

AK LEGISLATURE SPECIAL COMMITTEE FILES SCOMM 153 3268

percent response for maintaining and updating the GCEI, and district officials will adapt their own database systems to facilitate their ability to respond to such requests for data.

RECOMMENDATION 4: Frequency of Updates. *AIR recommends that the ASL conduct a study of school district cost differences at an interval of approximately every three to five years.*

Previous research suggests that the GCEI values are not likely to change very much from one year to the next or, for that matter, over a period of years. Such cost indices reflect relative differences in the costs of educational services. That is, while the absolute prices of certain inputs (e.g., the wages of school personnel) may change over time, the factors that affect the differences in prices across local school districts do not change very rapidly over time. Indeed, Chambers has done numerous studies of wage differences across school districts in the U.S., and has found that the correlations between these index values estimated at different points in time are quite high. Chambers (1981c) reported that the correlations between the Missouri GCEI for the 1974-75 and 1975-76 school years was 0.94. In California, the correlation across two different years, with a major property tax limitation measure passed between the two years (the famous Proposition 13), was 0.87. In a nationwide study of geographic cost differences using data for 1987-88, 1990-91, and 1993-94 (Chambers, 1997a), the correlation between the geographic cost indices for each pair of years (87-88 with 90-91, and 90-91 with 93-94) was 0.98, while the correlation across the six-year span was 0.96.

As a dramatic test of how such indices change over time, we decided to take the equivalent of the GCEI index values developed out of the previous Alaska cost study conducted by Chambers and Parrish (1984) and compare them to the values calculated in the current project.²⁴ The correlation between these two indices, which were calculated 18 years apart, exceeded 0.85.

The analysis of the Alaska personnel data is consistent with the findings of previous research on the stability of the index values over time. As part of our current project, the AIR research team acquired the personnel data files for four different school years from ADEED. Using these data, we were able to estimate a variety of statistical models and test the

²⁴ The earlier study by Chambers and Parrish was designed to develop a more comprehensive model of the cost of an "adequate" education in Alaska schools and included measures of cost differences arising out of differences in pupil need, scale of district and school operations, and the prices of comparable school inputs. Thus, the implicit cost index calculated from this model is not strictly comparable to the GCEI calculated in this report. In part this results from the fact that the budget weights used to aggregate the component index values into an overall index are based on the service delivery systems specified by a committee of educators selected from school districts in Alaska. Nevertheless, the basic component indices from which the 1984 GCEI was calculated were developed using methods very similar to those used in the current study.

stability of these index values for different years. Correlations among the personnel indices calculated for different years were all well above 0.90, and for adjacent years these correlations were above 0.95. (The actual parameter estimates for these statistical models are presented in Appendix E along with the correlations among all of the indices.)

The personnel components, which dominate the GCEI calculations, tend to be stable over a five to six year period of time. The non-personnel elements may tend to vary over a shorter time period, but there are no data other than the overall patterns to rely on for some assurance on these non-personnel components. Thus, AIR suggests that five-year studies on personnel are likely to be sufficient for changes in that component. However, it would be useful for further analysis of the patterns of change in the non-personnel components to be conducted over the next few years to explore how rapidly these components change. Given that the overall patterns over an 18-year period have been fairly stable, the non-personnel components could be done every three years until a database has been developed to sufficiently test the stability of these components. The energy component relies heavily on an engineering component that predicts the energy consumption levels, and this relies heavily on climatic norms that do not change dramatically over time. However, energy costs are also impacted by price differences in the energy fuel sources. Travel costs and other prices of goods do change from year to year, but much of the difference in these is associated with relative distances and the associated travel or transportation costs between points in Alaska. While these may change over time, the relative differences may not vary as much as the absolute values.

Recommendation 5: Use an Economist for Labor Market Analyses. *AIR recommends that the ASL employ or contract with a professional economist or an individual with proven experience and training in labor market studies to conduct the analyses of the compensation of school personnel that underlie the personnel cost index components.*

It is important to employ an individual with experience in labor market analysis and in the use of procedures such as the hedonic wage model. While the techniques appear fairly simple on the surface, this analysis does require an understanding of the conceptual framework and its limitations in empirical application. There are some significant judgments that need to be made in the selection of the independent variables, the measurement of the dependent variable, the choice of functional form, and the application of statistical techniques that require highly specialized training and experience. Employing an economist ensures that the person conducting future studies is familiar with standard techniques of analysis of labor markets. Because of changes over time in the labor markets, one cannot simply re-estimate the exact equations used for the current analysis of school personnel. It may also be important to take into account the potential for new measures of school, district, and regional characteristics that may be included in this analysis.

RECOMMENDATION 6: Phase in the New Index. *AIR recommends that the ALS develop procedures to phase in new GCEI numbers over time.*

It is important to recognize that the index values derived from the econometric models described in this report represent only approximations to the complex, real-world transactions that make up the labor markets for school personnel. While cost adjustments do not change rapidly over time, there are a number of factors that may result in some significant changes in the relative costs over time. For the current study, a completely different methodology was used to calculate the new GCEI than was used for the current district cost adjustment. In the future, even with a constant methodology, there may be changes in the index numbers that could have substantial impact on district budgets. Some of this occurs because of the statistical nature of the procedures used to estimate these index numbers. Even these estimates' relatively small standard error of one percent implies a confidence interval of plus or minus two percent. This means that over a five-year period, changes of as much as four percent could easily be accounted for by statistical error alone. A four percent change in budgets can mean hundreds of thousands of dollars in the budget of a given district. Therefore, in order not to cause any major disruptions in the flow of services, the ASL should consider methods for adjusting or phasing in new GCEI numbers over a period of approximately five years. For example, the allocations of aid could be adjusted so that any gap in funding resulting from changes in the GCEI over time would be closed at a rate of, for example, 20 percent per year. At the end of a five-year period, the full impact of the index value would be felt. Alternatively, the state could adopt a moving average technique that averages the values of the indices over a period of time (e.g., three years) so that changes are less disruptive.

