment paid for an M.A. degree could be developed. Note that the feasibility of the more complex model depends entirely on SASS, because there are no other sources of data on either average experience and training by state or on the salary premiums paid in each state for increments in experience and training.

The problem remains, however, that state-aggregate models would be incapable of dealing with more than a few of the many factors that are needed, in theory, to explain interstate variations in salaries. Some factors would have to be omitted because data are missing, others because there are too few state-level observations to disentangle their effects. To develop acceptable COE indices, it would almost certainly be necessary to analyze data disaggregated below the state level.

Models Based on District-Level Data. An alternative to working with state-level data is to develop supply and demand models with district-level data and then to use them to estimate interstate salary differentials. The district-level models are more likely to represent influences on teacher supply and demand accurately, both because they can take more supply and demand factors and interactions into account and because they would suffer fewer ill effects of overaggregation. These district-level models would be similar in many ways to the ones reviewed earlier but would differ in two important respects: They would be based on national samples of local school districts and would include state-level as well as district-level influences on teacher supply and demand.

Again, the availability of the SASS data bases is what makes such modeling feasible. SASS itself contains the basic data on teacher salaries and teacher characteristics needed for the analysis (although certain items are missing, as is explained below) plus data on such district attributes as size, pupil composition, and teacher-pupil ratio. To assemble the rest of the data needed for supply-demand modeling, it would be necessary to merge the SASS data with district-level and state-level data from other sources, such as the NCES Common Core of Data (CCD), the Census Bureau's data on the financing of public education, and the 1990 Census of Population files mapped onto school district boundaries.[9] The last-mentioned files, scheduled for release in final form by the end of 1993, contain information on per capita income, housing prices, and numerous demographic and socioeconomic characteristics of districts. Certain state-level variables also would have to be added to the data base, including indicators of state policies affecting teacher certification and collective bargaining and data on statewide fiscal and economic conditions. With this combined data set, it should be possible to construct the first district-level salary model that is national in scope and hence capable of supporting interstate comparisons of teacher salaries.

An important constraint on this type of model is that SASS provides only some of the data needed to analyze the salary variations associated with differences in experience and training. The key missing items are district-level data on average teacher experience and training and on the pertinent salary differentials. Until these data gaps are filled, it will not be feasible to construct supply-demand models containing separate equations for base teacher salary and the experience and training increments. However, it would take only relatively minor additions to existing SASS questionnaire items to provide the missing variables and thus to make estimation of the more complex models possible.

The procedure for deriving a state-level teacher salary index from a national district-level model would be only slightly different from the procedure used to derive an index for districts within a single state. Consider a model that relates teacher salary to an array of district and state characteristics, some of which are uncontrollable supply factors, some controllable supply factors, and some demand factors. The first step in computing a state-level index would be to hold the demand factors and controllable supply factors constant at their national average values. Variables that take on only discrete values (dummy variables) would require special treatment. For instance, one could hold constant a discrete factor such as the presence of a state law authorizing collective bargaining by setting it equal to the fraction of states (or districts) in which such a law exists. The second step would be to compute for each state a hypothetical state-average teacher salary by setting the uncontrollable supply factors in the model at their state-average values. For example, the factor "percentage of a district's pupils who are poor" would be set equal, for the purpose of this calculation, to the average percentage of poor pupils in the state. The final step would be to compute the index value for each state as the ratio of the hypothetical salary for that state to the actual average teacher salary in the nation. Note that although the underlying supply-demand model would be based on district-level data, the index itself would depend only on national-average and state-average values of the supply and demand factors.

Models Based on Individual-Level Data. The third possibility for constructing a state-level salary index is to work with data on individual teachers, using a state-level analog of the previously described hedonic price index method. Like the district-level analysis just discussed, an individual-level analysis would have been infeasible before the SASS data became available. Now, however, the SASS teacher survey provides the key ingredient needed for such an analysis: data on a national sample of teachers, large enough and appropriately stratified to provide representation of each state. In combination with SASS school-level and district-level data and the various non-SASS data files mentioned earlier, this data base should make it possible to develop on a national scale the same kinds of models as Chambers and others constructed for individual states.

In a model built on the SASS teacher data, the dependent variable would be the individual teacher's actual salary, and the explanatory variables would include (1) such teacher characteristics as experience, degree level, certification status, age, gender, and perhaps subject specialty and type of undergraduate institution attended, (2) indicators of working conditions, including class size and pupil characteristics, (3) indicators of district and community characteristics, including whatever measures of living cost (cost of housing) and opportunity wages (earnings outside teaching) can be derived from the Census population data, and (4) indicators of pertinent district and state policies. It would even be possible with the SASS data to measure class sizes and pupil characteristics at the school-building level rather than at the district level, thereby improving the accuracy of the model. Also, it should be possible to improve over past hedonic index studies by treating class size and other working conditions as endogenous variables. A combination of the 1990 Census data mapped by school district and the 1990-91 SASS data seems ideal for constructing this type of model.

The method of constructing an interstate teacher salary index from an individual-teacher model would be similar to that used in earlier district-level applications of the hedonic index approach. Teacher characteristics, demand factors, and controllable supply factors would be held constant at national-average values; a hypothetical salary for a "typical" teacher would be calculated for each state by setting the uncontrollable supply factors at state-average values; and the interstate salary index would be derived by calculating ratios of these hypothetical state salaries to the actual average salary in the nation. It would be possible, incidentally, to carry out a parallel analysis of salaries of school principals, using data from the SASS survey of school administrators. The resulting indices for teachers and principals could be combined to produce a broader, composite index of salaries of professional staff.

Limitations of Model-Based Methods

The encouraging fact that the development of new data sets has expanded the prospects for supply-demand modeling should not blind us to the limitations of model-based methods of measuring the cost of education. Some of these limitations may eventually be overcome by continued progress on the data collection, measurement, and modeling fronts, but others are inherent in the econometric approach. The following, very briefly, are some of the main generic shortcomings of the model-based approach:

First, despite recent improvements in the availability of data, we still fall short of being able to measure adequately--or at all--some of the key variables that theoretically belong in models of educator supply and demand. Satisfactory cost of living and opportunity wage indicators are lacking (see the later remarks on these indicators); data on amenities and working conditions are incomplete; and indicators of teacher quality are unavailable. Thus it is necessary either to make do with less-than-adequate proxies or to omit important factors from the models.

Second, there are unresolved issues concerning the proper specification of teacher supply and demand models. Analysts disagree, for example, about the breadth of the teacher market; the degree to which teachers are mobile; how economic opportunities outside teaching, price-quantity relationships, and differences in teacher quality should be represented; and which interactions among variables need to be taken into account. Thus a would-be index user might be faced with different, more or less equally plausible model-based indices but no clear basis for determining which formulation is best.

Third, apart from issues of model specification, there is also ambiguity about which factors in a teacher supply-demand model should be deemed state-controlled, and hence held constant, and which should be permitted to vary when each state's relative price of teachers is computed. Consequently, rival cost indices, reflecting different judgments about the reach of state and local policies, may be derived from the same econometric model.

Fourth, and perhaps most fundamental, not even the most detailed and sophisticated supply-demand model, developed from ideal data, could represent the full range of influences on teacher salary. Teacher salaries are undoubtedly determined, in part, by intangible, idiosyncratic, and state-specific factors that econometric analyses are inherently incapable of capturing (historical factors, political alignments, and even the impacts of particular personalities). The failure to take such factors into account, though unavoidable, could result in incorrect estimates of the relative prices prevailing in particular states. The existence of demonstrable errors for specific states then can become the basis for attacks on the model-based index as a whole.

In sum, any econometric model of teacher supply and demand, and hence any model-based index, would be subject to attack on the grounds that variables have been omitted, factors have been mismeasured or misclassified, causal relationships have been misrepresented, or interactions among variables have been neglected. A critic or an aggrieved states will usually be able to devise an alternative model that yields different estimates of interstate cost differentials. It is not always possible to demonstrate conclusively the superiority of one set of model specifications over another. Thus the impression may be created, rightly or wrongly, of a certain element of arbitrariness in assigning COE index scores to states, and the political acceptability of model-based indices may be undercut. The counterarguments are obvious: an imperfect index is far better than none, and simple cost proxies are at least as arbitrary as indices based on models. But these points must be made forcefully to prevail when the unavoidable limitations of model-based indices are exposed.

METHODS BASED ON SIMPLE INDICATORS AND PROXIES

In sharp contrast to the complexity of indices based on models of supply and demand, the cost indices and proxies that can be constructed today, with data already in hand, are very simple. The most frequently proposed "instant" cost indicator of cost differentials among states is nothing more than an index of actual state-average teacher salary. Other frequently mentioned cost proxies include indices of the salary paid to each state's starting teachers, indicators of general wage levels or earnings in the states, and estimates of relative state costs of living. None of these ready-made indicators qualifies as an acceptable COE index. Each deviates substantially and systematically from being a valid measure of the cost of education. The available options are not limited, however, only to using such indicators unaltered or rejecting them. The possibility also exists of adjusting and augmenting the simple indicators in ways intended to counter their more glaring defects. In the following discussion, I explore this possibility. I consider in turn four types of indicators and possible adjustments of them: (1) indices of average teacher salary, (2) indices of the salaries of teachers with specified qualifications, (3) indices of wages outside teaching, and (4) indices of state cost of living. Empirical findings concerning some of the same indicators are presented in Chapter 4.

Indices of Average Teacher Salary

An index of state-average teacher salary is probably the most frequently proposed proxy not only for the price of teachers and other professional staff but also for the cost of education as a whole. The rationale for focusing on teacher salaries is, of course, that teacher costs (along with the presumably more or less proportionate costs of other professional staff) account for the bulk of education outlays; consequently, variations in the cost of teachers are likely to be roughly proportional to variations in the cost of educational resources in general. Indices of average salary have the practical advantages that data on average teacher salary by state are readily available and relatively timely; the indices can be constructed almost instantly; and the results are easily communicated to, and comprehended by, nontechnical audiences. In addition, they have a certain surface validity as measures of teacher prices, at least to those unfamiliar with, or inclined to minimize, their conceptual flaws.

Shortcomings of Unadjusted Average Salary Indices. What exactly are the conceptual problems, and what kinds of errors in measuring the cost of education are likely to proceed from them? I summarize the main difficulties very briefly, because most have already been discussed in Chapter 2:

First, because teacher salary schedules in the United States generally are based on experience and training, interstate differences in average teacher salary reflect cross-state differences in average experience and training as well as differences in the salaries of teachers with fixed qualifications. It follows that an index of average teacher salary will tend to understate the cost of teachers in states whose teachers are relatively young or relatively less educated and to overstate the cost of teachers in states with older-than-average or more-educated-than-average teaching forces.

Second, an index of average teacher salary takes no account of differences in other teacher attributes (beyond experience and training) that may be reflected in salaries. For instance, if a state pays above-average salaries to attract teachers who have attended better postsecondary institutions, the superior educations of the state's teachers will not be reflected in the index. Instead, the index will merely show that the state's average salary is relatively high, incorrectly implying a higher cost for equivalent teachers.

Third, an average salary index necessarily reflects not only the salary differentials attributable to cost factors outside state control but also the differentials resulting from state decisions about such matters as certification standards and collective bargaining. A valid cost-of-education index, as explained earlier, would not be influenced by such policies. To the extent that interstate variations in average teacher salary are due to the states' own choices, an average salary index deviates from being a valid cost proxy.

Fourth, it is likely that state-average teacher salaries reflect, in part, interstate differences in conditions of teaching, including class size, teacher work load, the availability of support staff and other resources, and security conditions in the schools. All such conditions are determined at least partly by state and local policies. The economic theory of labor supply implies that states offering poorer conditions will have to pay higher salaries, other things being equal, to attract comparable teachers. Therefore, the lack of any adjustment for unequal conditions is another source of error in the average salary index.

Fifth, the average salary level in a state may depend, in part, on the number of teachers the state chooses to employ, because the salary required to attract a given caliber of teacher may increase with the number of teachers demanded. In principle, a salary index should measure the relative costs in different states of employing comparable numbers of teachers as well as teachers with comparable attributes, but a simple average salary index makes no adjustment for quantity differentials.

In sum, in addition to the distortions arising from interstate variations in experience and training, an index of state-average teacher salary will be systematically skewed in relation to a number of other factors. The index values will be too high for states that have, for example, (a) teachers abundantly endowed with attributes valued by school systems, (b) collective bargaining rules favorable to teachers' unions, (c) rigorous requirements for teacher certification, and (d) large classes or otherwise unattractive working conditions in their schools. Anyone who uses an unadjusted teacher salary index to represent the cost of education would, in effect, be ignoring the influences of these and many other factors on the salaries of teachers in different states.

Adjustments for Differences in Experience and Training. It has now become feasible to correct statistically for the first of the problems mentioned above--the fact that average levels of teacher experience and training vary among the states. Such adjustments were precluded until recently by the absence of state-level data on these key teacher attributes, but the SASS data base not only allows state-average experience and training (degree level) to be measured but also supports statistical adjustment procedures based on thousands of individual-teacher observations. Specifically, we can estimate what the average salary of teachers would be in each state if the state's teachers had the same levels of experience and training, on average, as teachers in the nation. We can then use the resulting estimates, rather than the actual, unadjusted state-average salaries, to calculate the teacher salary index. A brief description of the statistical adjustment procedure is provided here; the technical details and empirical results are presented in Chapter 4.

To make the desired adjustments, one must estimate the salary differentials associated with increments in teacher experience and teacher training. Such estimates can be obtained from a regression equation in which the dependent variable is salary and the independent variables are experience and training. The equation can be estimated from the SASS data on salaries and characteristics of thousands of individual teachers. Two different statistical methods--one designated the national regression method; the other, the state regression method--can be implemented using the same data.

According to the national regression method, a regression equation relating salary to experience and training (degree level) is fitted to data on the full SASS national sample of teachers.[10] Using this equation, one can estimate what the national-average teacher salary would be if teachers in the nation had the same characteristics as teachers in a particular state. The ratio of this hypothetical, statistically estimated national salary to the actual national average salary indicates the amount by which a state's average teacher salary deviates from the national-average teacher salary because of differences between the state's experience and training levels and the corresponding national means. As such, it provides the adjustment factor needed to convert each state's actual average teacher salary into the teacher salary that would exist if the state's teachers had national average characteristics.

According to the state regression method, separate regression equations relating salary to experience and training are fitted to SASS data on subsamples of teachers from each state. These equations are used to estimate the hypothetical average salaries that would have prevailed in each state if the state had a national-average level of teacher experience and a national-average percentage of teachers with higher degrees. The resulting estimates can be used directly to construct the desired adjusted salary index; the only remaining step is to compute the ratio of the estimated hypothetical salary for each state to the actual average teacher's salary in the nation.

The conceptual difference between the two methods is that one reflects national-average valuations, while the other reflects state-specific valuations, of increments in teacher experience and training. An important statistical difference is that the sample size is much smaller for each state-specific regression equation than for the national equation, which means that the standard errors of the state regression coefficients are correspondingly larger. Therefore, the choice between the two methods involves a trade-off: the advantage of state-specific information from the state regression approach versus more accurate estimates from the national regression approach.

Possible Adjustments for Other Factors. Although only the adjustments for experience and training are demonstrated in this report, adjustments for other factors may also be feasible or may become feasible in the future. Although experience and training are generally the only teacher characteristics taken into account explicitly in teacher salary schedules, other individual characteristics may also be systematically related to interstate salary differentials. For example, if school districts value university graduates more highly than graduates of, say, teacher training colleges, states with larger percentages of university graduates in their teaching forces are likely, other things being equal, to pay higher average salaries. The type of institution that a teacher has attended is, in fact, a variable that potentially could be analyzed with the SASS data. One of the items in the SASS teacher questionnaire is "name of the college or university where you earned your bachelor's degree." Properly coded and classified, this item would yield a variable that could be included, along with experience and training, in a regression equation for teacher salary. Additional teacher characteristics that could also be represented with the SASS data and brought into the same type of regression analysis are age, sex, major field of study, assignment or field of teaching specialization, and type and field of certification. Unfortunately, the SASS data base does not permit adjustments for any direct indicator of teacher proficiency or quality, such as verbal ability or score on the National Teacher Examination (NTE). The lack of any standardization across states with respect to a method of measuring ability or a requirement to take the NTE rules out the inclusion of such variables in any interstate analysis of salary variations.

The possibility could also be explored of adjusting state-average salaries for some of the state-level or district-level policy variables that should not be allowed, in theory, to influence a teacher salary index. Among the factors for which adjustments conceivably could be made are such things as whether the state authorizes collective bargaining by teachers, whether the state requires teachers to pass an examination to be certified, and whether the state or district requires prospective teachers to have five years of postsecondary schooling (or a master's degree) rather than just baccalaureate-level training. However, there is a substantial risk that the attempt to adjust statistically for such variables could yield spurious results.

To illustrate the risk, consider an adjustment to take into account the presence of state laws authorizing collective bargaining. This adjustment might seem accomplishable by including in the previously described individual-teacher regression equation a dummy variable indicating whether a teacher is in a state with such a law. But the problem is that state policies regarding collective bargaining are likely to be associated with other state characteristics that also affect teachers' salaries. For example, states with collective bargaining laws favorable to teachers are likely also to be industrialized states with relatively high incomes and high wages in occupations other than teaching. Consequently, the collective bargaining variable in the regression equation may represent the effects of these other state characteristics on teacher salary, not just the effects of the collective bargaining law itself. The result would be an exaggerated estimate of the effect of the collective bargaining provision. In general, it may not be feasible to adjust statistically for a particular state or district factor in isolation. Instead, such adjustments may have to be made in the context of a broader statistical analysis that takes an array of state and local characteristics into account. Such an analysis would belong, of course, to the previously discussed realm of econometric supply-demand modeling.

Indices of the Salaries of Teachers with Specified Experience and Training

An alternative to adjusting an average salary index for differences in experience and training is to shift to an index of the salary paid to teachers with specified standard qualifications. The most commonly mentioned index of this type is an index of *starting salary*--that is, the salary paid to teachers with a bachelor's degree and no teaching experience. However, indices might also be constructed, data permitting, of the salaries paid to teachers with other standard experience and training combinations, such as a bachelor's degrees and 10 years of experience or a master's degrees and 15 years of experience. Because the average experience of teachers in the United States is now about 15 years, an index of the salaries paid by different states to teachers in that age bracket would probably be a more valid indicator of interstate cost differentials than would an index of salaries of teachers just starting their careers.[11]

Before the SASS data became available, the only state-by-state data on salaries associated with standard teacher qualifications were data on the salaries of starting teachers compiled by the American Federation of Teachers (AFT). It is not clear exactly how these

AFT figures are produced or whether "starting salary" is defined uniformly across the states.[12] Now, the SASS LEA-level surveys for both 1987-88 and 1990-91 provide data on scheduled salaries corresponding to three experience-training combinations: bachelor's degree and zero experience (starting salary), master's degree and zero experience, and master's degree and 20 years of experience. Currently, these are the only combinations of teacher qualifications (and the only years) for which interstate comparisons can be made. A possibility for the future is to expand the relevant SASS survey items to cover scheduled salaries for teachers with bachelor's and master's degrees at other points along the experience scale (e.g., 5, 10, 15, and 30 years). This expansion not only would allow comparisons of salaries paid to more typical teachers but also would open up the possibility (discussed below) of constructing a composite, weighted index of the relative salaries paid to teachers with multiple experience-training combinations.

An index of salaries of teachers with standard qualifications has the advantage of being unaffected by interstate variations in average teacher experience and training, which means that no statistical adjustments for such variations are required. However, the value of this advantage is limited in two respects. First, such an index still shares all the other shortcomings of an index of average teacher salary, including the failure to take account of variations in other teacher characteristics, in working conditions, and in pertinent state and local policies. Second, an additional difficulty arises from the fact that the salary differentials associated with increments in teacher experience and training vary among the states. Such variability undercuts a key assumption implicit in using the salaries of standard teachers to represent the salaries of all teachers--namely, that salaries of teachers in general vary among states more or less proportionately to the salaries of teachers with the specified standard qualifications. For example, an index of starting salary would be adequate to represent salaries in general only if the ratio to starting salary of the salary paid to experienced teachers were roughly constant across the states. But in fact, this ratio varies substantially. As is shown in Chapter 4, some states' salary-versus-experience curves are considerably steeper than others. It follows that a single standard salary cannot represent all salaries adequately; rather, the shape of each state's salary curve needs to be taken into account.

One way to deal with interstate variability in the shapes of the salary-versus-experience and salary-versus-training curves is to construct a composite index of the salaries paid to teachers with multiple experience and training combinations. To illustrate with a highly simplified example, suppose that there were only three pay classifications of teachers: starting teachers (0-3 years experience), teachers with moderate experience (4-15 years), and teachers with extensive experience (15+ years). Suppose further that in the nation as a whole, the percentages of teachers in these three categories were 15 percent, 35 percent, and 50 percent, respectively. A composite salary index would take the form of a weighted sum of relative salaries in the three categories, with weights corresponding to the aforesaid percentages. Thus, if a particular state paid its starting teachers poorly (say, 70 percent of the U.S. average), its moderately experienced teachers somewhat better (85 percent of the U.S. average), and its highly experienced teachers relatively well (100 percent of the U.S. average), the value of the composite index for the state would be (.15 x 70) + (.35 x 85) + (.50 x 100), or 90.3, relative to a national average of 100. This result signifies that the state's average salary would be 90.3 percent of the national-average salary *if* the state maintained a national-average mix of teachers (the 15-35-50 distribution cited earlier). It is a hypothetical figure corresponding to a standard, national-average distribution of teacher experience rather than a measure of the state's actual average teacher salary.

A weighted, composite teacher salary index of the type just described has actually been developed in Canada as part of an effort to compare trends in the cost of education across provinces (Statistics Canada, 1985). The data needed to calculate the index are collected either from each province or from samples of local districts within each province, depending on whether salaries in the province are determined at the provincial or local level. These data include both the salary associated with each experience-training combination (i.e., the complete salary schedule of the district or province) and the numbers of teachers who have each combination of experience and training. A weighted average teacher salary is calculated for each district (if necessary) and for each province. The weights are the provincial-average percentages of teachers with the various experience-training combinations. The resulting teacher salary indices are then combined with indices of prices of other resources to produce an overall cost-of-education indicator. Although this Canadian index was designed only to measure trends in the cost of education in each province, the same data, weighted differently, could also have been used to compare salary and cost differentials cross-sectionally. Thus a variant of the Canadian method could be used to measure salary variations across our states.

It is not feasible to construct a Canadian-type composite index right now for the U.S., because we lack the necessary detailed information on teacher salary schedules. As explained earlier, SASS provides data for only three experience-training combinations, and no other source of data on scheduled salaries by state is available. One way to fill this data gap would be to request additional salary data in the SASS LEA survey--for instance, salaries paid to teachers with bachelor's and master's degrees and with 0, 5, 10, 15, 20 (and so forth) years of experience. There is no need to collect salary data corresponding to every single-year increment in experience; data for five-year increments should suffice to represent the shape of the salary scale in each state. Alternatively, one could collect the actual salary schedules of sample districts in each state and extract from them the salaries paid to teachers with selected experience-training combinations. Either approach would allow us to estimate what the average salary in each state would be if the state had a national-average distribution of teacher experience and training.

Indices of Wages Outside Teaching

Recognizing that variations in teacher salaries across states reflect variations in teacher characteristics, working conditions, and education policies, some analysts have proposed that we rely on indices of prices or wages outside education to represent relative teacher costs. Specifically, it has been suggested that an indicator of private-sector wages--either an index of private wages in general or, preferably, an index of private wages in professional occupations comparable to teaching--could be used as a proxy for the cost of teachers and other educators in each state. The argument that wages outside teaching could represent the price of teachers rests implicitly on a theory of intersector competition for labor and intersector wage equilibration. The theory is simply that the school systems in each state must compete for personnel, including teachers, against employers in other economic sectors. If wages outside teaching are relatively high in a state, then wages in teaching must also be set relatively high to prevent current and potential teachers from being attracted to other lines of work. Thus to the extent that the general wage level varies across states, the salaries that school systems must offer to attract teachers (with given characteristics) should vary correspondingly.

A supporting argument for relying on an index of private-sector wages is that such wages are not influenced by, or are less influenced by, the kinds of state policy variables that are responsible for some of the observed interstate variation in teachers' pay. For instance, private sector wages are presumably not affected by working conditions in the schools, the level of demand for teachers, certification standards, or the rules governing collective bargaining by teacher unions. Therefore, a private sector wage index may be free of some of the influences that cause direct comparisons of teacher salaries to be misleading.

Of course, there are counterarguments. Just as the validity of teacher salary comparisons is diminished by interstate variations in teacher characteristics, comparisons of private sector wages may be distorted by differences in the age, experience, education, and skill composition of different states' private labor forces. Also, differences in the industrial composition of different state economies, as between lower-paying and higher-paying industries, detract from the validity of interstate wage comparisons. Moreover, although private wages may be unaffected by state education policies, they are influenced by differences in state labor laws pertaining to workers in the private sector. In fact, policies affecting the two sectors are likely to be correlated: A state with collective bargaining laws favorable to industrial workers is likely to have collective bargaining laws favorable to teachers as well. To the extent that state labor policies differ, a private wage index will not reflect the wages that would be earned by standard workers, under standard policy regimes, in different states. Consequently, even if the basic theory of intersectoral wage equilibration is correct, the failure to observe comparable private sector wages could distort the education cost comparisons.

Assuming that a private wage index were to be used, which categories of private wages should be included? A comprehensive index (one covering all types of private-sector employees) would reflect the salaries of many types of workers whose jobs and wages bear little relationship to jobs and wages in public elementary and secondary education--for example, production workers in manufacturing, laborers, transport workers, low-level sales and service workers, and the like. In principle, a narrower, occupationally selective wage measure seems preferable--one limited, for example, to workers in the professional, technical, managerial, or, more broadly, white collar fields to whom teachers and other education personnel can reasonably be compared. But unfortunately, using wages in other white-collar occupations is not a current option. The Bureau of Labor Statistics (BLS) does provide state-level wage data broken down by industry (see, e.g., BLS, 1990), but breakdowns by occupation, or even by broad occupational category, are not available. One can construct a wage index for, say, workers in service industries but not for workers in the job categories against which teachers are most appropriately compared. The lack of occupationally specific wage data by state diminishes the attractiveness of the private-wage alternative.

On the other hand, a private-wage proxy for teacher salary would become more attractive if there were a way of correcting for interstate differences in the makeup of the private-sector work force. It would be desirable, for example, to adjust for differences in the age, gender, and educational attainment compositions of different states' work forces. Rafuse (1990) has recently demonstrated a method of making such adjustments. Using data on individual earnings from the 1980 Census, he constructs a state-level earnings index, in which earnings are disaggregated by level of educational attainment and then averaged according to a weighting procedure that compensates for interstate differences in the distribution of workers across the different attainment categories. Although Rafuse does this for only one age-gender stratum (males ages 45-54), the weighting method can be extended to adjust for interstate differences in age and gender distributions as well. One could determine, using 1990 Census data, how substantially interstate earnings comparisons are changed by adjustments for age, gender, and educational attainment. Then, if the changes prove to be substantial, adjustments based on the Census data could be made to any interstate index of private-sector wages.

Cost of Living as a Proxy for Cost of Education

Another suggested proxy for a cost of education index is an index of the general cost of living (COL) in each state. The rationale for using a COL index is that teacher salaries must vary more or less in proportion to the cost-of-living to attract equivalent teachers to different parts of the country. Expressing essentially the same thought more rigorously, if there is some mobility of teachers (or even of other classes of workers) across state lines, there should be a tendency toward interstate equalization of real teacher salary (nominal salary deflated by the cost of living). Such equalization implies that salaries will tend to vary among states, other things being equal, in proportion to the general price level; hence, a COL index would serve as an indirect indicator of relative teacher salaries.

The appropriateness of using COL as a proxy for COE has been criticized on the grounds that a cost-of-living index, or general price index, represents the prices of a market basket of goods and services very different from the mix of resources purchased by school systems; however, this criticism, though accurate, is somewhat off the point. The issue is not whether the consumer market basket resembles the education market basket--which it clearly does not--but rather whether labor-market forces are likely to cause the salaries of teachers and other educators to vary among states approximately in proportion to the cost of living.

Certainly, proportionality cannot be taken for granted. The cost of living is only one--albeit an important one--of the many factors that determine the relative attractiveness of teaching, and hence the supply price of teachers, in different states. Even if the cost of living were nationally uniform, interstate differences in other amenities and disamenities, in the nature of the teaching job, and in labor market conditions within and outside the education sector would still translate into differences in the salary levels required to attract equivalent teachers. To the extent that these other factors vary and affect salaries, the assumption of proportionality of COE to COL will be violated. What remains unknown (and unknowable until good teacher salary models are developed) is whether the deviations from proportionality are major or minor. If they turn out to be minor, then a COL index, conceptual flaws notwithstanding, could turn out to be an acceptable COE proxy.

Aside from the conceptual issues, the main practical obstacle to using a COL index to represent the cost of education is that no state COL index exists that has been constructed in the normal manner from state-level data on prices of goods and services. The Bureau of Labor Statistics (BLS), which prepares the national consumer price index (CPI), does not collect consumer price data or produce price indices by state. For many years, the lack of such indices has impeded not only interstate comparisons in education but also work in public finance and regional economics in general. A few analysts have attempted to fill the void by using cost data for entities other than states (namely, regions, metropolitan areas, and cities) to estimate interstate cost differentials. The resulting artificially synthesized COL indices are the only ones now available--or likely to be available in the foreseeable future--to use as proxies for the cost of education.

The most elaborate set of state COL estimates developed thus far are those produced by Nelson (1991) for the American Federation of Teachers. To put the AFT index in perspective, however, it is worth mentioning some of its methodological precursors. Among the early efforts, Barro (1975) and Grasberger (1980) constructed crude state COL indices by extrapolating to states the then-available Bureau of Labor Statistics (BLS) cost-of-living figures (family budget estimates) for selected metropolitan areas, but because these extrapolations depended on arbitrary assumptions about similarities between metropolitan area costs and state costs, the results were useful only for illustrative purposes. McMahon and Melton (1978) attempted an econometric transformation of the same BLS metropolitan area cost figures into a state COL index. They first fitted regression equations relating COL variations among metropolitan areas to such economic factors as income, housing prices, and population change and then used the resulting equations to estimate the cost of living in each state. The McMahon-Melton approach was subsequently extended by Fournier and Rasmussen (1986), who used 1980 Census data to construct a more elaborate model. Later, after BLS had ceased publishing its family budget data for metropolitan areas, McMahon (1988) and McMahon and Chang (1991) demonstrated extrapolation techniques for updating these regression-based state COL indices.

The AFT's main purpose in developing a state COL index was not to measure the cost of education but rather to provide a means of translating different states' teacher salaries into units of equivalent real purchasing power. The AFT approach (Nelson, 1991) relies on a nongovernmental source of data, namely, a consumer price index for over 200 metropolitan areas constructed by the American Chamber of Commerce Researchers Association (ACCRA). This index is derived from data on prices of selected consumer goods collected by ACCRA's local affiliates (ACCRA, 1988). The AFT methodology is an extension of the McMahon-Melton approach. It involves (1) developing regression equations (one equation for each of four regions) that relate inter-metropolitan variations in the ACCRA consumer price index to differences in per capita income, housing prices, population density, and population growth, and then (2) using these equations, in conjunction with state-level data on the same variables, to estimate the value of the cost-of-living index for each state. The resulting index is presented and compared with other indices in Chapter 4.

In addition to the general conceptual objections to using a COL index to represent education costs, there are reasons to question the validity of the AFT's econometrically synthesized COL indicator. Both the data underlying the index and the statistical methodology raise concerns. The ACCRA metropolitan area price data are collected by local Chamber of Commerce volunteers, supposedly according to standard ACCRA specifications, but apparently not in a manner that ensures strict comparability of data across places. The coverage of the ACCRA city sample is geographically uneven, with relatively extensive coverage of the South and much thinner coverage of the Northeast. Questions arise concerning the selection of goods to be priced, especially in the key area of housing, where the emphasis is on prices of relatively up-scale homes. The econometric model is an ad hoc formulation, the specifications of which depend strongly (of necessity) on which data items happen to be available for metropolitan areas and states. The explanatory power of the model is low for two of the four regions (South and North Central) for which regressions are fitted. All these points raise doubts about how accurately state costs of living have been estimated. Certainly, the procedure leaves room for substantial errors in the index values of particular states.

General Assessment

None of the immediately available simple proxies for a cost-of-education index stands on firm ground conceptually, and some are technically suspect as well. The issue at hand, however, is not whether such indices approach perfection but whether, in the absence of better measures, using one or another of them would be better than having no COE index at all. From that perspective, I offer these assessments of the alternative measures:

Because an unadjusted teacher salary index deviates systematically from being a valid measure of the price of teachers, incorporating it in its raw form into a COE index would not be desirable. Although using such an index to adjust the states' per pupil spending figures might be better than making no adjustment at all, the remaining distortions would be substantial. Adjusting the average teacher salary figures for differences in experience and training among the states would eliminate one major source of error. The adjusted index, demonstrated in this report, is certainly superior to an unadjusted salary index. Additional adjustments, some feasible now and some requiring additional data, would enhance the credibility of the index.

Although the currently available indices of starting salary and salaries of teachers with a master's degree and zero or 20 years of experience are not satisfactory proxies for a COE index, a composite index of the salaries of teachers with multiple, appropriately selected experience-training combinations would be a serious contender. Such an index would be preferable technically to the index of average teacher salary adjusted for experience and training, because it could take better account of the varying salary premiums associated with experience and training increments in different states. The coverage of salary items in SASS would have to be expanded substantially, however, to support construction of such an index.

Unadjusted indices of private-sector wages should not be used as proxies for education costs, because the interstate variations in such indices reflect many factors other than differences in the price of labor. However, a wage index adjusted for differences in the age, gender, and educational attainment mixes of different states' work forces would be more acceptable, especially if it could be based on wages in appropriately selected sectors or occupations. (Even if such an index were not the best for representing the cost of teachers, it would be useful for representing the nonprofessional staff component of education cost.)

Using the AFT's econometrically synthesized cost-of-living indicator as a COE proxy seems unwarranted, both because the relationship between COE and COL has yet to be explored empirically and because the validity of the AFT methodology and the underlying ACCRA data is in doubt. Further development of the COL index would be highly desirable, however, not so much because an improved COL index would be the best choice to represent the cost of education but because COL figures are needed to model teacher supply and demand properly.

NOTES

1. This discussion of COE indices based on teacher supply and demand models draws heavily on an earlier review of the literature on education price indices (Barro, 1981).

2. As explained in Chapter 2, the tax price is the price to an average resident or taxpayer of a state or school district of a unit increment in the resource in question. It reflects not only the price per unit of the resource but also other factors that affect the share of the cost borne by a typical resident or taxpayer. These include the pupil-population ratio and, where applicable, the rates at which state or local outlays are subsidized with outside financial aid.

3. An unusual and useful feature of Loatman's model is that he measures the salary premium paid for experience in terms of present value: specifically, he defines this premium as the increase in the present value of the stream of salaries paid to a teacher over a 20-year period attributable to the inclusion of rewards for experience in the local salary schedule, as compared with what the present value would be if the district had a flat salary scale.

4. Some analysts use other estimation methods, such as two-stage least-squares (2SLS) to allow for the endogeneity of certain influences on salary. For instance, although Kenny, Denslow, and Goffman (1975) did not produce a simultaneous-equation supply-demand model, they did use 2SLS to allow for the fact that class size, while an influence on salary, is itself determined by other variables in the model.

5. As shown in Barro (1981), extremely strong assumptions about equilibrium and competitiveness in the labor market, worker mobility, and similarity of preferences between teachers and other workers have to be made to justify the exclusion of opportunity wages from the model.

6. Chambers acknowledges in some of his theoretical work (e.g., Chambers, 1979) that pupil attributes may be legitimate price factors, but no such factors appear in his California COE study (1980), so it is unclear what his final position is on this issue.

7. The teacher supply-demand model in Rosenthal, Moskowitz, and Barro (1981) is fitted to five-years worth of data on the 24 districts of Maryland. Note, however, that it is possible, in working with data for a particular state, to deflate the dollars of different years by applying a statewide COL index, whereas the same procedure would not be feasible in a national model because an interstate COL index, which does not exist, would be required.

8. Note, however, that the experience-training combinations for which salary data are now provided in SASS are both too few and not optimally chosen for the purpose of salary modeling.

9. The CCD files provide district-level enrollment data; the Census Bureau finance data base provides information on education expenditure and certain of its components; and the 1990 Census district-mapped files will provide data on per capita income, housing prices, and many demographic characteristics of districts.

10. The sample was trimmed down for the purpose of the regression analysis by deleting part-time teachers, preschool teachers, teachers whose reported salaries were deemed unreasonable (e.g., below known state or district minimums), and teachers for whom data on the pertinent variables

were missing. The number of teachers remaining in the national sample after editing was nearly 35,000.

11. There was almost an equal division in 1987-88 between teachers with a bachelor's degree or less and teachers with a master's degree or more, so neither level of training can be said to be "typical." This is one reason why a composite index reflecting the salaries of teachers with multiple sets of standard qualifications may be necessary (as is discussed below).

12. The AFT data are published annually (see, e.g., Nelson, 1989). The salary data, including starting salaries, are obtained from state education agencies, but it is not clear how such agencies interpret, or respond to, the request to report the "average beginning teacher salary." For instance, states might conceivably report the average of the salaries paid to all individual beginning teachers in the state or the average across districts (unweighted or weighted) of the salaries actually paid to new teachers or the starting salaries in local district salary schedules. Also, they might include only the salaries of teachers with minimal qualifications (bachelor's degree and no experience) or the salaries of all newly hired teachers, regardless of their initial qualifications or their starting points on the local salary schedule.

4. DEMONSTRATION AND ASSESSMENT OF SIMPLE COST INDICES AND PROXIES

In contrast to the two preceding chapters, which focus on theory and methodology, this chapter examines some empirical results: What is the relative cost of education in each state according to different indices? How similar to one another are indices created from different data or by different methods? What would be the effects of calculating cost-adjusted per pupil expenditure according to one index or another?

Ideally, one would want to analyze and compare the results produced by a broad range of index construction methods, but only a much more limited assessment is now feasible. The model-based state COE indices described in Chapter 3 do not yet exist. Although teacher supply and demand models have been used in the past to compare costs among local school districts, analogous state models have not been developed. Indeed, the data needed to construct such models (mainly data from SASS) have only recently become available. Consequently, the only indices that can be examined now belong to the family of simple indicators and proxies. Moreover, even within this less sophisticated family, only a few approaches to index development have actually been pursued empirically. As explained earlier, the release of the SASS data has made it possible to demonstrate the effects of adjusting an index of average teacher salary for interstate differences in average teacher experience and training, but adjustments for other teacher characteristics have not yet been attempted. Some must await data from other sources. For the time being, only a few indices--mostly of the ready-made, or off-the-shelf, variety--are available for evaluation.