Bibliography

- Alexander, Celeste D, Timothy Gronberg, Dennis Jansen, Harrison Keller, Lori Taylor, and Philip Uri Treisman. "A Study of Uncontrollable Variations in the Costs of Texas Public Education." Prepared for the 77th Texas Legislature (November 1, 2000).
- Augenblick, John and Kathleen Adams. "An Analysis of the Impact of Changes in the Funding of Elementary/Secondary Education in Texas: 1974/75 to 1977/78." Denver, CO: Education Commission of the States (1979).
- Barro, S.M. "The Impact of Intergovernmental Aid on Public School Spending." Unpublished doctoral dissertation, Stanford University, Department of Economics (1974).
- Brazer, Harvey E. "Adjusting for Differences Among School Districts in the Costs of Educational Inputs: A Feasibility Report." In *Selected Papers in School Finance 1974*. Washington, DC: U.S. Department of Health, Education, and Welfare, Office of Education (1974).
- Caves, Douglas W., Laurits R. Christensen, and W. Erwin Diewert. "Multilateral comparisons of output, input, and productivity using superlative index numbers," *The Economic Journal*, 92, 73-86 (March 1982).
- Caves, Douglas W., Laurits R. Christensen, and W. Erwin Diewert. "The economic theory of index numbers and the measurement of input, output, and productivity." *Econometrica*, Vol. 50, No. 6, 1393-1414 (November 1982).
- Chambers, J.G. "Measuring Geographic Differences in Public School Costs." Washington, DC: U.S. Department of Education, National Center for Education Statistics (working paper, 1997a).
- Chambers, J.G. "Volume III - The Measurement of School Input Price Differences: A Technical Report on Geographic and Inflationary Differences in the Prices of Public School Inputs." Washington DC: U.S. Department of Education, National Center for Education Statistics (1997b).
- Chambers, J.G. "Public School Teacher Cost Differences Across the U.S.: the Development of a Teacher Cost Index." Final report to the National Center for Education Statistics, Task 2 of the Elementary Secondary Education Statistics Project, NCES Report #95-758. Palo Alto, CA: American Institutes for Research (1995).

- Chambers, J.G. and T.B. Parrish. "The development of a program cost model and a cost-of-education index for the State of Alaska: Final Report, Volumes I-IV." Stanford, CA: Associates for Education Finance and Planning, Inc. (1984).
- Chambers, J.G. "Cost and price level adjustments to state aid for education: A theoretical and empirical review." In K. Forbis Jordan (Ed.), *Perspectives in state school support programs* (2nd annual yearbook of the American Educational Finance Association). Cambridge, MA: Ballinger Publishing Co. (1981a).
- Chambers, J.G. "The hedonic wage technique as a tool for estimating the costs of school personnel: A theoretical exposition with implications for empirical analysis." *Journal of Education Finance* (Winter, 1981b).
- Chambers, J.G. "The impact of bargaining and bargaining statutes on the earnings of public school teachers: A comparison in California and Missouri." *Review of Economics of Education* (Fall, 1981c).
- Chambers, J.G. and P.E. Vincent. "Interim development and progress report on alternative cost-of-education models and indices (SRI International Report Number 3)." Prepared for the Florida Department of Education (1980).
- Chambers, J.G. "Educational cost differentials across school districts in California." Report prepared under subcontract to the Education Finance Center of the Education Commission of the States for the School Finance Equalization Project of the California State Department of Education (1978).
- Chambers, J.G., James Smith, Thomas Parrish, and James Guthrie. "A Proposal for Determining Adequate Resources for New York Public Schools" Palo Alto, CA: American Institutes for Research and Management Analysis and Planning, Inc. (2002).
- Diewert, W.E. "Exact and superlative index numbers," *Journal of Econometrics* 4 (November 1976), 115-145.
- Diewert, W.E. "The economic theory of index numbers: a survey." Discussion Paper No. 79-09, Department of Economics, University of British Columbia (March 1979).
- Goldhaber, Dan D. "An Alternative Measure of Inflation in Teacher Salaries." In *Selected Papers in School Finance*, 1997. William J. Fowler, Jr., editor. Washington, DC: U.S. Department of Education, National Center for Educational Statistics (1999).
- Guthrie, James and Richard Rothstein. "Enabling 'Adequacy' to Achieve Reality: Translating Adequacy into State School Finance Distribution Arrangements." In Helen F. Ladd, Rosemary Chalk, and Janet S. Hansen (Eds.), *Equity and Adequacy in Education Finance*. Washington, DC: National Academy Press (1999).
- Grubb, W. Norton and James Hyman. "Construction Teacher Cost Indices: Methodological

Explorations with California Unified School Districts." In *Selected Papers in School Finance 1975*. Washington, DC: U.S. Department of Health, Education, and Welfare, Office of Education (1975).

McMahon, Walter W. "Interstate Cost Adjustments." In William J. Fowler, Jr. (Ed.), *Selected Papers in School Finance*. Washington, DC: U.S. Department of Education, National Center for Educational Statistics (1994).