In this chapter, I compare and evaluate the following simple state-level indices and examine the implications of using them to compare levels or real, or cost-adjusted, per-pupil expenditure across states:

- Indices of average teacher salary,
- Indices of the salaries of starting teachers and teachers with other specified combinations of experience and training,
- Indices of average teacher salary adjusted for interstate differences in average experience and training,
- Indices of private sector wages,
- The AFT's econometrically synthesized index of state cost of living,
- The index of per-pupil education expenditure used as a cost proxy in the formula for distributing federal Chapter 1 grants, and
- An illustrative composite index, combining the adjusted index of average teacher salary and a private sector wage index.

I also consider, because of its immediate policy relevance, an indicator that does not qualify, strictly speaking, as a cost-of-education index but is used as such for the purpose of allocating federal education aid--namely, the per-pupil expenditure factor found in the formula for distributing federal Chapter 1 grants for education of disadvantaged children.

The discussion of each index includes (1) an explanation of data sources and index construction methods, (2) a summary of the statistical properties of the index and the pattern of variations in index values among the states, (3) comparisons of alternative versions of the index (where applicable), and (4) comparisons with indices of other types. A final section shows how interstate comparisons of per-pupil expenditure would be affected by choosing selected indices to translate nominal dollar outlays into cost-adjusted figures.

INDICES OF AVERAGE TEACHER SALARY

Conceptual problems notwithstanding, the simplicity and ready availability of indices of average teacher salary--not to mention the lack of attractive alternatives--has led many analysts at least to consider using them to represent the cost of education. Table 4-1 presents three such indices, each based on a different set of state-level teacher salary data for 1987-88: (1) estimates of state-average salaries published by the National Education Association (NEA), (2) state averages of the salaries reported by individual teachers in the public school teacher questionnaire of the NCES Schools and Staffing Survey (SASS), and (3) state averages of average teacher salaries reported by local school districts in the SASS survey of LEAs. The NEA data (and similar data compiled by AFT) have been produced annually for many years, but the SASS data have been released only for 1987-88 and 1990-91.[1] The first three columns of Table 4-1 present the salary figures themselves; the last three columns present the corresponding salary indices. The latter are expressed as ratios of state-average salaries to U.S.-average salary. Therefore, a state with the same average salary as the nation has an index value of 1.00, and states paying higher or lower average salaries than the nation have index values greater than 1.00 and less than 1.00, respectively.

The statistical properties of these average-salary indices are of interest both in their own right and as benchmarks against which to compare alternative cost measures. Several basic indicators of interstate disparity in the index values are shown in Table 4-2. As can be seen, the range of variation in average salary among states is about 1.7 or 1.8 to 1 according to all three salary measures (excluding Alaska), or from about 30 percent below the national average to 23 percent above it. Consequently, if such an index were used as a cost adjustor, the effect would be to deflate the per-pupil expenditures of the highest-salary states by about 19 percent (the result of dividing by 1.23) and to inflate the per-pupil spending figures for the lowest-salary states by about 43 percent (the result of dividing by 0.70). The unweighted coefficients of variation in average salary among the states are about .16 or .17 according to

Table 4-1

Indices of Average Teacher Salary, 1987-88

	Average Teacher Salary			Average Salary Indices		
	NEA	SASS Teacher Data	SASS LEA Data	NEA	SASS Teacher Data	SASS LEA Data
	(1)	(2)	(3)	(4)	(5)	(6)
United States	28,008	27,242	27,248	1.00	1.00	1.00
Alabama	23,320	23,155	23,076	0.83	0.85	0.85
Alaska	40,424	42,087	41,302	1.44	1.54	1.52
Arizona	27,388	26,878	27,151	0.98	0.99	1.00
Arkansas	20,340	19,672	20,368	0.73	0.72	0.75
California	33,159	33,564	32,987	1.18	1.23	1.21
Colorado	28,651	27,218	27,647	1.02	1.00	1.01
Connecticut	33,487	32,880	31,512	1.20	1.21	1.16
Delaware	29,573	28,494	27,343	1.06	1.05	1.00
Dist. of Col.	34,705	33,370	(a)	1.24	1.22	(a)
Florida	25,198	25,195	25,721	0.90	0.92	0.94
Georgia	26,190	25,325	25,810	0.94	0.93	0.95
Hawaii	28,785	26,869	28,785	1.03	0.99	1.06
Idaho	22,242	21,772	21,950	0.79	0.80	0.81
Illinois	29,663	28,077	28,861	1.06	1.03	1.06
Indiana	26,881	26,950	26,355	0.96	0.99	0.97
Iowa	24,847	23,110	23,632	0.89	0.85	0.87
Kansas	24,647	23,627	24,814	0.88	0.87	0.91
Kentucky	24,253	23,560	23,852	0.87	0.86	0.88
Louisiana	21,209	20,183	19,798	0.76	0.74	0.73
Maine	23,425	23,334	23,933	0.84	0.86	0.88
Maryland	30,933	29,109	29,060	1.10	1.07	1.07
Massachusetts	30,295	29,120	27,671	1.08	1.07	1.02
Michigan	32,926	32,730	31,432	1.18	1.20	1.15
Minnesota	29,900	29,252	29,027	1.07	1.07	1.07
Mississippi	20,562	20,042	20,085	0.73	0.74	0.74
Missouri	24,709	23,381	24,405	0.88	0.86	0.90
Montana	23,798	23,002	23,270	0.85	0.84	0.85
Nebraska	22,683	21,933	22,342	0.81	0.81	0.82
Nevada	27,600	28,116	27,786	0.99	1.03	1.02
New Hampshire	24,019	24,446	24,234	0.86	0.90	0.89
New Jersey	30,720	30,977	30,266	1.10	1.14	1.11
New Mexico	24,158	23,768	24,055	0.86	0.87	0.88
New York	34,500	33,183	33,418	1.23	1.22	1.23
North Carolina	24,900	23,140	23,598	0.89	0.85	0.87
North Dakota	21,660	20,881	21,817	0.77	0.77	0.80
Ohio	27,606	27,324	26,874	0.99	1.00	0.99
Oklahoma	21,630	21,447	20,921	0.77	0.79	0.77
Oregon	28,060	26,456	26,318	1.00	0.97	0.97
Pennsylvania	29,177	28,866	28,885	1.04	1.06	1.06
Rhode Island	32,858	31,149	32,564	1.17	1.14	1.20
South Carolina	24,403	24,205	24,230	0.87	0.89	0.89
South Dakota	19,758	18,446	19,471	0.71	0.68	0.71
Tennessee	23,785	22,418	22,655	0.85	0.82	0.83
Texas	25,558	24,630	24,052	0.91	0.90	0.88
Utah	22,572	22,616	21,625	0.81	0.83	0.79
Vermont	24,519	23,972	24,601	0.88	0.88	0.90
Virginia	27,193	25,743	26,779	0.97	0.94	0.98
Washington	28,217	28,218	28,357	1.01	1.04	1.04
West Virginia	21,736	21,538	20,543	0.78	0.79	0.75
Wisconsin	29,122	27,161	27,706	1.04	1.00	1.02
Wyoming	27,134	26,864	27,703	0.97	0.99	1.02

(a) D.C. entry omitted because of apparent reporting error.

Table 4-2

Summary Statistics: Indices of Average Teacher Salary

Statistic	NEA	SASS: Teacher Data	SASS: LEA Data
Ratios: maximum/minimum[a]	1.76	1.82	1.72
maximum/mean[a]	1.24	1.23	1.23
minimum/mean	0.71	0.68	0.72
Coefficient of variation (unweighted)	.161	.167	.162
Coefficient of variation (weighted[b])	.141	.149	.143

[a]The maximum salary is for states other than Alaska.
[b]The weighting factor is the number of teachers in each state.

all three indices, indicating that the average salaries paid in about two-thirds of the states fall within 16 to 17 percent of the national-average salary. The weighted coefficients of variation in average salary (i.e., weighted by the number of teachers in each state) are about .14 to .15. The fact that the weighted coefficients are smaller than the unweighted coefficients indicates that smaller states tend to deviate more from the national-average salary than do larger states. Most comparisons in this chapter are based on the weighted statistics because they take state size into account and do not place undue emphasis on small-state outliers such as Alaska.

The states that rank highest according to the indices of average teacher salary include such northeastern states as Connecticut, New York, Rhode Island, Michigan, and the District of Columbia plus California and, of course, Alaska. The lowest-ranking states are mainly southern (Arkansas, Louisiana, Mississippi, Oklahoma, West Virginia) but also include the North and South Dakota, Idaho, and Utah. As one would expect, teacher salaries tend to be higher in higher-income parts of the country, but the correlation between salary and income is too weak for per capita income itself to serve as a proxy for relative salary or cost.

Although the three indices of average teacher salary are similar to one another, the differences among them are not negligible. The correlation between each pair of indices is in the 0.98 to 0.99 range (corresponding to R^2s of about 0.97). In most instances, the index scores of particular states vary by only 2 or 3 percentage points from one index to another, but in some cases the deviations are greater. To illustrate, a comparison between the index of NEA average salaries and the index of SASS individual-teacher salaries shows that individual state scores differ by 2 percentage points or less in 28 out of 51 cases, by less than 3 percentage points in an additional 12 cases, by less than 4 points in 6 more cases, by less than 5 in another 4 cases, and by more than 5 percentage points only for Alaska. Therefore, if an index of average teacher salary were used as a proxy for the cost of education, the choice of one salary indicator or another would make a relatively modest difference (3 percentage points or less) for 40 states but would be of somewhat greater consequence for the remainder.

INDICES OF SALARIES ASSOCIATED WITH SPECIFIC COMBINATIONS OF EXPERIENCE AND TRAINING

Table 4-3 presents four indices of the salaries paid in different states to teachers with specific levels of experience and training: two indices of starting salary, an index of the salary paid to teachers with a master's degrees and no experience, and an index of the salary paid to teachers with a master's degree and 20 years of experience. The first index of starting salary (in 1987-88) is based on data from an AFT survey of state education agencies (AFT, 1989). The other three indices are based on data from the 1987-88 SASS LEA-level questionnaire. Specifically, each LEA in the SASS sample was asked to respond to these questions:

Table 4-3

Indices of Salaries of Starting Teachers and Other Teachers with Specified Combinations of Experience and Training, 1987-88

	Starting Salary (AFT data)	Salaries: SASS LEA Data			Indices (U.S. = 1.00)			
					Starting Salary (AFT data)	Salaries: SASS LEA Data		
		Starting Teacher	Master's No Exper.	Master's +20 Years		Starting Teacher	Master's No Exper.	Master's +20 Years
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
United States	18.557	18,485	20,135	31,705	1.00	1.00	1.00	1.00
Alabama	18,200	17,942	20,509	24,367	0.98	0.97	1.02	0.77
Alaska	26,880	26,188	29,824	45,422	1.45	1.42	1.48	1.43
Arizona	19,300	19,531	21,429	30,688	1.04	1.06	1.06	0.97
Arkansas	15,996	15,928	17,147	22,716	0.86	0.86	0.85	0.72
California	21,900	21,682	23,151	37,356	1.18	1.17	1.15	1.18
Colorado	16,813	17,965	20,131	32,468	0.91	0.97	1.00	1.02
Connecticut	20,703	20,956	22,458	35,923	1.12	1.13	1.12	1.13
Delaware	19,100	18,005	20,578	33,644	1.03	0.97	1.02	1.06
Dist. of Col.	19,116	19,116	21,029	37,288	1.03	1.03	1.04	1.18
Florida	19,500	19,550	20,768	30,644	1.05	1.06	1.03	0.97
Georgia	19,400	19,212	21,962	30,166	1.05	1.04	1.09	0.95
Hawaii	18,698	17,607	18,707	35,740	1.01	0.95	0.93	1.13
Idaho	14,793	14,965	16,975	25,729	0.80	0.81	0.84	0.81
Illinois	17,804	17,539	19,384	32,975	0.96	0.95	0.96	1.04
Indiana	17,300	17,411	18,481	31,018	0.93	0.94	0.92	0.98
Iowa	18,721	16,702	17,791	26,568	1.01	0.90	0.88	0.84
Kansas	17,377	17,880	19,482	26,982	0.94	0.97	0.97	0.85
Kentucky	16,150	16,441	18,598	26,493	0.87	0.89	0.92	0.84
Louisiana	14,966	15,487	15,844	21,768	0.81	0.84	0.79	0.69
Maine	15,863	15,801	17,131	26,612	0.85	0.85	0.85	0.84
Maryland	19,478	19,954	21,589	33,320	1.05	1.08	1.07	1.05
Massachusetts	18,800	18,696	20,072	31,020	1.01	1.01	1.00	0.98
Michigan	20,100	19,140	20,774	35,606	1.08	1.04	1.03	1.12
Minnesota	19,625	19,385	21,775	33,766	1.06	1.05	1.08	1.07
Mississippi	16,600	16,569	17,488	22,562	0.89	0.90	0.87	0.71
Missouri	17,717	17,381	18,965	27,429	0.95	0.94	0.94	0.87
Montana	15,709	15,894	18,011	28,726	0.85	0.86	0.89	0.91
Nebraska	15,350	15,184	17,770	25,990	0.83	0.82	0.88	0.82
Nevada	18,523	17,879	20,875	30,238	1.00	0.97	1.04	0.95
New Hampshire	17,300	16,597	18,083	29,032	0.93	0.90	0.90	0.92
New Jersey	20,500	20,205	21,860	37,109	1.10	1.09	1.09	1.17
New Mexico	17,897	17,405	18,872	27,174	0.96	0.94	0.94	0.86
New York	20,650	20,187	22,682	38,199	1.11	1.09	1.13	1.20
North Carolina	17,600	17,871	19,617	29,946	0.95	0.97	0.97	0.94
North Dakota	15,218	15,064	17,138	26,050	0.82	0.81	0.85	0.82
Ohio	16,374	17,154	18,900	32,650	0.88	0.93	0.94	1.03
Oklahoma	16,432	16,058	17,202	24,731	0.89	0.87	0.85	0.78
Oregon	18,022	17,275	19,319	30,269	0.97	0.93	0.96	0.95
Pennsylvania	18,400	18,307	19,475	33,298	0.99	0.99	0.97	1.05
Rhode Island	17,302	17,848	19,237	34,627	0.93	0.97	0.96	1.09
South Carolina	17,609	17,660	20,233	29,413	0.95	0.96	1.00	0.93
South Dakota	15,020	14,426	15,736	23,714	0.81	0.78	0.78	0.75
Tennessee	16,970	16,884	18,509	25,633	0.91	0.91	0.92	0.81
Texas	18,800	18,147	18,545	29,805	1.01	0.98	0.92	0.94
Utah	15,266	15,446	17,134	28,333	0.82	0.84	0.85	0.89
Vermont	14,966	15,645	17,648	28,227	0.81	0.85	0.88	0.89
Virginia	18,439	19,787	21,403	33,288	0.99	1.07	1.06	1.05
Washington	17,905	17,045	20,107	30,838	0.96	0.92	1.00	0.97
West Virginia	15,055	15,359	17,126	24,560	0.81	0.83	0.85	0.77
Wisconsin	18,332	17,926	20,087	32,154	0.99	0.97	1.00	1.01
Wyoming	19,000	18,865	21,967	32,005	1.02	1.02	1.09	1.01

What is the normal yearly starting salary in your district for a teacher with a bachelor's degree and no previous teaching experience?

According to your salary schedule, what is the normal yearly contract salary for--

(a) a teacher with a master's degree (or its equivalent in credits beyond the bachelor's degree) and no previous teaching experience?

(b) a teacher with a master's degree (or its equivalent in credits) and 20 years of teaching experience?

The first column of Table 4-3 gives the average starting salary in each state, as reported by the AFT; the next three columns give state averages of the LEA-level salary figures in the SASS data files. These averages, which were computed specifically for this study by NCES, are weighted averages that reflect the sampling weight assigned to each LEA in the SASS survey. The last four columns of the table present indices corresponding to the four sets of salary figures. All index values are expressed relative to the corresponding average salary in the United States. Statistics of interstate variation in these four indices are summarized in Table 4-4.

Starting Salary

The indices of starting salary are less variable across states than the previously presented indices of average salary. The lowest and highest values of the AFT index of starting salary, for example, are 0.81 and 1.18 (excluding Alaska), as compared with a range from 0.71 to 1.24 according to the NEA average salary measure. The weighted coefficients of variation of the AFT and SASS indices of starting salary, .099 and .093, respectively, are considerably lower than the coefficients of .14 to .15 shown for the various indices of average salary. There are two reasons for this lower variability. First, the average salary indices, but

Table 4-4

Summary Statistics: Indices of Salaries of Starting Teachers and Teachers with Other Experience/Degree Combinations

Statistic	Starting Salary (AFT)	Starting Salary (SASS)	Salary: Master's, No Experience (SASS)	Salary: Master's, 20 Years Experience (SASS)
Ratios: maximum/minimum[a]	1.48	1.50	1.47	1.75
maximum/mean[a]	1.18	1.17	1.15	1.21
minimum/mean	0.79	0.78	0.78	0.69
Coefficient of variation (unweighted)	.119	.114	.118	.154
Coefficient of variation (weighted[b])	.099	.093	.096	.137

[a]The maximum salary is for states other than Alaska.
[b]The weighting factor is the number of teachers in each state.

not the starting salary indices, reflect differences in average experience and training among the states. Second, the average salary indices also reflect interstate variations in the average salary premiums paid for increments in experience and training.

The two indices of starting salary agree closely in many cases, but the values for a few states diverge widely. For example, Delaware's starting salary is 3 percent above the U.S. average according to the AFT index but 3 percent below the U.S. average according to the SASS index; Iowa's starting salary is 101 percent of the U.S. average according to the AFT but only 90 percent of the average according to SASS; and Virginia's starting salary is 99 percent of the U.S. average on the AFT index but 107 percent on the SASS measure. These discrepancies are troubling but perhaps not surprising, given the very different methods by which the two sets of salary figures were obtained: the AFT data from an informal survey of state education agencies, the SASS data from a sample survey of LEAs. Deviations of such magnitude raise concern about the validity of the extant starting salary measures. Certainly, one would want to determine the reasons for the disparities before using either set of data.

The detailed differences between an index of starting salary and an index of average salary can be brought out by comparing ratios of the former to the latter across states. Table 4-5 compares the SASS starting salary index with the SASS average salary index based on individual-teacher data. The ratio of the former to the latter varies from as low as 0.84 to as high as 1.22. States that appear to pay low starting salaries relative to their average salaries include Illinois, Michigan, Rhode Island, and Washington; states with high ratios of starting salary to average salary include Arkansas, Mississippi, and South Dakota. There is an evident regional pattern to these results: All the southern states score relatively higher on the starting salary index than on the average salary index (i.e., the ratios shown for these states in Table 4-5 are greater than 1.0). The primary reason seems to be that teacher salary schedules are flatter in the South than in other regions; that is, pay is relatively high at the outset, but the salary increments for each year of teaching experience are relatively small.[2]

Salaries of Teachers with a Master's Degree

Table 4-3 also presents average salaries and salary indices for teachers with a master's degree and no experience and with a master's degree and 20 years of experience. The index for inexperienced teachers with master's degrees is similar statistically to that for the inexperienced teachers with only bachelor's degrees (i.e., the SASS index of starting salary). Values of the former range from 0.78 to 1.15, while values of the latter range from 0.78 to 1.17. The respective weighted coefficients of variation, .096 and .093, are nearly the same.

Table 4-5

Ratio of Starting Salary Index to Average Salary Index

(SASS LEA-Level Starting Salary Index/SASS Teacher-Level Average Salary Index. 1987-88)

State	Ratio	State	Ratio
United States	1.00	Missouri	1.10
		Montana	1.02
Alabama	1.14	Nebraska	1.02
Alaska	0.92	Nevada	0.94
Arizona	1.07	New Hampshire	1.00
Arkansas	1.19	New Jersey	0.96
California	0.95	New Mexico	1.08
Colorado	0.97	New York	0.90
Connecticut	0.94	North Carolina	1.14
Delaware	0.93	North Dakota	1.06
District of Columb	0.84	Ohio	0.93
Florida	1.14	Oklahoma	1.10
Georgia	1.12	Oregon	0.96
Hawaii	0.97	Pennsylvania	0.93
Idaho	1.01	Rhode Island	0.84
Illinois	0.92	South Carolina	1.08
Indiana	0.95	South Dakota	1.15
Iowa	1.07	Tennessee	1.11
Kansas	1.12	Texas	1.09
Kentucky	1.03	Utah	1.01
Louisiana	1.13	Vermont	0.96
Maine	1.00	Virginia	1.13
Maryland	1.01	Washington	0.89
Massachusetts	0.95	West Virginia	1.05
Michigan	0.86	Wisconsin	0.97
Minnesota	0.98	Wyoming	1.03
Mississippi	1.22		

The values of the two indices are close together for most states but differ substantially for a few (e.g., Nevada, Texas, Washington, and Wyoming). The differences reflect the varying premiums paid by different states to teachers who begin their teaching careers with a master's rather than a bachelor's degree.

The first two columns of Table 4-6 show explicitly the average amount paid for a master's degree in each state at the zero experience level. This amount varies, according to these figures, from less than $400 (Louisiana and Texas) to over $3,000 (Alaska, Washington, and Wyoming), or from only a 2.2 percent premium to as much as an 18 percent premium over the starting salary of a teacher with a bachelor's degree. These figures may be somewhat misleading because they pertain only to teachers with no experience. Some states that pay little for a master's degree at the outset may pay more for it later on. Nevertheless, there is little doubt that the pay increment for an advanced degree is highly variable across states and not in any fixed proportion to base salary.

The SASS index of salaries of teachers with master's degrees and 20 years of experience differs sharply from the other three indices shown in Table 4-3. Its range of variation, from 0.69 to 1.21 times the U.S. average (a ratio of 1.75 to 1), is much more similar to ranges in state-average salaries than to ranges in starting salaries (see the disparity statistics in Tables 4-2 and 4-4). The value of this index for a particular state often differs sharply from the values of the other indices. Most southern states, for example, score much lower on the index of salary paid to teachers with master's degrees and 20 years of experience than on any of the other indices of salary associated with a specific experience-degree combination.

The explanation is that the magnitudes of rewards for experience vary substantially among the states. These variations are presented, in both absolute and relative form, in the

Table 4-6

Differences Between Salaries Associated with Different Experience and Degree Combinations, SASS LEA Data for 1987-88

	Salary Increment Associated with Master's Degree: Teachers with No Experience		Salary Increment Associated with 20 Years Experience Teachers with Master's Degrees	
	Absolute	Percentage	Absolute	Percentage
	(1)	(2)	(3)	(4)
United States	1,650	8.9	11,570	57.5
Alabama	2,567	14.3	3,858	18.8
Alaska	3,636	13.9	15,598	52.3
Arizona	1,898	9.7	9,259	43.2
Arkansas	1,219	7.7	5,569	32.5
California	1,469	6.8	14,205	61.4
Colorado	2,166	12.1	12,337	61.3
Connecticut	1,502	7.2	13,465	60.0
Delaware	2,573	14.3	13,066	63.5
District of Columbia	1,913	10.0	16,259	77.3
Florida	1,218	6.2	9,876	47.6
Georgia	2,750	14.3	8,204	37.4
Hawaii	1,100	6.2	17,033	91.1
Idaho	2,010	13.4	8,754	51.6
Illinois	1,845	10.5	13,591	70.1
Indiana	1,070	6.1	12,537	67.8
Iowa	1,089	6.5	8,777	49.3
Kansas	1,602	9.0	7,500	38.5
Kentucky	2,157	13.1	7,895	42.5
Louisiana	357	2.3	5,924	37.4
Maine	1,330	8.4	9,481	55.3
Maryland	1,635	8.2	11,731	54.3
Massachusetts	1,376	7.4	10,948	54.5
Michigan	1,634	8.5	14,832	71.4
Minnesota	2,390	12.3	11,991	55.1
Mississippi	919	5.5	5,074	29.0
Missouri	1,584	9.1	8,464	44.6
Montana	2,117	13.3	10,715	59.5
Nebraska	2,586	17.0	8,220	46.3
Nevada	2,996	16.8	9,363	44.9
New Hampshire	1,486	9.0	10,949	60.5
New Jersey	1,655	8.2	15,249	69.8
New Mexico	1,467	8.4	8,302	44.0
New York	2,495	12.4	15,517	68.4
North Carolina	1,746	9.8	10,329	52.7
North Dakota	2,074	13.8	8,912	52.0
Ohio	1,746	10.2	13,750	72.8
Oklahoma	1,144	7.1	7,529	43.8
Oregon	2,044	11.8	10,950	56.7
Pennsylvania	1,168	6.4	13,823	71.0
Rhode Island	1,389	7.8	15,390	80.0
South Carolina	2,573	14.6	9,180	45.4
South Dakota	1,310	9.1	7,978	50.7
Tennessee	1,625	9.6	7,124	38.5
Texas	398	2.2	11,260	60.7
Utah	1,688	10.9	11,199	65.4
Vermont	2,003	12.8	10,579	59.9
Virginia	1,616	8.2	11,885	55.5
Washington	3,062	18.0	10,731	53.4
West Virginia	1,767	11.5	7,434	43.4
Wisconsin	2,161	12.1	12,067	60.1
Wyoming	3,102	16.4	10,038	45.7

last two columns of Table 4-6. These figures show that the difference between the salary paid to teachers with a master's degree and 20 years of experience and the salary paid to a teacher with a master's degree and no experience is less than $6,000 in some states (Alabama, Arkansas, Louisiana, Mississippi) but more than $15,000 in others (Hawaii, New Jersey, New York, Rhode Island). The states in the latter group score higher on the index of salary for teachers with a master's degree and 20 years of experience than on the index of average salary, because in addition to paying high salaries generally, they offer even higher premiums (relatively speaking) for increments in teaching experience. In percentage terms, the salary differential associated with 20 years of experience ranges (for teachers with a master's degree) from as low as 30 to 35 percent in some states (setting aside the possibly anomalous lower figure for Alabama) to 70 percent or more in others.

The finding that there are major differences between salary indices pertaining to different levels of teacher experience casts doubt on the strategy of comparing salaries corresponding to particular experience-training combinations. If a state's position on the relative salary scale differs substantially depending on whether teachers with zero years, 10 years, or 20 years of experience are being compared, then no index based on a single experience level can represent adequately the general differences in teacher salaries among states. The possibility remains open, of course, of measuring salaries corresponding to multiple levels of experience (and training) and then constructing a weighted average of the results, as in the previously described Canadian method. It would be possible, in principle, to develop such an index for cross-state comparisons in the United States, but this would require an expansion of the salary section of the SASS LEA-level questionnaire to include more than the present three or four experience-degree combinations.

INDICES OF AVERAGE SALARY ADJUSTED FOR EXPERIENCE AND TRAINING

The possibility of adjusting an index of average teacher salary to reflect interstate differences in experience and training was precluded until recently by the absence of suitable data on these characteristics of teachers, but the SASS data base not only provides these variables but also supports statistical adjustment procedures based on thousands of individual-teacher observations. This section begins with the facts on interstate differences in average experience and training, then explains how state-average teacher salary figures can be adjusted to compensate for these differences, and finally presents the adjusted average salary indices.

Experience and Training Differentials

Table 4-7 presents state-by-state estimates of average teacher experience and teacher training (the latter represented by the percentage of each state's teachers holding at least a master's degree). These figures were obtained by tabulating the responses of teachers in each state to the experience and educational background items on the SASS individual-teacher questionnaire. According to these estimates, the average experience of teachers in 1987-88 was 14.0 years nationally but varied from 11.0 years in Utah and 11.6 in Arkansas to 16.3 years in Rhode Island and 18.0 in the District of Columbia--a range of more than 1.6 to 1. In the same year, the percentage of teachers with advanced degrees varied more drastically among states--from highs of nearly 84 percent in Indiana and over 78 percent in Connecticut to lows of 17 to 18 percent in the Dakotas and 26 percent in Utah. Given the near-universal practice of basing teachers' salaries on experience and degree levels, such differences translate, other things being equal, into significant differences in state-average salary.

Table 4-7

Average Teacher Experience and Percent of Teachers with At Least Master's Degrees, 1987-88

	Teacher Experience		Teachers with Higher Degrees	
	Average Years	Relative to U.S. Average	Percent	Relative to U.S. Average
United States	14.0	1.00	47.9	1.00
Alabama	13.4	0.96	58.9	1.23
Alaska	12.5	0.89	43.7	0.91
Arizona	12.1	0.86	44.0	0.92
Arkansas	11.6	0.83	34.1	0.71
California	15.0	1.07	45.1	0.94
Colorado	13.1	0.94	50.1	1.05
Connecticut	15.6	1.11	78.2	1.63
Delaware	14.8	1.06	30.6	0.64
District of Columbia	18.0	1.28	58.2	1.21
Florida	12.9	0.92	40.8	0.85
Georgia	12.1	0.86	53.9	1.12
Hawaii	16.2	1.16	46.8	0.98
Idaho	12.1	0.87	27.9	0.58
Illinois	15.4	1.10	48.9	1.02
Indiana	15.0	1.07	83.9	1.75
Iowa	15.5	1.11	36.4	0.76
Kansas	13.2	0.94	47.0	0.98
Kentucky	13.8	0.99	76.1	1.59
Louisiana	13.2	0.94	48.2	1.01
Maine	13.6	0.97	30.5	0.64
Maryland	14.1	1.01	56.4	1.18
Massachusetts	15.2	1.09	53.1	1.11
Michigan	15.9	1.14	61.4	1.28
Minnesota	15.6	1.11	35.2	0.73
Mississippi	12.9	0.92	42.4	0.88
Missouri	13.2	0.94	47.3	0.99
Montana	13.0	0.93	24.1	0.50
Nebraska	13.8	0.98	40.2	0.84
Nevada	13.6	0.97	54.6	1.14
New Hampshire	12.9	0.92	33.9	0.71
New Jersey	14.7	1.05	41.1	0.86
New Mexico	13.0	0.93	53.3	1.11
New York	14.7	1.05	68.7	1.43
North Carolina	13.7	0.98	31.8	0.66
North Dakota	13.1	0.94	17.8	0.37
Ohio	14.0	1.00	44.0	0.92
Oklahoma	12.1	0.86	44.4	0.93
Oregon	13.1	0.94	48.1	1.00
Pennsylvania	15.9	1.14	52.6	1.10
Rhode Island	16.3	1.17	64.2	1.34
South Carolina	12.6	0.90	49.8	1.04
South Dakota	12.2	0.87	17.0	0.36
Tennessee	13.5	0.97	46.4	0.97
Texas	11.9	0.85	35.4	0.74
Utah	11.0	0.78	25.9	0.54
Vermont	13.0	0.93	41.6	0.87
Virginia	13.5	0.97	37.8	0.79
Washington	14.5	1.04	31.8	0.66
West Virginia	12.9	0.92	46.8	0.98
Wisconsin	15.1	1.08	37.7	0.79
Wyoming	13.1	0.93	30.1	0.63

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Adjustment Methods

The purpose of the adjustment procedures described here is to estimate what each state's average teacher salary would be if the state's teachers had the same average experience and training as teachers in the nation. As explained in Chapter 3, the estimates have been produced by two different methods, designated the "national regression method" and the "state regression method," respectively. Both are based on the SASS individual-teacher data. The resulting adjustments reflect national-average valuations and state-specific valuations, respectively, of the salary premiums associated with increments in teacher experience and training. The following discussion of the adjustment methodology takes up where the general description in Chapter 3 left off.

The National Regression Method. According to this method, the prices of master's degrees and years of teaching experience are estimated from a regression equation fitted to data for all full-time, elementary-secondary (K-12) teachers who responded to the 1987-88 SASS public school teacher questionnaire.[3] The relevant data items are (1) academic base year salary, (2) experience (years of full-time teaching plus years of part-time teaching weighted at 50 percent), and (3) whether the teacher has a master's or higher degree or a bachelor's degree or less.[4] The regression equation relating salary to experience and degree level has the form

$$SALARY = a_0 + a_1 EXP + a_2 EXP^2 + a_3 DEG + a_4(EXP)(DEG) + a_5(EXP^2)(DEG),$$

where EXP and DEG are the experience and higher-degree variables defined above. The quadratic experience terms appear in the equation to allow for the fact that the relationship between salary and experience is usually not linear but levels off after a certain number of years of experience. The interaction terms (products of DEG and EXP or EXP^2) are included to take into account that the salary increments associated with additional years of experience are usually larger for teachers with higher degrees. The estimated regression equation (showing t-values of the regression coefficients in parentheses) is

$$\underset{}{\text{SALARY}} = \underset{(175)}{16958} + \underset{(50.1)}{758\text{EXP}} - \underset{(-21.1)}{10.3\text{EXP}^2} + \underset{(4.4)}{842\text{DEG}} + \underset{(10.8)}{264(\text{EXP})(\text{DEG})} - \underset{(-6.7)}{4.8(\text{EXP}^2)(\text{DEG})}.$$

The equation R^2 is 0.45, indicating that 45 percent of the variance in salary among teachers in the sample is explained by the experience and degree-level variables.[5]

The process of computing an adjusted salary for each state consists of (1) inserting the statewide average values of EXP and DEG for that state into the foregoing equation and computing the corresponding hypothetical national average salary (i.e., the average salary that would be paid nationally if the nation had the same values of EXP and DEG as the state in question), (2) computing the ratio of this hypothetical national average salary to the actual national-average salary, and (3) dividing the state's actual average salary by the resulting ratio. Stated mathematically, the adjusted salary for state S is calculated as

$$\text{Adjusted salary for state S} = \frac{\text{Actual salary for state S}}{\text{Hypothetical U.S. salary/Actual U.S. salary}},$$

where the hypothetical U.S. salary is the salary estimated from the national regression equation by inserting into that equation the actual values of EXP and DEG for state S.

For example, the average teacher in the state of Connecticut in 1987-88 had 15.6 years of experience, and 78.2 percent of the state's teachers had higher degrees, as compared with

14.0 years and 47.9 percent, respectively, for the nation as a whole. Inserting the Connecticut values into the foregoing national regression equation yields a hypothetical salary of $29,230. This is the estimated average salary that would be paid nationally if teachers in the nation had the same average experience and training levels as teachers in Connecticut. The ratio of this hypothetical salary to the actual national-average salary is 1.072 ($29,230/$27,242), which signifies that Connecticut's above-average experience and training translate into an average salary 7.2 percent higher than what it would be if the state's teachers had only national average experience and training. To complete the calculation, one divides Connecticut's actual average salary, $32,880, by the adjustment factor of 1.072, which yields an adjusted average salary of $30,677. In other words, Connecticut's average teacher salary would have been 6.7 percent lower than it actually was in 1987-88 (a reduction factor of 1/1.072) if the state's teachers had only U.S. average levels of experience and training. The same procedure, applied to all the states, yields the adjusted salaries shown in column 2 of Table 4-8. The corresponding adjusted salary index is shown in column 5 of the same table. Differences between the adjusted and unadjusted indices are discussed later, following an explanation of the second adjustment method.

The State Regression Method. According to the second adjustment method, regression equations similar to the aforementioned national regression equation are fitted to individual-state subsamples of the SASS data on teacher salary, experience, and training. Each such equation is, in effect, a statistical representation of a single state's statewide-average teacher salary schedule. The sample size is naturally much smaller for the state-specific equations than for the national equation (it runs from fewer than 300 teachers in the smallest states to over 2,000 in the largest), and the standard errors of the regression

Table 4-8

Indices of Average Teacher Salary Adjusted for Interstate Differences in Experience and Training

	Average Salary (SASS Teacher Data)	Adjusted Salary Based on National Regression	Adjusted Salary Based on State Regressions	Index of Actual Average Salary	Indices of Adjusted Salaries: Based on National Regression	Indices of Adjusted Salaries: Based on State Regressions
	(1)	(2)	(3)	(4)	(5)	(6)
United States	27,242	27,242	27,242	1.00	1.00	1.00
Alabama	23,155	23,092	22,977	0.85	0.85	0.84
Alaska	42,087	43,627	43,855	1.54	1.60	1.61
Arizona	26,878	28,101	28,204	0.99	1.03	1.04
Arkansas	19,672	21,044	20,473	0.72	0.77	0.75
California	33,564	33,069	33,604	1.23	1.21	1.23
Colorado	27,218	27,618	27,464	1.00	1.01	1.01
Connecticut	32,880	30,677	32,131	1.21	1.13	1.18
Delaware	28,494	28,716	29,522	1.05	1.05	1.08
District of Columbia	33,370	30,742	31,654	1.22	1.13	1.16
Florida	25,195	25,985	25,469	0.92	0.95	0.93
Georgia	25,325	26,154	25,568	0.93	0.96	0.94
Hawaii	26,869	25,843	25,096	0.99	0.95	0.92
Idaho	21,772	23,225	23,294	0.80	0.85	0.86
Illinois	28,077	27,303	26,989	1.03	1.00	0.99
Indiana	26,950	25,241	25,695	0.99	0.93	0.94
Iowa	23,110	22,823	22,919	0.85	0.84	0.84
Kansas	23,627	24,033	23,472	0.87	0.88	0.86
Kentucky	23,560	22,793	23,510	0.86	0.84	0.86
Louisiana	20,183	20,509	20,431	0.74	0.75	0.75
Maine	23,334	24,059	24,146	0.86	0.88	0.89
Maryland	29,109	28,696	29,642	1.07	1.05	1.09
Massachusetts	29,120	28,244	29,107	1.07	1.04	1.07
Michigan	32,730	31,013	31,398	1.20	1.14	1.15
Minnesota	29,252	28,896	28,973	1.07	1.06	1.06
Mississippi	20,042	20,624	20,285	0.74	0.76	0.74
Missouri	23,381	23,773	23,257	0.86	0.87	0.85
Montana	23,002	24,187	23,995	0.84	0.89	0.88
Nebraska	21,933	22,257	21,921	0.81	0.82	0.80
Nevada	28,116	28,094	29,075	1.03	1.03	1.07
New Hampshire	24,446	25,443	25,674	0.90	0.93	0.94
New Jersey	30,977	30,846	30,535	1.14	1.13	1.12
New Mexico	23,768	24,100	24,048	0.87	0.88	0.88
New York	33,183	31,880	31,627	1.22	1.17	1.16
North Carolina	23,140	23,765	23,505	0.85	0.87	0.86
North Dakota	20,881	22,122	22,291	0.77	0.81	0.82
Ohio	27,324	27,450	27,705	1.00	1.01	1.02
Oklahoma	21,447	22,421	21,833	0.79	0.82	0.80
Oregon	26,456	26,912	26,870	0.97	0.99	0.99
Pennsylvania	28,866	27,680	27,592	1.06	1.02	1.01
Rhode Island	31,149	29,225	30,829	1.14	1.07	1.13
South Carolina	24,205	24,838	24,609	0.89	0.91	0.90
South Dakota	18,446	19,931	19,850	0.68	0.73	0.73
Tennessee	22,418	22,672	22,418	0.82	0.83	0.82
Texas	24,630	26,162	25,547	0.90	0.96	0.94
Utah	22,616	24,809	25,161	0.83	0.91	0.92
Vermont	23,972	24,647	25,078	0.88	0.90	0.92
Virginia	25,743	26,333	26,284	0.94	0.97	0.96
Washington	28,218	28,565	28,621	1.04	1.05	1.05
West Virginia	21,538	22,040	21,934	0.79	0.81	0.81
Wisconsin	27,161	26,978	27,598	1.00	0.99	1.01
Wyoming	26,864	28,020	27,948	0.99	1.03	1.03

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coefficients are often correspondingly larger. However, the overall explanatory power of the individual-state equations is generally greater than that of the national regression equation, with most R^2 values falling between 0.5 and 0.7. The causes of this difference in goodness of fit are, first, that the state equations, unlike the national equation, do not reflect the large variations in teacher salary levels among states and, second, local salary schedules are likely to be more homogeneous in form within than across states. The detailed results of the individual-state regressions are too voluminous to present here.