Rothstein, Richard and James R. Smith. "Adjusting Oregon Education Expenditures for Regional Cost Differences: A Feasibility Study." Sacramento, CA: Management Analysis & Planning Associates, L.L.C. (1997).

Wendling, Wayne. "Cost-of-Education Indices for New York State School Districts." Denver, CO: Education Commission of the States (1979).

Wynne, Mark and Fiona Sigalla. "The Consumer Price Index." *Federal Reserve Bank of Dallas Economic Review* (2nd quarter, 1994).

Appendix A. Data Sources

Certified Staff. A primary data source for the analysis of certified school personnel (teachers, school administrators, and other professional personnel) is the *Certified Staffing Accounting Report (CSAR)* submitted by each district to ADEED. The CSAR provides basic information on the personal characteristics and job assignments of all certified school personnel in the state of Alaska. These variables include salary, total years of experience, educational background, race-ethnicity, age, gender, job title, and teaching assignment codes. Virtually all of these variables are within the control of the local district. That is, district administrators can select the characteristics of its staff as long as sufficient turnover exists in the district. AIR received four years of the CSAR data from ADEED, from the 1998-1999 school year to the 2001-2002 school year. These data were used in analysis of salaries and turnover for teachers, administrators and other certified professional staff.

Benefits. Part of our data collection involved asking districts about contributions or expenditures for such things as housing subsidies for professional staff. The data were collected on a number of benefits, including: medical, dental, vision, travel, and life insurance; housing subsidies; travel benefits; and retirement benefits.

Classified Staff. While there are some differences in the patterns of wage variations for classified staff across local school districts, they do represent a substantially smaller percentage of the overall school district budget. Moreover, there is generally a correlation between classified cost differences and those observed for teachers and other certified school personnel.²⁵ AIR collected original data from district payroll records on pay rates and hours of work per year, a limited set of personal characteristics, and job-related characteristics for a large sample of classified school personnel employed by Alaska school districts. The personal characteristics included: birthdate, gender, and race-ethnicity. These data were combined with school- and district-level data for use in the classified staff salary regression model.

School and District Data. ADEED provided AIR with a set of files containing location and enrollment data on each school. The enrollment data spanned five years, from the 1997-1998 school year to the 2001-2002 school year, and included ethnicity counts at each school. Data on school enrollments were then aggregated to the district level. Additional information was provided by ADEED on the gross square footage of each building within the school districts in Alaska.

Climate Data. Climate data were obtained from the National Oceanographic Association of America (NOAA) for all weather stations in Alaska. These datasets include data on precipitation and temperature, reported in 30-year normals by month and year. The temperature data were reported in heating, cooling, and total degree days, which were used in the salary

²⁵ The correlation between teachers' salaries and benefits and the salaries of classified staff in the superlative index is 0.71.

models. To assign data to each school, values were taken from each weather station around the school and weighted by proximity of the school to the specific station.

Census Data. The Alaska Department of Community and Economic Development (DCED) reported Census 2000 data at a community level. Data on each community fell into the four following large categories: demographic, social, economic, and housing. These communities contained in the DCED datasets were then combined with the school-level data obtained from ADEED. This provided a clearer picture of the communities within which these schools were located. The data were helpful in the analysis of comparable wages and salary models.

Appendix B. Data Collection

For a copy of the data collection instruments, please contact Eddy Jeans at the Alaska Department of Education and Early Development:

Eddy Jeans
Manager of School Finance and Facilities
School Finance Section
Dept of Education & Early Development
801 W 10th Street, Suite 200
Juneau, AK 99801-1894

Appendix C.

Comparable Wage Model Technical Information

District Name	Labor Market Area	Comparable Wage Index	Average Wage Index	Average Wage
North Slope Borough	31 North Slope Borough	1.33	1.61	\$49,172
Aleutians East	57 Aleutians East	1.00	0.62	\$18,991
Anchorage	62 Anchorage	1.00	1.00	\$30,606
Valdez-Cordova	75 Valdez-Cordova	0.98	1.05	\$32,193
Denali Borough	47 Denali Borough	0.96	1.06	\$32,355
Aleutians West	58 Aleutians West	0.94	0.73	\$22,319
Northwest Arctic Borough	33 Northwest Arctic Borough	0.91	1.08	\$33,125
Fairbanks	44 Fairbanks	0.90	0.88	\$26,983
Juneau	86 Juneau	0.90	0.92	\$28,089
Ketchikan	95 Ketchikan	0.88	0.78	\$23,763
Kodiak	73 Kodiak	0.88	0.68	\$20,866
Sitka	87 Sitka	0.86	0.74	\$22,576
Kenai	71 Kenai	0.84	0.83	\$25,407
MatSu	61 MatSu	0.83	0.74	\$22,741
Bristol Bay Borough	55 Bristol Bay Borough	0.81	0.57	\$17,456
Wrangell-Petersburg	91 Wrangell-Petersburg	0.81	0.66	\$20,324
Yakutat	79 Yakutat	0.78	0.63	\$19,175
Dillingham	50 Dillingham	0.78	0.75	\$22,944
Haines	85 Haines	0.78	0.58	\$17,839
Southeast Fairbanks	46 Southeast Fairbanks	0.76	0.70	\$21,493
Skagway-Angoon	80 Skagway-Angoon	0.75	0.61	\$18,619
POW-Outer Ketchikan	93 POW-Outer Ketchikan	0.75	0.67	\$20,594
Bethel	52 Bethel	0.74	0.72	\$22,012
Nome	34 Nome	0.73	0.72	\$22,141
Lake and Peninsula	59 Lake and Peninsula	0.70	0.55	\$16,925
Yukon-Koyukuk	41 Yukon-Koyukuk	0.68	0.81	\$24,838
Wade Hampton	51 Wade Hampton	0.63	0.64	\$19,719

Appendix D1.