The method of constructing an adjusted salary index from the state regression equations is very simple. It consists of substituting into each state equation the national average level of teacher experience and percentage of teachers with higher degrees, calculating the corresponding hypothetical state-average salary, and then computing the ratio of this hypothetical salary to the actual average teacher salary in the nation. The estimated hypothetical salary for each state and the corresponding salary index are shown in columns 3 and 6, respectively, of Table 4-8.

Comparisons Among the Adjusted and Unadjusted Indices

Some basic summary statistics for the two adjusted indices are presented in Table 4-9, accompanied, for purposes of comparison, by the corresponding statistics for the unadjusted average salary index based on the SASS individual-teacher data. These statistics show that the adjustment procedure results in a moderate reduction in the degree of interstate variation in average teacher salary. The weighted coefficients of variation are .128 for the adjusted index derived from the national regression equation and .136 for the index derived from the state-specific regression equations, as compared with a coefficient of .149 for the original, unadjusted index of average teacher salary. In other words, about 10 to 15 percent of the

Table 4-9

Summary Statistics: Adjusted and Unadjusted Indices

Statistic	Unadjusted Average Salary Index	Adjusted Index Based on National Regression	Adjusted Index Based on State Regressions
Ratios: maximum/minimum[a]	1.82	1.66	1.69
maximum/mean[a]	1.23	1.21	1.23
minimum/mean	0.68	0.73	0.73
Coefficient of variation (unweighted)	.170	.152	.160
Coefficient of variation (weighted[b])	.149	.128	.136

[a]The maximum salary is for states other than Alaska.
[b]The weighting factor is the number of teachers in each state.

interstate variation in average teacher salary is attributable to experience and training differentials, and that fraction of the variation is eliminated by the adjustment procedure.

It is encouraging that the two salary adjustment methods yield very similar results. State scores on the two adjusted salary indices in Table 4-8 differ by more than 2 percentage points in only 8 out of 51 cases and by more than 4 percentage points in only 2 cases. This degree of similarity in index scores is surprising, considering that the shapes of the individual-state regression equations differ sharply in some instances from that of the national regression equation. Although there are conceptual arguments favoring each of the two methods, the choice between them is of relatively little practical significance.

Differences between the adjusted and unadjusted indices of state-average salary are small in many cases, but in some instances the adjustment causes a substantial change in a state's relative salary score. Naturally, the states that are most affected by the adjustment are those whose levels of teacher experience and training are the least typical. The states whose relative salary scores are substantially *greater* (5 percentage points or more) according to one or both of the adjusted indices than according to the unadjusted index are Alaska, Arizona, Idaho, Montana, North Dakota, South Dakota, Texas, and Utah. All these states have both lower average teacher experience and smaller percentages of teachers with advanced degrees than the nation as a whole. The states that score at least 5 percentage points *lower* on one or both adjusted indices than on the unadjusted index are Connecticut, the District of Columbia, Hawaii, Indiana, Michigan, New York, Pennsylvania, and Rhode Island. All have more experienced teachers, on average, than the nation as a whole, and all but Hawaii also have above-average percentages of teachers with higher degrees. The states in the first group would appear to have lower per-pupil spending if an adjusted rather than an unadjusted salary index were used as an expenditure deflator; the states in the second group would appear to have higher per-pupil spending if expenditures were deflated by the adjusted salary indices.

INDICES OF PRIVATE-SECTOR WAGES

Although a number of different private sector wage indicators conceivably could be used as proxies for a teacher price index, only two are presented here: a comprehensive index covering all categories of private industry and a narrower index covering service industries only. Both are based on data for calendar year 1988 collected from state employment agencies by the Bureau of Labor Statistics (BLS) and published in the BLS annual *Employment and Wages* report (BLS, 1989). Table 4-10 presents the two sets of BLS wage data and the corresponding indices and, to facilitate comparisons, ratios of the wage indices to an index of average teacher salary.

Table 4-10

Indices of Private-Sector Wages and Comparison with Index of Average Teacher Salary

	Average Annual Wages per Employee (BLS)		Indices (U.S. = 1.00)			Ratio of Private Wage Index to Teacher Salary Index	
	All Private Employees	Service Sector Employees	Wages of All Private Employees	Wages of Service Sector Employees	Average Teacher Salary	All-Employee Index	Service Sector Index
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
United States	21,649	19,984	1.00	1.00	1.00	1.000	1.000
Alabama	18,631	17,851	0.86	0.89	0.85	1.012	1.051
Alaska	26,149	20,735	1.21	1.04	1.54	0.782	0.672
Arizona	19,858	18,516	0.92	0.93	0.99	0.930	0.939
Arkansas	16,747	15,244	0.77	0.76	0.72	1.071	1.056
California	23,738	23,279	1.10	1.16	1.23	0.890	0.945
Colorado	21,116	19,017	0.98	0.95	1.00	0.976	0.952
Connecticut	26,277	22,632	1.21	1.13	1.21	1.006	0.938
Delaware	21,987	17,692	1.02	0.89	1.05	0.971	0.846
District of Columbia	27,817	28,491	1.28	1.43	1.22	1.049	1.164
Florida	19,085	19,207	0.88	0.96	0.92	0.953	1.039
Georgia	20,498	19,473	0.95	0.97	0.93	1.019	1.048
Hawaii	19,437	19,064	0.90	0.95	0.99	0.910	0.967
Idaho	17,501	17,207	0.81	0.86	0.80	1.011	1.077
Illinois	23,613	20,924	1.09	1.05	1.03	1.058	1.016
Indiana	20,417	16,535	0.94	0.83	0.99	0.953	0.836
Iowa	17,567	14,399	0.81	0.72	0.85	0.957	0.849
Kansas	19,034	16,683	0.88	0.83	0.87	1.014	0.963
Kentucky	18,320	15,547	0.85	0.78	0.86	0.978	0.900
Louisiana	19,678	17,869	0.91	0.89	0.74	1.227	1.207
Maine	18,001	16,325	0.83	0.82	0.86	0.971	0.954
Maryland	21,645	21,689	1.00	1.09	1.07	0.936	1.016
Massachusetts	24,034	22,578	1.11	1.13	1.07	1.039	1.057
Michigan	24,366	20,116	1.13	1.01	1.20	0.937	0.838
Minnesota	21,142	17,674	0.98	0.88	1.07	0.909	0.824
Mississippi	16,344	15,320	0.75	0.77	0.74	1.026	1.042
Missouri	20,165	17,477	0.93	0.87	0.86	1.085	1.019
Montana	16,134	14,337	0.75	0.72	0.84	0.883	0.850
Nebraska	16,880	14,978	0.78	0.75	0.81	0.968	0.931
Nevada	19,945	19,308	0.92	0.97	1.03	0.893	0.936
New Hampshire	20,781	18,805	0.96	0.94	0.90	1.070	1.049
New Jersey	25,637	23,669	1.18	1.18	1.14	1.041	1.042
New Mexico	17,557	18,421	0.81	0.92	0.87	0.930	1.057
New York	26,316	23,016	1.22	1.15	1.22	0.998	0.946
North Carolina	18,407	16,968	0.85	0.85	0.85	1.001	1.000
North Dakota	16,104	15,077	0.74	0.75	0.77	0.970	0.984
Ohio	21,376	18,121	0.99	0.91	1.00	0.984	0.904
Oklahoma	19,109	16,598	0.88	0.83	0.79	1.121	1.055
Oregon	19,167	17,046	0.89	0.85	0.97	0.912	0.878
Pennsylvania	21,240	19,525	0.98	0.98	1.06	0.926	0.922
Rhode Island	19,437	18,152	0.90	0.91	1.14	0.785	0.794
South Carolina	17,547	15,452	0.81	0.77	0.89	0.912	0.870
South Dakota	14,880	13,652	0.69	0.68	0.68	1.015	1.009
Tennessee	18,882	17,861	0.87	0.89	0.82	1.060	1.086
Texas	21,195	19,303	0.98	0.97	0.90	1.083	1.068
Utah	18,503	16,920	0.85	0.85	0.83	1.030	1.020
Vermont	18,397	15,505	0.85	0.78	0.88	0.966	0.882
Virginia	20,413	20,367	0.94	1.02	0.94	0.998	1.079
Washington	20,222	16,686	0.93	0.83	1.04	0.902	0.806
West Virginia	19,549	16,092	0.90	0.81	0.79	1.142	1.019
Wisconsin	19,360	16,195	0.89	0.81	1.00	0.897	0.813
Wyoming	18,595	13,442	0.86	0.67	0.99	0.871	0.682

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Summary statistics for the two private-sector wage indices are presented in Table 4-11. As can be seen, the overall statistical properties of these indices are not too different from those of an unadjusted index of average teacher salary. The comprehensive wage index has about the same range of variation as the teacher salary index but exhibits less variation among states according to both the weighted and unweighted coefficient of variation. The index of service sector wages varies over a broader range than the teacher salary index (the respective ratios of maximum to minimum salary are 2.12 and 1.82), but its coefficients of variation are slightly smaller nevertheless than those for the teacher salary measure.

Upon closer inspection, however, it can be seen that the private sector wage indices differ substantially from the teacher salary index in many specific instances. The ratios in

Table 4-11

Summary Statistics: Private Sector Wage Indices
and Index of Average Teacher Salary

Statistic	Comprehensive Private Wage Index	Service Sector Private Wage Index	Teacher Salary Index (SASS Teacher Data)
Ratios: maximum/minimum[a]	1.87	2.12	1.82
maximum/mean[a]	1.28	1.43	1.23
minimum/mean	0.69	0.67	0.68
Coefficient of variation (unweighted)	.143	.159	.170
Coefficient of variation (weighted[b])	.127	.137	.150

[a]The maximum salary is for states other than Alaska.
[b]The weighting factor is the number of teachers in each state.

columns 6 and 7 of Table 4-10 are significantly below 1.0 for such states as California, Michigan, and Rhode Island, indicating that teacher salaries are relatively high in those states compared to private sector wages. They are significantly above 1.0 for Louisiana, Tennessee, and Texas, indicating that the salaries of teachers in those states fall short relative to those of private-sector workers. In 28 states, the comprehensive private sector wage index differs from the average teacher salary index by 5 percentage points or more. Also, the two private sector wage indices sometimes differ sharply from each other--see, for example, the figures for Delaware, Minnesota, New Mexico, and Wyoming. The correlations between the private sector wage indices and the teacher salary index are not very strong.

The correlation coefficients are .85 and .88 for the comprehensive wage index and the service sector wage index, respectively (corresponding to R^2s of .73 and .78). Interestingly, the two private sector wage indices correlate more strongly with the teacher salary index than with each other. The correlation coefficient between the two is only .71, corresponding to an R^2 of .50. In sum, the pattern of interstate cost variation appears much different according to either private sector wage index than according to an index based on teacher salary itself.

Probably the main reason that the private-sector wage indices diverge from the teacher salary index is that the former, but not the latter, reflect substantial interstate variations in the educational attainment of the work force. Teachers are all college-educated, but workers in general have widely varying levels of education. As explained in Chapter 3, Rafuse (1990), has demonstrated a method of controlling for differences in educational attainment (and other personal characteristics) statistically. It is likely that a private wage index incorporating such adjustments would correspond more closely than the unadjusted wage index to an indicator of average teacher salary. Unfortunately, Rafuse worked with 1980 Census data, which makes it impossible to compare his results with the other indices discussed in this chapter. It would be worthwhile to apply Rafuse's approach to 1990 Census data and to compare the resulting adjusted private wage index with other proxy measures of education costs.

THE AFT COST-OF-LIVING INDEX

The AFT's statistically synthesized cost-of-living index is the closest thing now available to a state-level general price index. The index construction method is described in Chapter 3. Table 4-12 presents the AFT index (reproduced from Nelson, 1991) and, for comparison, the index of average teacher salary based on SASS individual-teacher data and the ratio of the AFT index to the average salary measure. The AFT index is less variable among states than the average teacher salary index and, for that matter, less variable than most of the other indices previously discussed. The ratio of its maximum value (1.26, for Connecticut) to its minimum value (.90, for Mississippi) is only 1.4, and its unweighted and weighted coefficients of variation are .095 and .097, respectively. (These compare with a ratio of 1.8 and unweighted and weighted coefficients of variation of .17 and .15, respectively, for the average salary index.).

In many instances, the values of the COL and average salary indices are quite different. The ratio of the AFT index to the teacher salary index (column 3 of Table 4-12) is conspicuously low for such states as California, Michigan, and Minnesota, indicating that teachers in these states are well paid relative to the state cost of living. The same ratio is notably high for such states as Arkansas, Louisiana, Mississippi, and North and South Dakota, which indicates--if the COL index is even roughly accurate--that teachers' salaries in these low-paying states are far below levels that can be accounted for by these states' below-average costs of living.

Table 4-12

AFT Cost of Living Index and Comparison with Index of Average Teacher Salary

State	AFT Cost of Living Index	Index of Average Teacher Salary (SASS Teacher Data)	Ratio of AFT Index to Index of Average Teacher Salary
United States	1.00	1.00	1.000
Alabama	0.92	0.85	1.081
Alaska /a	--	--	--
Arizona	1.01	0.99	1.022
Arkansas	0.91	0.72	1.259
California	1.06	1.23	0.860
Colorado	1.00	1.00	0.999
Connecticut	1.26	1.21	1.042
Delaware	1.03	1.05	0.987
District of Columbia	1.21	1.22	0.988
Florida	0.97	0.92	1.052
Georgia	0.94	0.93	1.012
Hawaii /a	--	--	--
Idaho	0.91	0.80	1.142
Illinois	0.97	1.03	0.945
Indiana	0.93	0.99	0.939
Iowa	0.94	0.85	1.103
Kansas	0.92	0.87	1.057
Kentucky	0.92	0.86	1.065
Louisiana	0.93	0.74	1.261
Maine	0.92	0.86	1.074
Maryland	1.11	1.07	1.037
Massachusetts	1.22	1.07	1.139
Michigan	0.95	1.20	0.794
Minnesota	0.96	1.07	0.890
Mississippi	0.90	0.74	1.227
Missouri	0.93	0.86	1.082
Montana	0.91	0.84	1.079
Nebraska	0.93	0.81	1.154
Nevada	0.98	1.03	0.951
New Hampshire	1.08	0.90	1.202
New Jersey	1.26	1.14	1.106
New Mexico	0.93	0.87	1.065
New York	1.13	1.22	0.929
North Carolina	0.94	0.85	1.102
North Dakota	0.92	0.77	1.203
Ohio	0.96	1.00	0.955
Oklahoma	0.93	0.79	1.175
Oregon	0.94	0.97	0.970
Pennsylvania	1.10	1.06	1.041
Rhode Island	1.07	1.14	0.934
South Carolina	0.93	0.89	1.042
South Dakota	0.92	0.68	1.353
Tennessee	0.93	0.82	1.131
Texas	0.94	0.90	1.041
Utah	0.93	0.83	1.119
Vermont	0.94	0.88	1.067
Virginia	0.97	0.94	1.028
Washington	0.97	1.04	0.936
West Virginia	0.92	0.79	1.162
Wisconsin	0.95	1.00	0.957
Wyoming	0.93	0.99	0.947

(a) Alaska and Hawaii are not covered by the AFT index

THE CHAPTER 1 PER-PUPIL EXPENDITURE INDEX

Federal financial aid under Chapter 1 of the Elementary and Secondary Education Act (aid for education of the disadvantaged) is allocated to states and counties according to a formula based on two factors: (1) the number of low-income children in each county, and (2) a bounded per-pupil expenditure factor that is intended to serve as a proxy for the cost of education in each state. Specifically, the cost proxy is defined as elementary-secondary outlay per pupil in average daily attendance (ADA), subject to the limits that no state's value may exceed 120 percent or fall below 80 percent of national-average spending per pupil in ADA. The Chapter 1 formula, incorporating this proxy for the cost of education, controls the annual distribution of over $6 billion in federal education aid.[6]

Table 4-13 presents an index of the Chapter 1 per-pupil expenditure factor and, for comparison, an index of average teacher salary and the ratio of the Chapter 1 index to the average salary measure. The Chapter 1 factor is, by definition, allowed to vary by only a factor of 1.5 among the states (i.e., from 0.8 to 1.2 times the national mean). Note that the factor takes on the permitted maximum value of 1.2 for 10 states and the permitted minimum value of 0.8 for 11 states. Its weighted coefficient of variation, .142, is similar to that of the index of average teacher salary.