Final Estimating Equations for Administrators, Teachers, and Classified Personnel

Exhibit D1-a. Final Econometric Model for Explaining the Patterns of Compensation for Administrators and Other Non-Teaching Personnel

The LIFEREG Procedure

Model Information

Data Set	WORK.TCHR
Dependent Variable	lsal
Dependent Variable	cens
Number of Observations	2801
Noncensored values	2200
Right Censored values	601
Left Censored values	0
Interval Censored values	0
Missing values	731
Name of Distribution	Normal
Log Likelihood	910.50923045

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits		Chi-Square	Pr > ChiSq
Intercept	1	10.0926	0.1314	9.8352	10.3501	5903.05	<.0001
percent_teaching	1	-0.0008	0.0003	-0.0015	-0.0002	6.58	0.0103
fy2000	1	-0.0149	0.0069	-0.0284	-0.0014	4.68	0.0306
fy2001	1	0.0135	0.0074	-0.0011	0.0281	3.31	0.0690
adjexp	1	0.0334	0.0044	0.0247	0.0421	56.47	<.0001
adjexp2	1	-0.0007	0.0007	-0.0021	0.0007	1.06	0.3042
adjexp3	1	-0.0000	0.0000	-0.0001	0.0000	1.17	0.2804
adjexp4	1	0.0000	0.0000	0.0000	0.0000	4.03	0.0447
female	1	-0.0295	0.0068	-0.0429	-0.0162	18.84	<.0001
age1	1	0.0055	0.0004	0.0047	0.0063	181.27	<.0001
age_missing	1	0.1520	0.1039	-0.0516	0.3557	2.14	0.1433
degree3	1	0.0446	0.0088	0.0273	0.0619	25.45	<.0001
degree4	1	-0.0107	0.0522	-0.1131	0.0917	0.04	0.8373
degree5	1	0.0886	0.0262	0.0372	0.1401	11.41	0.0007
ethnic_black	1	-0.0177	0.0161	-0.0492	0.0138	1.21	0.2707
ethnic_hisp	1	0.0222	0.0247	-0.0263	0.0707	0.81	0.3694
ethnic_asian	1	0.0107	0.0248	-0.0379	0.0593	0.19	0.6669
ethnic_indian	1	0.0408	0.0314	-0.0207	0.1023	1.69	0.1936
ethnic_nativeAK	1	-0.0511	0.0201	-0.0905	-0.0117	6.46	0.0110
assign_elem	1	0.0065	0.0100	-0.0131	0.0260	0.42	0.5172
assign_mathsci	1	-0.0219	0.0314	-0.0835	0.0397	0.48	0.4864
assign_multigrade	1	-0.0324	0.0132	-0.0583	-0.0065	6.00	0.0143
assign_se	1	-0.0245	0.0194	-0.0624	0.0135	1.60	0.2063
assign_004	1	-0.0953	0.0625	-0.2178	0.0271	2.33	0.1271
headtchr	1	0.1020	0.0462	0.0114	0.1926	4.87	0.0274
principal	1	0.2702	0.0119	0.2468	0.2936	513.48	<.0001
asst_principal	1	0.2778	0.0151	0.2482	0.3073	339.41	<.0001
counselor	1	-0.0534	0.0124	-0.0777	-0.0290	18.45	<.0001
librarian	1	-0.0840	0.0127	-0.1090	-0.0590	43.50	<.0001
prof	1	-0.0714	0.0119	-0.0947	-0.0482	36.16	<.0001
secondary_school	1	0.0132	0.0087	-0.0038	0.0301	2.31	0.1287
totlfr_radius	1	0.2106	0.0635	0.0863	0.3350	11.02	0.0009
wage_index	1	0.2064	0.0570	0.0948	0.3180	13.13	0.0003
utilities	1	0.0193	0.0147	-0.0095	0.0481	1.73	0.1885
hdd	1	0.0000	0.0000	-0.0000	0.0000	0.95	0.3288
hdd2	1	-0.0000	0.0000	-0.0000	0.0000	0.85	0.3578
cdd	1	-0.0005	0.0004	-0.0013	0.0003	1.40	0.2370
minDistanceCC	1	0.0001	0.0000	0.0000	0.0001	8.18	0.0042
lowrain	1	0.0007	0.0130	-0.0247	0.0261	0.00	0.9563
water_radius	1	0.0100	0.0094	-0.0084	0.0284	1.13	0.2875
member_lea_1000	1	-0.0625	0.0378	-0.1366	0.0116	2.73	0.0982
member_lea_2500	1	-0.0771	0.0362	-0.1479	-0.0062	4.54	0.0330
member_lea_10000	1	-0.0822	0.0379	-0.1566	-0.0079	4.70	0.0302
member_lea_250	1	-0.1004	0.0358	-0.1706	-0.0301	7.85	0.0051
AKNative	1	0.0567	0.0211	0.0154	0.0980	7.24	0.0071
Asian	1	-0.1583	0.0545	-0.2652	-0.0514	8.42	0.0037
Black	1	0.0024	0.0627	-0.1206	0.1253	0.00	0.9697
Hispanic	1	-0.1408	0.0943	-0.3257	0.0441	2.23	0.1355