The per-pupil expenditure index deviates significantly from the average teacher salary index in numerous instances. As can be seen from the last column of the table, the two indices differ by 10 percent or more in 20 out of 51 cases. In particular, some of the high-expenditure states for which the per-pupil spending index reaches the maximum allowable value of 1.2 score much lower on the teacher salary index (see, for example, the figures for

Table 4-13

Chapter 1 Bounded Per-Pupil Expenditure Index and Comparison with Index of Average Teacher Salary

State	Chapter 1 Bounded Per-Pupil Expenditure Index	Index of Average Teacher Salary (SASS Teacher Data)	Ratio of Chapter 1 Index to Index of Average Teacher Salary
United States	1.00	1.00	1.000
Alabama	0.80	0.85	0.941
Alaska	1.20	1.54	0.779
Arizona	0.89	0.99	0.904
Arkansas	0.80	0.72	1.108
California	0.94	1.23	0.762
Colorado	1.06	1.00	1.056
Connecticut	1.20	1.21	0.994
Delaware	1.20	1.05	1.147
District of Columbia	1.20	1.22	0.980
Florida	0.95	0.92	1.030
Georgia	0.85	0.93	0.909
Hawaii	0.96	0.99	0.966
Idaho	0.80	0.80	1.001
Illinois	1.03	1.03	0.999
Indiana	0.90	0.99	0.909
Iowa	0.96	0.85	1.136
Kansas	1.00	0.87	1.148
Kentucky	0.80	0.86	0.925
Louisiana	0.80	0.74	1.080
Maine	0.97	0.86	1.132
Maryland	1.20	1.07	1.123
Massachusetts	1.20	1.07	1.123
Michigan	1.09	1.20	0.907
Minnesota	1.06	1.07	0.987
Mississippi	0.80	0.74	1.087
Missouri	0.88	0.86	1.022
Montana	1.06	0.84	1.253
Nebraska	0.95	0.81	1.176
Nevada	0.91	1.03	0.881
New Hampshire	0.99	0.90	1.104
New Jersey	1.20	1.14	1.055
New Mexico	0.89	0.87	1.018
New York	1.20	1.22	0.985
North Carolina	0.80	0.85	0.942
North Dakota	0.86	0.77	1.127
Ohio	0.92	1.00	0.919
Oklahoma	0.80	0.79	1.016
Oregon	1.10	0.97	1.128
Pennsylvania	1.16	1.06	1.095
Rhode Island	1.20	1.14	1.049
South Carolina	0.81	0.89	0.911
South Dakota	0.80	0.68	1.181
Tennessee	0.80	0.82	0.972
Texas	0.85	0.90	0.943
Utah	0.80	0.83	0.964
Vermont	1.10	0.88	1.252
Virginia	0.96	0.94	1.013
Washington	1.00	1.04	0.964
West Virginia	0.95	0.79	1.203
Wisconsin	1.15	1.00	1.149
Wyoming	1.20	0.99	1.217

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Delaware, Maryland, Massachusetts, and Wyoming). Considering that the teacher salary index itself tends to exaggerate relative costs in the high-spending, high-salary states, this fact alone is sufficient to raise doubts about the validity of the Chapter 1 factor as a cost proxy.

Elsewhere, I have shown in more detail that the per-pupil expenditure factor does not have the properties one would expect of a sound proxy for the cost of education (Barro, 1991). In the present context, however, the issue is essentially moot. One of the main intended uses of a cost-of-education index is to translate figures on state spending per pupil into constant-dollar outlays, but deflating per-pupil spending by a per-pupil spending index makes no sense. Therefore, although the Chapter 1 per-pupil expenditure factor has been officially adopted as a cost proxy for the purpose of distributing federal aid, it is not a serious contender for wider use as a cost-of-education indicator.

AN ILLUSTRATIVE COMPOSITE INDEX

A cost-of-education indicator suitable for practical use should represent not only the relative salaries of teachers but also the relative prices of other items making up the education market basket. It is not yet feasible to construct a full-fledged composite index, because suitable state-level data on the salaries of nonteaching personnel and the prices of nonpersonnel resources are not available. It is possible, however, to provide a simplified demonstration of how such an index would be assembled and what the general effects would be of combining indices for different resource categories. Specifically, I present an illustrative composite index consisting of three components: (1) the previously discussed index of average teacher salary adjusted for experience and training, interpreted here to represent the price not only of teachers but also of all other professional educators; (2) the comprehensive index of private sector wages, taken to represent the price of nonprofessional staff; and (3) a constant factor to represent the price of all nonpersonnel resources used in the schools. (That is, the price of nonpersonnel resources is assumed, for lack of data, to be nationally uniform.)

I have shown in Chapter 2 that about 68 percent of all current education expenditure is for compensation of teachers and other professional staff; about 17 percent is for compensation of nonprofessional personnel; and the remaining 15 percent covers all nonpersonnel costs. Accordingly, the weights assigned to the three index components are 68, 17, and 15 percent, respectively. The composite index is calculated as

$$\text{INDEX} = .68 \times \text{ADJTCHSAL} + .17 \times \text{PRIVWAGE} + .15,$$

where ADJTCHSAL is the adjusted index of teacher salary, derived according to the previously described national regression method, and PRIVWAGE is the index of wages of all private-sector employees. The resulting index values, together with values of the individual component indices, are show in Table 4-14.

Not surprisingly, considering that a constant term has been included, the composite index varies less among states than its main component, the index of average teacher salary adjusted for experience and training. The range of interstate variation in the composite index is from .76 to 1.16 (excluding Alaska), as compared with .73 to 1.21 for the adjusted salary measure. The ratios of maximum to minimum values are 1.52 for the former and 1.66 for the latter (again, without Alaska). The respective unweighted coefficients of variation are .123 and .152, and the respective teacher-weighted coefficients of variation are .106 and .128. Based on the weighted coefficients, one can say that the composite index is about 17 percent less variable among the states than the index of teacher salary alone.

Table 4-14

An Illustrative Composite Cost-of-Education Index and Its Components

	Index of Average Teacher Salary Based on National Regression (1)	Index of Wages of All Private Employees (2)	Illustrative Composite Cost-of-Education Index (3)
United States	1.00	1.00	1.00
Alabama	0.85	0.86	0.87
Alaska	1.60	1.21	1.44
Arizona	1.03	0.92	1.01
Arkansas	0.77	0.77	0.81
California	1.21	1.10	1.16
Colorado	1.01	0.98	1.01
Connecticut	1.13	1.21	1.12
Delaware	1.05	1.02	1.04
District of Columbia	1.13	1.28	1.14
Florida	0.95	0.88	0.95
Georgia	0.96	0.95	0.96
Hawaii	0.95	0.90	0.95
Idaho	0.85	0.81	0.87
Illinois	1.00	1.09	1.02
Indiana	0.93	0.94	0.94
Iowa	0.84	0.81	0.86
Kansas	0.88	0.88	0.90
Kentucky	0.84	0.85	0.86
Louisiana	0.75	0.91	0.82
Maine	0.88	0.83	0.89
Maryland	1.05	1.00	1.04
Massachusetts	1.04	1.11	1.04
Michigan	1.14	1.13	1.12
Minnesota	1.06	0.98	1.04
Mississippi	0.76	0.75	0.79
Missouri	0.87	0.93	0.90
Montana	0.89	0.75	0.88
Nebraska	0.82	0.78	0.84
Nevada	1.03	0.92	1.01
New Hampshire	0.93	0.96	0.95
New Jersey	1.13	1.18	1.12
New Mexico	0.88	0.81	0.89
New York	1.17	1.22	1.15
North Carolina	0.87	0.85	0.89
North Dakota	0.81	0.74	0.83
Ohio	1.01	0.99	1.00
Oklahoma	0.82	0.88	0.86
Oregon	0.99	0.89	0.97
Pennsylvania	1.02	0.98	1.01
Rhode Island	1.07	0.90	1.03
South Carolina	0.91	0.81	0.91
South Dakota	0.73	0.69	0.76
Tennessee	0.83	0.87	0.86
Texas	0.96	0.98	0.97
Utah	0.91	0.85	0.91
Vermont	0.90	0.85	0.91
Virginia	0.97	0.94	0.97
Washington	1.05	0.93	1.02
West Virginia	0.81	0.90	0.85
Wisconsin	0.99	0.89	0.98
Wyoming	1.03	0.86	1.00

EXPENDITURE COMPARISONS ACCORDING TO ALTERNATIVE INDICES

Finally, I demonstrate the effects of using selected cost indices and proxies to translate the nominal dollar values of state education outlays per pupil into cost-adjusted figures. I have chosen, somewhat arbitrarily, the following six indices for this exercise:

1. The index of average teacher salary based on SASS individual teacher data,
2. The AFT index of starting salaries,
3. The index of scheduled salaries for teachers with master's degrees and no experience based on SASS LEA-level data,
4. The index of average teacher salary adjusted for experience and training differentials (specifically, the version based on a national regression equation),
5. The index of wages of all private sector workers, and
6. The illustrative composite index presented just above.

These represent the principal approaches discussed in the chapter, except for those clearly unsuitable for adjusting the 1987-88 per-pupil expenditure figures.

Except for the composite index, which takes account explicitly (though crudely) of multiple cost categories, all these indices pertain only to the teacher component of the cost of education or, at most, by extension, to the broader professional staff component. Consequently, it would not be correct to apply them as is to total current education spending. As a rough-and-ready method of acknowledging that other elements of cost probably are less variable than the cost of teachers, I work with slightly diluted versions of the indices, in which 75 percent of total cost is assumed to vary according to the specified measure, while the other 25 percent is held constant across states.[7] To be precise, I deflate each state's current expenditure per pupil by indices of the form, INDEX = .75(SALIND) + .25, where SALIND is a specified measure of, or proxy for, relative teacher salary.

The resulting figures on cost-adjusted expenditure per pupil are presented in absolute and relative forms in Tables 4-15 and 4-16, respectively. Table 4-15 shows the absolute dollar amounts of unadjusted current expenditure per pupil (as reported by NCES) and the adjusted dollar amounts corresponding to all six selected cost adjustors. The table also shows how the states rank according to each set of adjusted expenditure figures. The states are arranged in descending order of unadjusted expenditure per pupil. Table 4-16 presents the corresponding relative measures, or indices of current expenditure per pupil. All index values are expressed relative to U.S. average per pupil expenditure, which is set equal to 1.00.

It is apparent from the tables that there is considerably less interstate variation in adjusted than in unadjusted spending per pupil, regardless of which index is used to make the adjustment. The extent of the reduction in interstate inequality is brought out by the summary statistics in Table 4-17. The ratio of the maximum to the minimum state expenditure per pupil falls from 3.1 before adjustment to between 2.1 and 2.4 after adjustment, depending on which index is used. The weighted coefficient of variation in spending per pupil falls from .24 before adjustment to between .17 and .20 after adjustment, depending again on the choice of index. In sum, there is about 20 to 30 percent less interstate variation in the adjusted than in the unadjusted expenditure figures.

For the most part, the rankings of the states according to per pupil spending are altered only moderately by the cost adjustments, but more drastic changes in rank do occur in some instances. Interestingly, the changes tend to be greater in the mid-range of the distribution of per-pupil spending than at the extremes. Most states that rank among the first 10 in per pupil

Table 4-15

Current Expenditure per Pupil by State After Deflation by Selected Cost Indices and Proxies, 1987-88

State	Current Expenditure per Pupil (CEP) Unadjusted		CEP Deflated by Average Salary Index (SASS)		CEP Deflated by AFT Starting Salary Index		CEP Deflated by Index of Salary for Master's, No Exper. (SASS		CEP Deflated by Adjusted Index of Average Salary		CEP Deflated by Index of Private Wages, All Workers		CEP Deflated by Illustrative Composite Index	
	Amount	Rank	Amount	Rank	Amount	Rank	Amount	Rank	Amount	Rank	Amount	Rank	Amount	Rank
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Alaska	7,159	1	5,082	5	5,357	6	5,260	6	4,933	6	6,193	1	4,957	6
New York	6,196	2	5,325	3	5,713	2	5,659	2	5,494	2	5,334	4	5,377	3
New Jersey	6,059	3	5,494	1	5,618	3	5,693	1	5,512	1	5,324	5	5,404	2
Connecticut	5,905	4	5,112	4	5,434	5	5,435	4	5,395	3	5,089	7	5,263	4
District of Columbia	5,662	5	4,845	6	5,537	4	5,480	3	5,164	5	4,665	12	4,985	5
Massachusetts	4,965	6	4,721	8	4,917	8	4,977	8	4,832	7	4,586	13	4,757	8
Rhode Island	4,951	7	4,470	9	5,216	7	5,122	7	4,695	8	5,362	3	4,797	7
Vermont	4,927	8	5,414	2	5,763	1	5,430	5	5,306	4	5,553	2	5,416	1
Wyoming	4,724	9	4,774	7	4,641	9	4,422	12	4,625	9	5,283	6	4,746	9
Delaware	4,606	10	4,453	10	4,507	11	4,531	10	4,426	11	4,553	15	4,431	13
Pennsylvania	4,603	11	4,406	13	4,632	10	4,719	9	4,548	10	4,669	9	4,568	10
Maryland	4,575	12	4,351	17	4,411	14	4,340	15	4,399	13	4,576	14	4,415	15
Michigan	4,350	13	3,779	29	4,095	21	4,249	17	3,941	25	3,976	28	3,900	28
Wisconsin	4,296	14	4,306	19	4,335	17	4,304	16	4,327	15	4,666	11	4,404	17
Oregon	4,266	15	4,360	16	4,360	16	4,400	14	4,305	16	4,667	10	4,388	18
Minnesota	4,132	16	3,915	27	3,961	23	3,894	24	3,952	24	4,206	20	3,983	25
Colorado	4,100	17	4,103	22	4,411	13	4,101	20	4,058	22	4,177	21	4,079	22
New Hampshire	4,080	18	4,420	12	4,298	18	4,418	13	4,293	18	4,206	19	4,303	19
Maine	3,965	19	4,443	11	4,449	12	4,465	11	4,346	14	4,539	16	4,446	12
Montana	3,878	20	4,391	14	4,382	15	4,211	19	4,234	19	4,794	8	4,405	16
California	3,876	21	3,301	44	3,415	35	3,485	36	3,340	43	3,614	35	3,336	43
Washington	3,875	22	3,774	30	3,980	22	3,879	25	3,739	32	4,077	24	3,792	31
Virginia	3,873	23	4,040	24	3,892	27	3,698	29	3,972	23	4,046	25	4,003	24
Iowa	3,867	24	4,363	15	3,842	28	4,237	18	4,403	12	4,504	17	4,509	11
Illinois	3,822	25	3,736	31	3,942	25	3,932	23	3,816	28	3,579	38	3,758	32
Florida	3,778	26	4,004	25	3,639	31	3,691	30	3,913	26	4,146	22	3,983	26
Kansas	3,724	27	4,136	21	3,910	26	3,817	27	4,085	21	4,095	23	4,141	21
Nebraska	3,712	28	4,347	18	4,265	19	4,071	21	4,303	17	4,447	18	4,429	14
Hawaii	3,661	29	3,699	32	3,640	30	3,867	26	3,808	29	3,965	29	3,863	29
Ohio	3,595	30	3,587	34	3,943	24	3,768	28	3,574	34	3,629	34	3,584	35
West Virginia	3,579	31	4,246	20	4,169	20	4,031	22	4,177	20	3,860	30	4,193	20
Arizona	3,498	32	3,533	37	3,396	36	3,337	39	3,417	39	3,729	31	3,472	38
Indiana	3,454	33	3,482	40	3,639	32	3,681	31	3,655	33	3,608	37	3,673	33
Missouri	3,425	34	3,832	28	3,545	34	3,581	34	3,787	30	3,611	36	3,798	30
Texas	3,334	35	3,592	33	3,302	39	3,544	35	3,436	38	3,387	41	3,439	40
Nevada	3,298	36	3,221	46	3,303	38	3,210	42	3,222	46	3,505	40	3,272	46
North Dakota	3,239	37	3,927	26	3,744	29	3,646	33	3,771	31	4,009	27	3,909	27
Georgia	3,195	38	3,373	43	3,090	45	2,991	46	3,294	44	3,328	43	3,315	44
New Mexico	3,190	39	3,527	38	3,277	41	3,347	38	3,492	36	3,717	32	3,587	34
North Carolina	3,153	40	3,554	36	3,280	40	3,215	41	3,487	37	3,552	39	3,552	36
South Carolina	3,143	41	3,430	42	3,268	42	3,132	43	3,366	40	3,664	33	3,462	39
South Dakota	3,071	42	4,052	23	3,583	33	3,673	32	3,845	27	4,012	26	4,018	23
Oklahoma	2,897	43	3,447	41	3,169	43	3,252	40	3,340	42	3,177	44	3,370	42
Louisiana	2,886	44	3,582	35	3,376	37	3,435	37	3,543	35	3,098	46	3,535	37
Tennessee	2,855	45	3,292	45	3,051	46	3,039	45	3,266	45	3,158	45	3,304	45
Arkansas	2,771	46	3,501	39	3,091	44	3,118	44	3,341	41	3,338	42	3,435	41
Kentucky	2,710	47	3,016	47	3,002	47	2,875	47	3,088	47	3,063	47	3,141	47
Alabama	2,569	48	2,895	50	2,607	51	2,534	51	2,900	49	2,869	50	2,944	49
Idaho	2,505	49	2,949	49	2,954	48	2,839	48	2,816	50	2,925	49	2,889	50
Mississippi	2,416	50	3,013	48	2,624	50	2,680	49	2,954	48	2,960	48	3,046	48
Utah	2,302	51	2,638	51	2,655	49	2,592	50	2,467	51	2,584	51	2,517	51
United States	3,930		3,930		3,930		3,930		3,930		3,930		3,930	

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Table 4-16

Indices of Current Expenditure per Pupil by State After Deflation by Selected Cost Indices and Proxies, 1987-88

	Indices of Current Expenditure Per Pupil with Cost Adjustments as Indicated:						
State	No Cost Adjustment (1)	Deflated by Average Teacher Salary Index (SASS) (2)	Deflated by AFT Starting Salary Index (3)	Deflated by Index of Salary for Master's No Exper. (SASS) (4)	Deflated by Adjusted Index of Average Teacher Salary (5)	Deflated by Index of Private Wages, All Workers (6)	Deflated by Illustrative Composite Index (7)
Alabama	0.65	0.74	0.66	0.64	0.74	0.73	0.75
Alaska	1.82	1.29	1.36	1.34	1.26	1.58	1.26
Arizona	0.89	0.90	0.86	0.85	0.87	0.95	0.88
Arkansas	0.71	0.89	0.79	0.79	0.85	0.85	0.87
California	0.99	0.84	0.87	0.89	0.85	0.92	0.85
Colorado	1.04	1.04	1.12	1.04	1.03	1.06	1.04
Connecticut	1.50	1.30	1.38	1.38	1.37	1.29	1.34
Delaware	1.17	1.13	1.15	1.15	1.13	1.16	1.13
District of Columbia	1.44	1.23	1.41	1.39	1.31	1.19	1.27
Florida	0.96	1.02	0.93	0.94	1.00	1.06	1.01
Georgia	0.81	0.86	0.79	0.76	0.84	0.85	0.84
Hawaii	0.93	0.94	0.93	0.98	0.97	1.01	0.98
Idaho	0.64	0.75	0.75	0.72	0.72	0.74	0.74
Illinois	0.97	0.95	1.00	1.00	0.97	0.91	0.96
Indiana	0.88	0.89	0.93	0.94	0.93	0.92	0.93
Iowa	0.98	1.11	0.98	1.08	1.12	1.15	1.15
Kansas	0.95	1.05	1.00	0.97	1.04	1.04	1.05
Kentucky	0.69	0.77	0.76	0.73	0.79	0.78	0.80
Louisiana	0.73	0.91	0.86	0.87	0.90	0.79	0.90
Maine	1.01	1.13	1.13	1.14	1.11	1.15	1.13
Maryland	1.16	1.11	1.12	1.10	1.12	1.16	1.12
Massachusetts	1.26	1.20	1.25	1.27	1.23	1.17	1.21
Michigan	1.11	0.96	1.04	1.08	1.00	1.01	0.99
Minnesota	1.05	1.00	1.01	0.99	1.01	1.07	1.01
Mississippi	0.61	0.77	0.67	0.68	0.75	0.75	0.78
Missouri	0.87	0.98	0.90	0.91	0.96	0.92	0.97
Montana	0.99	1.12	1.12	1.07	1.08	1.22	1.12
Nebraska	0.94	1.11	1.09	1.04	1.09	1.13	1.13
Nevada	0.84	0.82	0.84	0.82	0.82	0.89	0.83
New Hampshire	1.04	1.12	1.09	1.12	1.09	1.07	1.09
New Jersey	1.54	1.40	1.43	1.45	1.40	1.35	1.37
New Mexico	0.81	0.90	0.83	0.85	0.89	0.95	0.91
New York	1.58	1.35	1.45	1.44	1.40	1.36	1.37
North Carolina	0.80	0.90	0.83	0.82	0.89	0.90	0.90
North Dakota	0.82	1.00	0.95	0.93	0.96	1.02	0.99
Ohio	0.91	0.91	1.00	0.96	0.91	0.92	0.91
Oklahoma	0.74	0.88	0.81	0.83	0.85	0.81	0.86
Oregon	1.09	1.11	1.11	1.12	1.10	1.19	1.12
Pennsylvania	1.17	1.12	1.18	1.20	1.16	1.19	1.16
Rhode Island	1.26	1.14	1.33	1.30	1.19	1.36	1.22
South Carolina	0.80	0.87	0.83	0.80	0.86	0.93	0.88
South Dakota	0.78	1.03	0.91	0.93	0.98	1.02	1.02
Tennessee	0.73	0.84	0.78	0.77	0.83	0.80	0.84
Texas	0.85	0.91	0.84	0.90	0.87	0.86	0.88
Utah	0.59	0.67	0.68	0.66	0.63	0.66	0.64
Vermont	1.25	1.38	1.47	1.38	1.35	1.41	1.38
Virginia	0.99	1.03	0.99	0.94	1.01	1.03	1.02
Washington	0.99	0.96	1.01	0.99	0.95	1.04	0.96
West Virginia	0.91	1.08	1.06	1.03	1.06	0.98	1.07
Wisconsin	1.09	1.10	1.10	1.10	1.10	1.19	1.12
Wyoming	1.20	1.21	1.18	1.13	1.18	1.34	1.21
United States	1.00	1.00	1.00	1.00	1.00	1.00	1.00