Exhibit D1-b. Final Econometric Model for Explaining the Patterns of Compensation for Full-Time Teachers

The REG Procedure
Model: MODEL1
Dependent Variable: lsalben

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	41	198.77919	4.84827	450.24	<.0001
Error	6076	65.42752	0.01077		
Corrected Total	6117	264.20670			

Root MSE	0.10377	R-Square	0.7524
Dependent Mean	10.75471	Adj R-Sq	0.7507
Coeff Var	0.96488		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	10.20922	0.05590	182.64	<.0001
adjexp	1	0.03961	0.00197	20.15	<.0001
adjexp2	1	-0.00070202	0.00023621	-2.97	0.0030
adjexp3	1	-0.00001535	0.00001040	-1.48	0.1399
adjexp4	1	3.261337E-7	1.482422E-7	2.20	0.0278
newjob	1	-0.01926	0.00449	-4.29	<.0001
female	1	0.00203	0.00303	0.67	0.5034
age1	1	0.00359	0.00017620	20.40	<.0001
age_missing	1	0.15539	0.01882	8.25	<.0001
degree1	1	-0.11023	0.03959	-2.78	0.0054
degree3	1	0.05555	0.00376	14.76	<.0001
degree4	1	0.09734	0.07405	1.31	0.1887
degree5	1	0.12567	0.03013	4.17	<.0001
ethnic_black	1	-0.00466	0.01085	-0.43	0.6679
ethnic_hisp	1	-0.04236	0.01112	-3.81	0.0001
ethnic_asian	1	-0.01910	0.01042	-1.83	0.0668
ethnic_indian	1	-0.00443	0.01528	-0.29	0.7720
ethnic_nativeAK	1	-0.04410	0.00653	-6.75	<.0001
assign_elem	1	0.00566	0.00382	1.48	0.1390
assign_mathsci	1	0.00645	0.00605	1.07	0.2867
assign_multgrade	1	-0.01482	0.00363	-4.08	<.0001
assign_se	1	0.01004	0.00493	2.04	0.0418
assign_004	1	-0.01684	0.01552	-1.09	0.2779
headtchr	1	0.11578	0.01342	8.63	<.0001
secondary_school	1	0.00838	0.00394	2.13	0.0333
totlfpr_radius	1	0.07236	0.02777	2.61	0.0092
wage_index	1	0.11904	0.02117	5.62	<.0001
utilities	1	-0.01607	0.00610	-2.64	0.0084
hdd	1	-0.00001460	0.00000739	-1.97	0.0484
hdd2	1	5.6724E-10	2.79442E-10	2.03	0.0424
cdd	1	0.00188	0.00018556	10.12	<.0001
minDistanceCC	1	0.00009835	0.00000947	10.39	<.0001
lowrain	1	-0.03616	0.00678	-5.34	<.0001
water_radius	1	-0.01627	0.00408	-3.99	<.0001
member_lea_1000	1	0.07546	0.01151	6.56	<.0001
member_lea_2500	1	0.06851	0.01140	6.01	<.0001
member_lea_10000	1	0.08661	0.01266	6.84	<.0001
member_lea_250	1	0.05949	0.01119	5.32	<.0001
AKNative	1	0.07309	0.00872	8.38	<.0001
Asian	1	0.07588	0.02416	3.14	0.0017
Black	1	-0.06900	0.03324	-2.08	0.0380
Hispanic	1	-0.01548	0.04912	-0.32	0.7526

Exhibit D1-c. Final Econometric Model for Explaining the Patterns of Compensation for Classified Personnel

The REG Procedure
Model: MODEL1
Dependent Variable: lsal

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	29	174.68213	6.02352	203.94	<.0001
Error	5798	171.24507	0.02954		
Corrected Total	5827	345.92720			

Root MSE	0.17186	R-Square	0.5050
Dependent Mean	2.70680	Adj R-Sq	0.5025
Coeff Var	6.34913		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	2.04715	0.08061	25.39	<.0001
YrsDist	1	0.03549	0.00105	33.90	<.0001
YrsDist2	1	-0.00077121	0.00004160	-18.54	<.0001
female	1	-0.04651	0.00557	-8.35	<.0001
age1	1	0.00150	0.00025307	5.94	<.0001
age_missing	1	0.07201	0.01702	4.23	<.0001
ethnic_black	1	0.00545	0.01213	0.45	0.6529
ethnic_hisp	1	-0.02306	0.01302	-1.77	0.0766
ethnic_asian	1	-0.04193	0.01011	-4.15	<.0001
ethnic_indian	1	-0.00034938	0.03328	-0.01	0.9916
ethnic_nativeAK	1	-0.03636	0.00882	-4.12	<.0001
computer_tech	1	0.15191	0.02723	5.58	<.0001
supervisor	1	0.36133	0.02830	12.77	<.0001
clerical	1	0.03382	0.00767	4.41	<.0001
ed_aide	1	-0.02360	0.00520	-4.54	<.0001
totlfr_radius	1	0.09289	0.03604	2.58	0.0100
wage_index	1	0.23167	0.02726	8.50	<.0001
utilities	1	0.01002	0.00755	1.33	0.1845
hdd	1	-9.0039E-7	0.00001066	-0.08	0.9327
hdd2	1	7.05444E-10	3.99757E-10	1.76	0.0777
minDistanceCC	1	0.00013954	0.00001319	10.58	<.0001
lowrain	1	0.00392	0.01132	0.35	0.7291
water_radius	1	-0.01802	0.00602	-2.99	0.0028
member_lea_1000	1	0.02416	0.00947	2.55	0.0108
member_lea_2500	1	0.10758	0.00785	13.70	<.0001
member_lea_10000	1	0.03760	0.01262	2.98	0.0029
AKNative	1	0.08075	0.01557	5.19	<.0001
Asian	1	-0.09344	0.04261	-2.19	0.0283
Black	1	0.04845	0.05942	0.82	0.4149
Hispanic	1	0.00743	0.08426	0.09	0.9297

Appendix D2.