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Table 4-17

Summary Statistics: Interstate Variations in Adjusted and Unadjusted Current Expenditure per Pupil, 1987-88

Measure of Current Expenditure per Pupil	Minimum/ Mean	Maximum/ Mean[a]	Maximum/ Minimum[a]	Weighted Coefficient of Variation[b]
Unadjusted	.59	1.82	3.11	.242
Deflated by Average Salary Index (SASS)	.67	1.40	2.08	.168
Deflated by AFT Starting Salary Index	.66	1.47	2.21	.204
Deflated by Index of Salary for Master's, No Experience	.64	1.45	2.25	.201
Deflated by Adjusted Index of Average Salary	.63	1.40	2.23	.181
Deflated by Index of Private Wages, All Workers	.66	1.58	2.40	.175
Deflated by Illustrative Composite Index	.64	1.38	2.15	.172

[a]The maximum salary is for states other than Alaska.
[b]The weighting factor is the number of pupils enrolled in each state in the fall of 1987.

spending initially (before any adjustment) remain in the top 10 after adjustment. Specifically, the number one state in unadjusted per-pupil expenditure, Alaska, falls to fifth or sixth place when adjusted by any index based on teacher salary, but the next few highest-ranked states, New York, New Jersey, Connecticut, and the District of Columbia, remain at or very close to their initial positions. At the opposite end of the spending scale, the five states ranked lowest in unadjusted per-pupil expenditure, Utah, Mississippi, Idaho, Alabama, and Kentucky, remain the five lowest after the adjustments. In contrast, Michigan, which is a high-cost state according to all indicators, falls from thirteenth place in the unadjusted ranking to anywhere from seventeenth to as low as twenty-ninth place in the adjusted rankings, depending on which cost index is used. Minnesota follows a similar pattern. California, also a high-cost state by any measure, drops even more sharply, falling from twenty-first place initially to as low as forty-third or forty-fourth. States that rise in the rankings because of the adjustments include Iowa, Louisiana, Montana, Nebraska, South Dakota, and West Virginia.

Tables 4-15 and 4-16 also show that the quantitative effects of the adjustments (i.e., effects on absolute and relative per-pupil expenditure, as opposed to effects on rankings) depend strongly on which cost indicator is selected. Even where the direction of the adjustment for a particular state is unambiguous, there is often considerable disagreement about the magnitude. Moreover, in some cases, the disagreement concerns even the direction of change. For example, some adjustments raise the per pupil spending figures for Arizona, Rhode Island, and Washington, while others lower them.

It is important to recognize, however, that not all the indices represented in these tables have equal claims to validity. For instance, the teacher salary index adjusted for experience and training has stronger a priori credentials than the other indices based on teacher salary, and the illustrative composite index arguably has stronger claims still. Consequently, where there is disagreement between the results based on these indicators and those based on the index of starting salary or the index of salary for teachers with master's degrees and no experience, the former should be given greater weight.

What can we conclude about how "true" cost adjustments would affect interstate comparisons of current expenditure per pupil? To help answer this question, I have sorted the states into several groups, based on how they are affected by the illustrative adjustments in Tables 4-15 and 4-16.

First, there is a large group of states whose levels of support for the schools appear to be considerably *understated* (relative to average per pupil spending in the nation) by the unadjusted per-pupil expenditure figures. These states all score well below 1.00 on the various cost indices. Consequently, unless all the indices presented here are grossly incorrect, the real level of per-pupil spending of each of these states is significantly higher than the unadjusted nominal-dollar value. The following 23 states are in this category:

Alabama	Mississippi	Oklahoma
Arkansas	Missouri	South Carolina
Idaho	Montana	South Dakota
Iowa	Nebraska	Tennessee
Kansas	New Hampshire	Utah
Kentucky	New Mexico	Vermont
Louisiana	North Carolina	West Virginia
Maine	North Dakota	

In addition, the states of Georgia, Hawaii, Indiana, Oregon, and Texas can be deemed marginal members of the same group, in that their per-pupil outlays are raised by most of the adjustments, but by smaller percentages than for the states listed above.

At the opposite end of the spectrum are 8 states whose levels of real support for education appear, with relatively little ambiguity, to be *exaggerated* by unadjusted per-pupil expenditure figures. Because these states score well above 1.00 on the various cost indices, their adjusted levels of per-pupil spending are substantially lower than the original unadjusted values. The members of this group are:

Alaska	Maryland
California	Michigan
Connecticut	New Jersey
District of Columbia	New York

In addition, Delaware and Massachusetts qualify as marginal members of this high-cost group.

The remaining 13 states occupy in-between positions, meaning either that their per-pupil expenditure figures are affected only slightly by the adjustments or that the direction of the effect depends on which cost indicator is selected. These states include:

Arizona
Colorado
Florida
Illinois
Minnesota
Nevada
Ohio
Pennsylvania
Rhode Island
Virginia
Washington
Wisconsin
Wyoming

In sum, recognizing that the available cost indices are crude and allowing for substantial margins of error, we can still be reasonably confident about the directions and (sometimes) the general magnitudes of the effects on the per pupil expenditure statistics of most states of adjusting for differences in state costs of education. For at least the 31 states that fall clearly into the positive-change or negative-change groups, it seems unlikely that omitted factors, such as differences in teacher attributes other than experience and training, could account for the apparent large deviations of state costs from the national average. It follows, then, that despite the inadequacies of all the available cost measures, a set of estimates of cost-adjusted state per-pupil expenditure is likely to be significantly closer to the truth than a set of unadjusted expenditure figures.

NOTES

1. For many years, NCES has used the NEA or AFT data on teacher salary in its official publications instead of collecting salary data of its own. Even in the 1991 *Digest of Education Statistics* (NCES, 1991), the state-level teacher salary data are from NEA and AFT; only a table of national salary data is from SASS.

]2. Another reason is that average teacher experience is somewhat lower in most southern states than in the nation as a whole, but this is a less important part of the explanation. For confirmation, see the figures on average experience by state in Table 4-7 and the estimates of the salary premiums associated with experience increments in Table 4-6.

3. As explained in Chapter 3, the SASS teacher data were edited to exclude part-time teachers, teachers of grades other than K-12, teachers who reported unreasonable salaries (e.g., salaries below known district or state minimums), and teachers for whom pertinent data items were missing. The number of teachers in the final sample was nearly 35,000.

4. The numbers of teachers with less than a bachelor's degree and with a degree higher than a master's are much too small to justify placing them in separate categories. Note that it was not possible in this analysis to take account of other gradations in qualifications that are reflected in teacher salary schedules. These are usually expressed in terms of course credits or units--e.g., teachers with a bachelor's degree plus 30 or 60 units, a master's degree plus 30 units, etc. SASS does not collect data on these course credits, and it is questionable whether such data, if collected, would be comparable across states.

5. It is likely that only a very small fraction of the unexplained variance arises from either (1) roles played by factors other than experience and training in determining scheduled teacher salaries or (2) deviations of actual salaries from the mathematical form assumed in the regression analysis. Most of the unexplained variance undoubtedly reflects interstate and interdistrict variations in the levels of teacher salary schedules.

6. The same per-pupil expenditure factor influences allocations of federal aid not only under the main Chapter 1 program of grants for compensatory education of the disadvantaged but also under such other programs as Migrant Education, Chapter 1 Grants for the Handicapped, Mathematics and Science Education, and Drug-Free Schools (see Barro, 1991, for the details of these formulas).

7. The assumptions that 75 percent of the cost of education varies among states according to an indicator of labor cost and 25 percent of the cost is nationally uniform are the same as were used by Rafuse (1990) in his attempt to measure the expenditure needed in each state to support a national-average level of services. The assumption that nonpersonnel costs are essentially constant is not unreasonable with respect to such educational resources as equipment and supplies but is clearly incorrect with respect to such things as the costs of energy and pupil transportation.

5. CONCLUSIONS: CURRENT CAPABILITIES AND PROMISING OPTIONS

The conclusions of this report are summarized here under the following headings: (1) currently available cost proxies, (2) options for developing improved non-model-based indices, (3) prospects for developing a cost-of-education index econometrically, and (4) implications for data collection.

CURRENTLY AVAILABLE COST PROXIES

Our current capacity to measure and adjust for interstate differences in the cost of education is rudimentary. No "off the shelf" indicator qualifies as a conceptually sound or empirically well-developed COE index. We have only some rough proxy measures. Given this unsatisfactory state of the art, it might seem reasonable to conclude, in the abstract, that no extant indicator should be put to practical use, especially in any situation where the stakes are substantial. A strong practical argument can be offered, however, for modifying this conclusion in light of the potential adverse consequences. Making no cost adjustments at all, because the available methods are less than satisfactory, is not always better than making them crudely. I return to this point after reviewing the serious limitations of the currently available measures.

Most of the immediately available rough COE indicators or proxies have been discussed and compared in Chapter 4. A quick recapitulation of their strengths and (mainly) weaknesses is as follows:

- Although teacher compensation is the largest single component of the education budget, an unadjusted index of average teacher salary is an unsatisfactory proxy for the cost of education because it takes no account of interstate variations in teacher characteristics or quality and makes no allowance for the influence on salaries of an array of state and local policies.

- An index of the salary of a starting teacher or a teacher with some other specified combination of experience and training circumvents the problem of variations in average experience and training among states, but this benefit is offset by a reduced ability to represent the cost of the teaching force as a whole. Otherwise, such indices have the same defects as an index of average teacher salary.

- All indices based solely on teacher salary data also share the shortcoming that other components of the cost of education--salaries of other professional staff, salaries of support staff, costs of fringe benefits, and prices of nonpersonnel resources--do not necessarily vary among states in proportion to teacher salary.

- A general wage index has the advantages of being unaffected by interstate variations in teacher characteristics and state education policies. The offsetting disadvantages are that it reflects differences in general state labor policies, in the composition of different states' labor forces, and in the structure of different states' economies.

- Although a valid cost-of-living (COL) index might be an acceptable proxy for, or component of, a COE index, the only COL indicators now available are econometrically synthesized ones, such as those of Nelson (1991) and McMahon and Chang (1991), which depend on data of unknown quality and on crude econometric methods.

- The new composite index presented in Chapter 4 has the advantages that (1) its teacher salary component is adjusted for interstate variations in experience and training and (2) it combines the teacher salary component with a rough proxy for the wages of nonprofessional staff. Otherwise, it shares the limitations of the other indices based on teacher salaries and general wage levels.

Note that certain whole categories of potentially stronger indicators are missing from this list. There is no COE index--not even a very simple one--based on a statistical model of teacher supply and demand. There is no multi-component index that includes sub-indices for different categories of education staff or for the main groupings of nonpersonnel resources. There is no teacher salary index in the form of a weighted average of indices of the salaries paid to teachers with multiple combinations of experience and training. These items are absent mainly because the data needed to create them were not available in the past. Recent and forthcoming improvements in the data should now make it feasible to produce some of the hitherto unrepresented types of indicators (see below). Nevertheless, for the time being we face a lack of variety as well as a lack of quality in the set of available COE proxies.

The foregoing recitation of shortcomings makes it evident that none of the immediately available indicators meets even moderate standards of conceptual soundness and comprehensiveness. (The perhaps more important but mainly empirical question of whether any extant indicator is a reasonably close proxy for a "true" COE index cannot yet be answered.) Still, it does not follow that no practical application whatsoever of any available indicator is appropriate. To see why, consider again some of the reasons for wanting a COE index that were mentioned at the very beginning of this report.

One reason would be to present a more accurate picture of interstate variations in support for education than is conveyed by unadjusted statistics on expenditure per pupil by state. Because no good COE index is available, this mission now goes unaccomplished. Some users of education statistics, presented only with unadjusted expenditure figures, are led astray. They infer, incorrectly, that a state spending about twice as much per pupil as another should also have about twice as many staff members per pupil and twice as much of everything else. Even a rough, illustrative adjustment for interstate cost differences--explicitly labeled as such--would quickly dispel that wrong impression.

Another reason, with more of a research character, would be to examine relationships between real spending per pupil and educational outcomes. It is clearly improper (except, perhaps, for polemical purposes) to compare the states' educational outcomes against their unadjusted outlays per pupil. Spending variations attributable only to cost differentials do not reflect, or translate into, variations in real educational resources; hence, one would not expect them to be associated with variations in educational results. A comparison of outcomes with cost-adjusted expenditure figures--even if the cost adjustment method is crude--would yield more valid results.

In each of these real-world situations, something useful could be accomplished by applying an existing, crude, admittedly unsatisfactory proxy for a COE measure. In each instance, the choice is between a rough cost adjustment or none; and in each instance, the rough adjustment could balance what would otherwise be misleading statistical information. In no case would it be necessary to pretend, when applying a crude cost proxy, that the problem of constructing a valid cost-of-education index has been solved.

If an extant indicator were to be used for the purposes mentioned above, which indicator should it be? At the moment, the least objectionable option is probably a composite measure of the type demonstrated at the end of Chapter 4. The main ingredient of this composite indicator is average teacher salary, adjusted for experience and training. In addition, the indicator also includes a general wage index to represent the price of nonprofessional staff and a constant term to represent the price of all nonpersonnel resources. Despite the many and obvious limitations of this measure, the adjustments for experience and training give it an incremental advantage over the other immediately available candidates.

In what ways would it be legitimate to use so crude an index without claiming or implying more than is appropriate? The first imperative is truth in labeling. Given the limitations of this composite index, it would be misleading to present either the index itself or any cost-adjusted expenditure figures based upon it without attaching such explanations and cautionary notices as the following:

- The cost-adjustment procedure takes no account of interstate variations in teacher characteristics other than experience and training.

- The procedure does not correct for the influence on teacher salaries of variations in state certification requirements, collective bargaining rules, and other relevant policies.

- The procedure reflects the unverified assumptions that salaries of professional educators other than teachers and costs of fringe benefits vary among states in proportion to the salary of teachers.

- The general wage index used to represent nonprofessional salaries has not been adjusted to reflect interstate differences in labor force composition.

- The adjustment method reflects the implicit assumption that prices of nonpersonnel resources are nationally uniform, but this is clearly not correct with respect to prices of such things as fuel and power.

A second step to prevent misinterpretation would be to focus any such presentation on the general pattern and the national implications of cost adjustments rather than on the results for particular states. It would be appropriate, for example, to present the finding that interstate disparities in cost-adjusted expenditures per pupil among states (based on a crude cost index) are only about 70 percent as great as disparities in unadjusted spending. It would not be legitimate, however, to highlight the state-specific estimate that the cost of education in New Jersey is 12 percent higher than in the nation as a whole.

A third safeguard would be to present not just a single set of estimates of cost-adjusted expenditures but rather multiple estimates, or perhaps estimated ranges of adjusted expenditures, corresponding to alternative crude cost indicators. This would avoid the false impression of exactness that might otherwise be conveyed by a single set of modified spending figures.

I sum up by noting the possible implications of this line of argument for NCES. Currently, NCES publications present only unadjusted expenditure and revenue per pupil by state. For example, the most recent *Condition of Education* (Alsalam et al., 1993) uses unadjusted figures for 1991-92 to show an almost three to one range of variation in public revenue per pupil among the states. This exaggerates the extent of inequality in real per pupil spending. In the future, NCES might consider supplementing the unadjusted data and the corresponding statistics of interstate disparity with parallel estimates of cost-adjusted figures, based on the best available, or least objectionable, crude cost proxy. The latter estimates, accurately labeled and hedged about with all the aforementioned safeguards, would counter what might otherwise be a misleading impression, leaving the users of NCES's statistics with a more complete and balanced picture of the true degree of fiscal inequality among states.

OPTIONS FOR DEVELOPING IMPROVED NON-MODEL-BASED INDICES

The prospects are now favorable, and likely to become more favorable, for developing improved cost indices that do not depend on explicit supply and demand models. The composite index demonstrated in Chapter 4 is a simple example of this type of index. More complex versions would also be composed of adjusted salary indices and other adjusted price measures, but more components of cost would be represented and the adjustments would be more elaborate. I distinguish in these remarks between short-term and longer-term options. "Short term" means, for the purpose of this discussion, the period during which analysts must make do with existing or soon-to-be-released data sets. "Longer term" refers to the later period during which new data collection efforts could be initiated and brought to fruition.

Short-Term Options

Within the short term, so defined, it would be feasible to develop a more comprehensive and significantly improved composite index, still based mainly on adjusted teacher salary. The options include using the 1990-91 SASS data to improve the teacher salary and other professional staff salary components and using other data sets to develop more and better measures of other components of cost. Some specific methods of exploiting the new SASS data are as follows:

- Use the SASS individual-teacher data for 1990-91 to develop updated estimates of adjusted teacher salary by state, controlling for interstate differences in teacher experience and in the percentage of teachers with a higher degree.

- Expand the procedure for adjusting teacher salaries to take into account interstate differences in teacher characteristics other than experience and training. The possibilities (based on the 1990-91 SASS individual teacher questionnaire) include adjusting for age, gender, marital status, elementary or secondary assignment, undergraduate and graduate major fields of study, and subject specialization.[1]

- Attempt to adjust the teacher salary index for variations in certain state policy variables. This might be done, for example, by inserting into the teacher salary regression equations one or more dummy variables representing the presence or absence of particular state policies. (This suggestion should be considered tentative, because the feasibility of making valid statistical adjustments for state policy factors has not yet been demonstrated.)

- Add to the composite index a component based on the SASS data on salaries of school principals, with adjustments for differences in principals' characteristics similar to those made for teachers. The resulting adjusted index of principals' salaries could be taken to represent the salaries of administrators and nonteaching professionals generally and given appropriate weight in the overall index.

In addition to the improvements based on SASS, the following steps could be taken to improve or develop other components of an enhanced composite index:

- Use 1990 Census of Population data to create an adjusted general wage index for the states, taking into account interstate differences in age structure, gender composition, distribution of educational attainment, and perhaps other attributes of state labor forces. The methodology for making these adjustments has been demonstrated by Rafuse (1990). The resulting wage index would be used to represent the cost of nonprofessional personnel in the composite COE index.