Alternative Estimating Equations for School Personnel

Exhibit D2-a. Administrators and Professional Staff: the Salary and Benefits Model

The REG Procedure
Model: MODEL1
Dependent Variable: lsalben

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	46	55.25048	1.20110	78.57	<.0001
Error	990	15.13450	0.01529		
Corrected Total	1036	70.38498			

Root MSE	0.12364	R-Square	0.7850
Dependent Mean	10.94831	Adj R-Sq	0.7750
Coeff Var	1.12933		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	10.18317	0.17910	56.86	<.0001
percent_teaching	1	0.00005879	0.00047198	0.12	0.9009
adjexp	1	0.03274	0.00648	5.06	<.0001
adjexp2	1	-0.00088241	0.00096054	-0.92	0.3585
adjexp3	1	-0.00000674	0.00005090	-0.13	0.8947
adjexp4	1	3.247347E-7	8.71209E-7	0.37	0.7094
newjob	1	-0.02233	0.01084	-2.06	0.0396
female	1	-0.03170	0.00969	-3.27	0.0011
age1	1	0.00343	0.00053109	6.45	<.0001
age_missing	1	0.10388	0.05846	1.78	0.0759
degree3	1	0.04454	0.01157	3.85	0.0001
degree4	1	0.07724	0.07310	1.06	0.2909
degree5	1	0.07501	0.03429	2.19	0.0289
ethnic_black	1	-0.00972	0.02309	-0.42	0.6739
ethnic_hisp	1	-0.01121	0.02762	-0.41	0.6850
ethnic_asian	1	-0.02282	0.03637	-0.63	0.5305
ethnic_indian	1	-0.04977	0.03717	-1.34	0.1809
ethnic_nativeAK	1	0.05248	0.02786	1.88	0.0599
assign_elem	1	-0.00574	0.01369	-0.42	0.6751
assign_mathsci	1	0.02951	0.03561	0.83	0.4075
assign_multgrade	1	0.01596	0.01940	0.82	0.4108
assign_se	1	0.11768	0.02247	5.24	<.0001
assign_004	1	-0.07090	0.06553	-1.08	0.2795
headtchr	1	0.00541	0.04435	0.12	0.9029
principal	1	0.37206	0.01623	22.93	<.0001
asst_principal	1	0.36020	0.01989	18.11	<.0001
counselor	1	0.01927	0.01676	1.15	0.2506
librarian	1	0.02399	0.01773	1.35	0.1762
prof	1	-0.00368	0.01643	-0.22	0.8227
secondary_school	1	0.01811	0.01055	1.72	0.0863
totlfpr_radius	1	0.15159	0.08681	1.75	0.0811
wage_index	1	0.04946	0.07128	0.69	0.4880
utilities	1	0.00644	0.01942	0.33	0.7402
hdd	1	0.00000450	0.00002221	0.20	0.8393
hdd2	1	-1.9546E-11	8.53375E-10	-0.02	0.9817
cdd	1	-0.00127	0.00052143	-2.44	0.0147
minDistanceCC	1	0.00005793	0.00002962	1.96	0.0507
lowrain	1	-0.00261	0.02012	-0.13	0.8967
water_radius	1	0.02496	0.01445	1.73	0.0844
member_lea_1000	1	0.07868	0.04378	1.80	0.0726
member_lea_2500	1	0.03880	0.04404	0.88	0.3785
member_lea_10000	1	0.06854	0.04822	1.42	0.1555
member_lea_250	1	0.03587	0.04179	0.86	0.3910
AKNative	1	0.03740	0.02808	1.33	0.1833
Asian	1	-0.02420	0.06812	-0.36	0.7225
Black	1	-0.04890	0.09138	-0.54	0.5927
Hispanic	1	-0.15070	0.13004	-1.16	0.2468

Exhibit D2-b. Full-Time Teachers: the Turnover-Adjusted Model

The LIFEREG Procedure

Model Information

Data Set	WORK.TCHR
Dependent Variable	lsal
Dependent Variable	cens
Number of Observations	17011
Noncensored Values	14723
Right Censored Values	2288
Left Censored Values	0
Interval Censored Values	0
Missing Values	5049
Name of Distribution	Normal
Log Likelihood	9284.8514448

Analysis of Parameter Estimates

Parameter	DF	Estimate	Standard Error	95% Confidence Limits		Chi-Square	Pr > ChiSq
Intercept	1	10.1651	0.0388	10.0890	10.2412	68511.7	<.0001
fy2000	1	-0.0178	0.0023	-0.0224	-0.0133	59.04	<.0001
fy2001	1	0.0154	0.0026	0.0104	0.0205	36.20	<.0001
adjexp	1	0.0437	0.0014	0.0411	0.0463	1045.78	<.0001
adjexp2	1	-0.0010	0.0002	-0.0014	-0.0006	25.90	<.0001
adjexp3	1	-0.0000	0.0000	-0.0000	0.0000	1.87	0.1714
adjexp4	1	0.0000	0.0000	0.0000	0.0000	7.62	0.0058
female	1	0.0025	0.0021	-0.0016	0.0066	1.45	0.2293
age1	1	0.0045	0.0001	0.0043	0.0048	1248.04	<.0001
age_missing	1	0.1726	0.0320	0.1098	0.2353	29.03	<.0001
degree1	1	-0.1737	0.0259	-0.2244	-0.1230	45.13	<.0001
degree3	1	0.0631	0.0027	0.0578	0.0683	556.39	<.0001
degree4	1	0.0871	0.0467	-0.0045	0.1787	3.48	0.0623
degree5	1	0.1317	0.0215	0.0895	0.1739	37.38	<.0001
ethnic_black	1	-0.0047	0.0072	-0.0188	0.0094	0.43	0.5143
ethnic_hisp	1	-0.0209	0.0078	-0.0361	-0.0057	7.27	0.0070
ethnic_asian	1	-0.0093	0.0070	-0.0231	0.0044	1.78	0.1825
ethnic_indian	1	-0.0040	0.0098	-0.0232	0.0152	0.17	0.6823
ethnic_nativeAK	1	-0.0442	0.0045	-0.0531	-0.0354	96.06	<.0001
assign_elem	1	-0.0059	0.0025	-0.0108	-0.0010	5.48	0.0192
assign_mathsci	1	0.0054	0.0044	-0.0032	0.0140	1.52	0.2171
assign_multgrade	1	-0.0176	0.0024	-0.0223	-0.0129	54.21	<.0001
assign_se	1	0.0130	0.0032	0.0067	0.0192	16.63	<.0001
assign_004	1	-0.0378	0.0103	-0.0580	-0.0177	13.50	0.0002
headtchr	1	0.1076	0.0098	0.0884	0.1269	120.43	<.0001
secondary_school	1	0.0022	0.0031	-0.0038	0.0082	0.53	0.4665
totlfr_radius	1	0.0819	0.0192	0.0443	0.1195	18.19	<.0001
wage_index	1	0.1443	0.0148	0.1153	0.1732	95.36	<.0001
utilities	1	-0.0129	0.0044	-0.0215	-0.0043	8.63	0.0033
hdd	1	-0.0000	0.0000	-0.0000	-0.0000	17.19	<.0001
hdd2	1	0.0000	0.0000	0.0000	0.0000	18.63	<.0001
cdd	1	0.0013	0.0001	0.0011	0.0016	100.14	<.0001
minDistanceCC	1	0.0001	0.0000	0.0001	0.0001	245.85	<.0001
lowrain	1	-0.0102	0.0043	-0.0187	-0.0017	5.53	0.0187
water_radius	1	-0.0210	0.0028	-0.0265	-0.0154	54.99	<.0001
member_lea_1000	1	0.0381	0.0091	0.0203	0.0559	17.56	<.0001
member_lea_2500	1	0.0634	0.0086	0.0465	0.0803	54.07	<.0001
member_lea_10000	1	0.0469	0.0094	0.0284	0.0653	24.82	<.0001
member_lea_250	1	0.0435	0.0087	0.0266	0.0605	25.28	<.0001
AKNative	1	0.0696	0.0061	0.0577	0.0815	130.64	<.0001
Asian	1	0.1370	0.0178	0.1021	0.1719	59.11	<.0001
Black	1	-0.1283	0.0233	-0.1739	-0.0827	30.41	<.0001
Hispanic	1	-0.0350	0.0377	-0.1089	0.0390	0.86	0.3541

Exhibit D2-c. Full-Time Teachers: the Salary Model

The REG Procedure
Model: MODEL1
Dependent Variable: lsal

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	43	622.89251	14.48587	1184.98	<.0001
Error	17547	214.50434	0.01222		
Corrected Total	17590	837.39685			

Root MSE	0.11056	R-Square	0.7438
Dependent Mean	10.72926	Adj R-Sq	0.7432
Coeff Var	1.03050		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t value	Pr > t
Intercept	1	10.13937	0.03434	295.23	<.0001
fy2001	1	0.03014	0.00221	13.67	<.0001
fy2002	1	0.04416	0.00209	21.12	<.0001
adjexp	1	0.04312	0.00127	33.97	<.0001
adjexp2	1	-0.00096498	0.00016197	-5.96	<.0001
adjexp3	1	-0.00001025	0.00000753	-1.36	0.1731
adjexp4	1	3.274282E-7	1.133263E-7	2.89	0.0039
newjob	1	-0.01993	0.00278	-7.16	<.0001
female	1	0.00271	0.00190	1.42	0.1545
age1	1	0.00397	0.00011286	35.21	<.0001
age_missing	1	0.16272	0.01638	9.93	<.0001
degree1	1	-0.18599	0.02294	-8.11	<.0001
degree3	1	0.05768	0.00238	24.22	<.0001
degree4	1	0.08579	0.04194	2.05	0.0408
degree5	1	0.11074	0.01804	6.14	<.0001
ethnic_black	1	-0.00430	0.00668	-0.64	0.5203
ethnic_hisp	1	-0.02847	0.00697	-4.09	<.0001
ethnic_asian	1	-0.01107	0.00648	-1.71	0.0877
ethnic_indian	1	-0.00736	0.00923	-0.80	0.4252
ethnic_nativeAK	1	-0.03643	0.00406	-8.97	<.0001
assign_elem	1	0.00171	0.00222	0.77	0.4410
assign_mathsci	1	0.00784	0.00391	2.01	0.0447
assign_multgrade	1	-0.01910	0.00218	-8.75	<.0001
assign_se	1	0.00918	0.00305	3.01	0.0026
assign_004	1	-0.03368	0.00940	-3.58	0.0003
headtchr	1	0.09019	0.00833	10.82	<.0001
secondary_school	1	0.00534	0.00272	1.96	0.0498
totlfr_radius	1	0.09345	0.01695	5.51	<.0001
wage_index	1	0.12976	0.01307	9.93	<.0001
utilities	1	-0.01141	0.00385	-2.96	0.0031
hdd	1	-0.00001966	0.00000449	-4.38	<.0001
hdd2	1	7.92115E-10	1.74218E-10	4.55	<.0001
cdd	1	0.00172	0.00011632	14.75	<.0001
minDistanceCC	1	0.00010924	0.00000592	18.47	<.0001
lowrain	1	-0.02297	0.00404	-5.69	<.0001
water_radius	1	-0.01678	0.00253	-6.64	<.0001
member_lea_1000	1	0.06483	0.00760	8.53	<.0001
member_lea_2500	1	0.07364	0.00729	10.10	<.0001
member_lea_10000	1	0.07755	0.00801	9.68	<.0001
member_lea_250	1	0.05326	0.00727	7.32	<.0001
AKNative	1	0.06117	0.00531	11.51	<.0001
Asian	1	0.11211	0.01560	7.19	<.0001
Black	1	-0.11687	0.02110	-5.54	<.0001
Hispanic	1	-0.02361	0.03293	-0.72	0.4735