- Assemble existing information on energy prices and energy usage in different states or regions and use it to construct a price index for the energy component of the education market basket.

- Deal separately with the cost of pupil transportation, perhaps simply by assuming that such costs are proportional to actual outlays or, if feasible, by using data on the percentage of pupils transported at public expense in each state.

- Use the recently released Census district-level file on education finance (known as the F-33 survey) to develop an adjustment for the varying scale of the school districts in different states. This would entail analyzing the relationship between per-pupil expenditure and district or school size. The resulting adjustment factor, based perhaps on the percentage of each state's pupils enrolled in small districts, would be applied to some or all components of the composite index.

These (and perhaps other) technical improvements should yield a considerably more sophisticated composite cost indicator than the one demonstrated in this report--namely, one that takes account explicitly of several additional components of the cost of education and adjusts for a larger number of influences on salaries of teachers and other personnel.

Longer-Term Options

The main impediment to further near-term improvement is that only limited data are available on the salaries and characteristics of teachers and other education personnel. A secondary obstacle is that little information is available on some nonpersonnel components of education costs. In the longer run, these limits could be relaxed by expanding existing data collection systems or introducing new ones. The following are some specific possibilities. (More detailed recommendations for improving the data are presented later.)

- If more detailed data were collected on each state's teacher salary scales, it would become possible to construct a more elaborate teacher salary index, calculated as a weighted average of salaries paid to teachers with multiple combinations of experience and training. Such an index would be superior to an adjusted index of average teacher salary because it would deal more flexibly and in greater detail with interstate differences in the shapes of teacher salary schedules.

- If additional data were collected on teacher attributes (presumably through an expanded SASS teacher questionnaire), it would be possible to adjust salaries more thoroughly for differences in the makeup of state teaching forces. Probably the most valuable additions to the present data base would be data on such quality-related attributes of teachers as test scores or grade-point averages. but additional data on teachers' educational backgrounds and assignments would also be helpful.

- New data on the characteristics and salaries of staff other than teachers and principals would create the opportunity to analyze variations in some currently unanalyzable components of personnel compensation. Separate price indices could be constructed for such groups as teacher aides. librarians. counselors. psychologists. curriculum specialists. and supervisors. and perhaps for selected categories of noninstructional support staff.

- The important but as yet unexamined area of fringe benefit costs could be opened up for analysis by collecting. first. more detailed information on expenditures for fringe benefits than is provided by existing school finance data sets and. second. information on the types and levels of benefits provided to teachers and other educators in different states.

- The collection (presumably by BLS) of state-level data on wages paid outside the education system to workers in selected occupational categories would make it possible. first. to construct improved proxy measures for the salaries of clerical. maintenance. and other support staffs in education and perhaps. second. to develop alternative proxy indicators. based on professional and white-collar salaries. of the prices of teachers and other educators. (The possibility should be explored of using occupationally specific 1990 Census earnings data for these same purposes.)

- In addition to the previously mentioned possibility of compiling existing data on geographical variations in energy costs. it would be useful to collect state-level or regional data (perhaps from samples of school districts) on both expenditures for. and prices of. not only energy but also materials. supplies. instructional equipment. and other nonpersonnel resources used in the schools. Such data could be used directly to fill the present gap in information concerning the nonpersonnel components of the cost of education.

- Finally. the collection or compilation of data on the cost of constructing school buildings in different states or regions would make it possible to address the completely neglected dimension of facilities costs.

As the foregoing lists of short-term and long-term options suggest. the development of an improved non-model-based (noneconometric) COE index is likely to occur. if at all. through a process of incremental upgrading and accretion. A crude. illustrative version of such an index is available today. Certain important advances can be made in the short term using data already in hand or soon to become available. The resulting index would almost certainly be superior to anything hitherto available. I would expect it to be suitable for a variety of practical applications in the fields of education statistics and research, specifically including use by NCES to produce estimates of cost-adjusted expenditures per pupil by state. Longer-term improvements, which would require the collection of new sets of data, could be expected to yield a more comprehensive, more detailed, and more refined measure of interstate differences in the cost of education. We cannot know in advance, of course, whether these refinements would materially affect the results--that is, whether they would cause significant changes in the index values for particular states. Even if they did not, the fact that a more detailed, more sophisticated analysis had confirmed earlier estimates would be important, because it would enhance the credibility and acceptability of the index.

How "good" a COE index can ultimately be produced by this essentially ad hoc approach to cost measurement (i.e., how close an approximation to a "true" index) is difficult to say. The non-model-based method probably will never fully overcome two major obstacles to validity: the lack of adequate measures of quality of education personnel and the difficulty of correcting for variations in state and local policies. We do not yet have enough knowledge to assess the quantitative importance of these shortcomings. What does seem clear, however, is that even a moderately improved version of the type of composite index already in hand would be a more respectable COE indicator than any current competitor.

PROSPECTS FOR DEVELOPING A COST-OF-EDUCATION INDEX ECONOMETRICALLY

Compared with the ad hoc, non-model-based approach, the econometric supply-demand modeling approach has both advantages (thus far mainly conceptual) and disadvantages (mainly practical). In principle, only the econometric approach is capable of (1) controlling for interstate differences in multiple characteristics of teachers and other staff, (2) distinguishing between controllable influences (including state policies) and uncontrollable influences on salaries and holding the former but not the latter constant, and (3) taking demand factors into account and differentiating between the supply-side and demand-side influences of the same (or correlated) influences on education costs. The question is whether, or to what extent, these potential benefits can be realized in the face of both data limitations and technical problems of statistical estimation.

No one, to my knowledge, has yet attempted to construct a state-level COE index from an econometric model of teacher supply and demand. The only empirical examples of model-based cost indicators are district-level COE indices for particular states, of the type cited in Chapter 3. Until recently, no data were available that could have supported the development of state-level versions. Now, thanks to the availability of the 1990-91 SASS data and the imminent availability of district-mapped Census of Population data (see below), experiments can be initiated with several of the econometric approaches outlined earlier in this report. As in the case of non-model-based indices, however, a distinction has to be made between what is feasible now and what might become feasible later. The availability of SASS notwithstanding, data on some important supply and demand factors are still missing, and certain other factors must be represented by crude proxies. These data limitations are reflected in the following conclusions about the prospects for constructing state-level, district-level, and individual-level models of teacher supply and demand.

First, an analysis based on state-aggregate data could be undertaken immediately, using estimates of statewide-average salaries and teacher attributes from SASS and data on state characteristics from a variety of sources. The analysis could include an effort to explain interstate variations in actual or adjusted state-average teachers' salaries, using either a reduced-form or (perhaps) a simultaneous-equation model of salary determination. It seems improbable, however, for reasons explained earlier, that so aggregative an analysis would prove useful for constructing a practical COE index. Rather, it would be worth undertaking mainly for developmental purposes--namely, to allow relatively quick and easy exploration of relationships that would later be examined more thoroughly in a district-level or individual-level analysis.

Second, although district-level supply-demand modeling appears to be the most promising long-term strategy, certain limitations of the district-level data restrict what can be accomplished in the short run. However, it appears that one major data gap is about to be filled. Until now, district-level modeling would have been precluded by the lack of data on demographic and economic characteristics of school districts, which, in theory, should enter into an econometric model as influences on teacher supply. Very shortly, however, the Census Bureau is expected to release its file of district-mapped 1990 Census of Population data, which will include data on many such characteristics, even including, for example, district-level estimates of per capita income and the price of housing.

Another major data gap concerns SASS. Although SASS provides district-level data on teacher salaries, it does not provide corresponding data on teacher experience, teacher training, or other teacher attributes. These variables have been included, unfortunately, only in the SASS individual-teacher and school-level data files, where they are of little use for district-level analysis.[2] Without such data, a district-level model--and any COE index derived from it--probably would not deal adequately with interdistrict and interstate differences in teacher characteristics. Therefore, although some preliminary district-level modeling is feasible now, a more complete analysis is a task for the longer run.

Third, it should be feasible in the near future to develop a version of the hedonic salary model for teachers, using the SASS individual-teacher and district-level data in combination with the aforementioned district-mapped Census of Population data. The effort would center around an effort to explain variations in salaries among individual teachers, using a regression equation containing individual teacher variables, district-level variables, and selected state policy variables. Although there are conceptual and technical reasons to prefer district-level supply-demand models to hedonic models, the hedonic approach is respectable and practical, and can be implemented sooner. Given the present limitations on district-level modeling, it appears that individual-level modeling according to the hedonic methodology is the best available short-term option for constructing a cost-of-education index econometrically.

In the longer term, improvements in the data bases could make possible full-scale development of the various econometric approaches to constructing a COE index, specifically including the approach based on district-level supply and demand models. The latter is the most promising long-term approach for several reasons: Districts are the key decisionmaking units; they decide what mixes of staff and other resources will be used to produce educational services. The most important prices of educational resources--salary schedules for teachers and other staff--are generally set at the district level. A district-level analysis avoids the problem of overaggregation inherent in a state-level analysis. Also, a district-level analysis has the important advantages over an individual-level analysis that it permits the separation of supply-side and demand-side influences on prices, which is important for constructing a valid COE index. Thus, although the hedonic price index method can be implemented sooner, only a modeling effort based on district-level data will provide the ultimate test of whether a conceptually sound and practical COE index can be generated econometrically.

IMPLICATIONS FOR DATA COLLECTION

Although some steps to improve COE indices can be taken with existing data, many of the more promising approaches are now obstructed by data deficiencies. Data gaps impede the development of both non-model-based, ad hoc indicators and, even more so, indicators based on econometric supply and demand models. They interfere with efforts to produce more valid indices of teacher salary and preclude entirely the development of separate salary indices for most categories of nonteaching staff. Strengthening the data base is therefore a prerequisite for developing better cost-of-education indices in the future.

Data files from the SASS surveys of individual teachers and LEAs, now available for 1987-88 and 1990-91, are unquestionably the most valuable resource available to would-be developers of improved state-level cost indicators. Although SASS does not provide state-level data directly, it can be used to produce state-level estimates from individual-teacher and district-level data. (Precisely for this purpose, SASS was designed to be state-representative.) In addition, the teacher and LEA data in SASS can be used directly to construct or adjust cost indices, as has been demonstrated by the regression-based adjustments for experience and training in Chapter 4. Nevertheless, the SASS data are now limited in ways that diminish their usefulness and block some promising strategies for improving COE indices. Because of the substantial benefits that might be realized if these limitations were overcome, this discussion begins with and emphasizes options for strengthening SASS.

Additional Data on Scheduled Salaries of Teachers

SASS would become more useful both for constructing indices directly and for modeling teacher supply and demand if its coverage of teacher salaries were expanded. The most useful change would be to replace the few salary items in the SASS LEA questionnaire with a matrix of scheduled salaries for teachers with a bachelor's or a master's degree and, say, 0, 5, 10, 15, 20, 25, 30, and 35 years of experience.[3] This additional detail, combined with correspondingly detailed information on the distribution of teachers by experience and degree level (see the comments concerning data on teacher attributes, below) would permit both construction of the multicomponent, weighted-average teacher salary indices described earlier and development of better econometric models of influences on salary.

Instead of, or in addition to, adding detail to the SASS salary data, NCES could collect the actual, complete teacher salary schedules used by a national (but state-representative) sample of local school systems. This could be done either in conjunction with the SASS surveys or separately, but coordination with SASS would be advantageous, and asking each LEA in the SASS sample to append its salary schedule to the completed SASS LEA questionnaire is a simple, workable method. Having the full salary schedules would allow for a more detailed analysis of the relationship between salary and teacher characteristics. For instance, we would be able to compare the experience levels at which different states' salary scales level off and to consider more aspects of teacher training than just whether or not the teacher has a higher degree. In addition, the detailed data would yield better estimates of the prices of teacher attributes (the salary increments associated with increments in experience and training) to use in district-level econometric modeling efforts.

Additional Data on Teacher Attributes

The problem with SASS data on teacher attributes is not so much that items are missing as that they are sometimes not available at the right levels of aggregation. In particular, although data on teacher experience and training are available in the SASS individual-teacher files and, to a limited extent, in the school-level files, they are absent from the LEA-level files, where they would be the most useful for supply and demand modeling. This data gap could be filled simply by adding the pertinent items from the SASS school-level questionnaire to the LEA-level questionnaire; that is, each LEA could be asked to report the percentage of its teachers with at least a master's degree and the percentages in various experience strata. Further, each LEA could be asked to report districtwide averages or percentage distributions of such other attributes as gender, age, certification status, and (perhaps) type of undergraduate institution attended.[4]

The last-mentioned attribute, type of undergraduate institution attended, is potentially useful for analyzing teacher supply. Whether teachers attended universities, four-year colleges, or specialized teacher training institutions may help to explain interstate variations in salary. The survey item from which this factor could have been derived, name of undergraduate institution attended, appeared in the 1987-88 SASS teacher questionnaire but not in the 1990-91 edition. NCES should consider restoring it to future teacher questionnaires, perhaps accompanied by a built-in code for category of institution.

Data on Salaries and Characteristics of Staff Other than Teachers

True to its title ("teacher demand and shortage questionnaire for public school districts"), the SASS surveys of LEAs have collected considerable information on teachers but little on other kinds of staff.[5] Thus far, the only SASS salary data, other than for teachers, are data on the salaries of principals taken from the school administrator survey. If data on the numbers, salaries, and characteristics of other types of staff (counselors, psychologists, librarians, aides, etc.) were available, the comparisons of personnel cost could be broadened and disaggregated. It would no longer be necessary to rely on the unsubstantiated assumption that prices of other staff vary among states precisely in proportion to the price of teachers. There seems to be no technical obstacle to covering other types of staff in SASS. What would be required, however, is a decision to expand the LEA questionnaire from a survey of teachers only to a broader survey of education personnel.

Data on Nonsalary Compensation (Fringe Benefits)

Because no data are available on the costs of fringe benefits, nothing more can be done than to assume that they vary in proportion to teacher salary. The SASS LEA survey asks whether certain fringe benefits are offered but collects no information on their magnitudes. There seems to be no alternative source from which such data can be derived, either for LEAs or for states. Consequently, it would be necessary to develop a new data base, essentially from scratch, to deal with this important component of education cost.

Dealing with fringe benefit costs would be complicated. We would need data on both the benefits themselves and on state expenditures to provide them. Such information cannot be gathered just by conducting a survey, much less by appending questions to an existing survey instrument. A more intensive special study would be required. The logical starting point would be an inquiry into the benefits provided and costs incurred under each state's teacher retirement system. It is not clear now what data are feasible to collect or what sort of data collection process would be appropriate. Developmental work would be required, which makes dealing with fringe benefits unambiguously a long-term endeavor.

Data on Education Budgets and Market Baskets

We lack adequate data on the composition of the education market basket--that is, expenditure by resource category. NCES's principal education finance data system, the National Public Education Finance Survey (NPEFS), provides breakdowns of expenditure by function (instruction administration, etc.) and by object (salary, fringe benefits, materials, etc.) but yields little information on the shares of expenditure devoted to compensation of teachers, administrators, other professionals, and nonprofessional staff and to the various categories of nonpersonnel resources.[6] The Census Bureau's survey of finances of local education agencies (Form F-33) yields even less information about the composition of education outlay. SASS provides no fiscal data at all. As a result, we have only rough estimates of the weights to be assigned to different components of a COE index, and we have insufficient information to analyze interstate or interdistrict variations in the composition of education spending. These data gaps could be filled by adding appropriate resource categories to either the NPEFS or the Census district-level finance survey, or both. Such additions, incidentally, would serve many purposes in the fields of education finance and policy analysis and would be well worth making even apart from their usefulness in developing a COE index.

Data on Wages Outside the Education Sector

The data needed to develop a model-based COE index include not only what are normally considered education data but also more general data on economic and labor conditions by state. In particular, data are needed on wages (and, in principle, other compensation and conditions of employment) outside the education sector. Such data would be used in supply-demand models to represent the "opportunity wages" potentially available to current or prospective teachers in alternative occupations. They might also be used as proxies for prices of nonprofessional personnel, as in the illustrative composite index presented earlier. Although wage data by state are produced by BLS, they are not suitable for the purpose at hand because they are industry-specific rather than occupationally specific. What is needed are data on salaries in professional, technical, or white collar jobs normally filled by college graduates. I have not investigated the prospects for, or obstacles to, producing such data, so I note only that anything that could be done to generate such salary figures by state would enhance the prospects for modeling teacher supply.

State or Metropolitan Cost-of-Living Data

Finally, although I recognize that the prospects are dim, I note for the record that the likelihood of developing satisfactory cost-of-education indices would be much greater if reliable cost-of-living (consumer price) data by state were available. In the absence of official data from BLS, the only cost-of-living estimates for states have been those synthesized by the AFT and by McMahon and his associates (see the citations in Chapter 3) from data for metropolitan areas and cities. Although there is no doubt that BLS could produce state-level COL indices if given the assignment and budget, the probability of that occurring seems quite low. A less satisfactory but still useful alternative would be for BLS to resume production of its estimates by metropolitan area of family budgets for specified standards of living, which were suspended over a decade ago. These data would be more reliable than the privately produced data on which the AFT cost-of-living figures are now based and could be used (if provided for a sufficiently large number of metropolitan areas) to generate state-level cost-of-living estimates. Such estimates, if available, would play a central role in any effort to construct a COE index from an econometric supply-demand model.

NOTES

1. The 1987-88 SASS teacher questionnaire included an item, the name of the teacher's undergraduate college or university, that might have been translated into an indicator of type of institution attended, a possible determinant of teacher salary. Unfortunately, this potentially valuable item was not included in the 1990-91 SASS survey.

2. SASS now provides data on the experience and training of individual teachers in the teacher sample and certain summary statistics concerning the experience and training of the teachers in each sample school (percentage of teachers with a master's degree and numbers with less than 3, 3-9, 10-20, and more than 20 years of experience). These data cannot be used, however, to estimate the average experience or training of the teachers in each LEA.

3. The salary data requested in the 1987-88 LEA questionnaire (items 15-17) include starting salaries for teachers with a bachelor's degree and no experience, a master's degree and no experience, and a master's degree and 20 years of experience and the average gross salary for all teachers. The 1990-91 questionnaire deletes the question about average gross salary but requests the salary paid to a teacher at the highest step on the salary schedule and the range of salaries from lowest to highest.

4. Interestingly, the SASS LEA questionnaire already asks districts to report numbers of teachers by race and ethnicity, even though it does not request data on such characteristics as gender, age, experience, and training.

5. The 1990-91 LEA survey covers one category of nonteaching staff, librarian/media specialist; however, the survey asks only about the numbers of such staff, not about their characteristics or salaries. The 1990-91 SASS public school survey asks each school to report all its full-time and part-time employees, broken down into multiple categories (principal, assistant principal, guidance counselor, vocational counselor, librarian, other professional staff, teaching aide, library aide, other noninstructional staff). However, there are no corresponding data on staff salaries or characteristics. Moreover, the school-level data are of no use for district-level analysis or modeling.

6. Certain limited inferences about the makeup of the market basket can be made from the breakdowns of expenditure by function and object. In particular, the percentage of the budget devoted to compensation of teachers can be estimated reasonably accurately. It is not possible, however, to estimate with any confidence the percentages of expenditure accounted for by other specific types of personnel, nor to infer anything about the makeup of the nonpersonnel portion of the budget.

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