Appendix E.

Index Values of Salary Models, and Correlations between Final and Alternative Equations

Exhibit E-1. Index Values of Salary Models

	district ID	PRIMARY			ALTERNATIVE		
		Admin Tobit	Teacher Regression: Salary & Benefits	Classified Regression: Wage	Teacher Regression: Salary	Teacher Tobit	Admin Regression: Salary & Benefits
		admintobit	tchrben	class02	tchr02	tchrtobit	adminben
Denali Borough	2	0.97	1.00	1.01	1.01	1.03	0.94
Alaska Gateway	3	0.97	1.05	1.09	1.05	1.09	0.96
Aleutian Region	4	1.25	1.17	1.23	1.18	1.22	1.04
Anchorage	5	1.00	1.00	1.00	1.00	1.00	1.00
Annette Island	6	0.95	1.08	0.93	1.06	1.07	0.94
Bering Strait	7	1.05	1.11	1.19	1.11	1.13	1.07
Bristol Bay Borough	8	1.01	1.03	1.03	1.03	1.06	0.99
Chatham Region	9	1.05	0.95	0.92	0.94	0.96	0.93
Chugach	10	1.11	0.96	0.98	0.96	0.99	0.95
Copper River	11	0.99	0.99	1.05	1.00	1.03	0.98
Cordova City	12	0.99	1.04	0.96	1.04	1.05	0.99
Craig City	13	0.95	1.02	0.90	1.01	1.02	0.96
Delta Greely	14	0.94	1.00	0.98	1.00	1.00	0.95
Dillingham City	15	1.02	1.08	1.05	1.07	1.09	1.01
Fairbanks North Star Borough	16	0.97	1.06	1.04	1.06	1.05	0.94
Galena City	17	0.97	1.04	1.14	1.06	1.06	0.96
Haines Borough	18	0.94	0.99	0.90	0.98	0.98	0.97
Hoonah City	19	1.06	0.95	0.93	0.94	0.96	0.95
Hydaburg City	20	1.00	1.02	0.91	1.00	1.03	0.88
Iditarod Area	21	0.93	1.01	0.98	1.00	1.03	0.95
Juneau Borough	22	0.99	1.01	1.02	1.02	1.03	0.98
Kake City	23	1.09	0.97	0.93	0.96	0.99	0.96
Kenai Peninsula Borough	24	0.97	0.96	1.03	0.97	0.99	0.97
Ketchikan Gateway Borough	25	0.99	1.04	0.92	1.03	1.02	1.00
Klawock City	27	1.05	0.97	0.91	0.97	0.98	0.93
Kodiak Island Borough	28	0.97	1.03	1.03	1.04	1.06	0.98
Kuspuk	29	0.99	1.06	1.07	1.05	1.08	1.01
Lake And Peninsula	30	0.96	1.04	0.99	1.03	1.05	0.97
Lower Kuskokwim	31	1.04	1.07	1.23	1.08	1.12	1.03
Lower Yukon	32	1.02	1.09	1.13	1.08	1.09	1.06
Matanuska-Susitna Borough	33	0.96	0.98	0.96	0.98	0.98	0.97
Nenana City	34	0.93	0.99	0.98	0.98	0.98	0.95
Nome City	35	1.03	1.05	1.12	1.05	1.08	1.05
North Slope Borough	36	1.17	1.18	1.48	1.21	1.24	1.14
Northwest Arctic	37	1.07	1.14	1.24	1.14	1.16	1.06
Pelican City	38	1.03	0.95	0.90	0.94	0.96	0.93
Petersburg City	39	0.94	1.01	0.91	1.00	1.02	0.95
Pribilof Island	40	1.25	1.13	1.22	1.13	1.16	1.05
Sitka Borough	42	1.00	1.02	0.93	1.01	1.01	1.02
Skagway City	43	1.04	0.95	0.90	0.95	0.96	0.91
Southeast Island	44	1.01	0.94	0.87	0.94	0.95	0.90
Southwest Region	45	0.97	1.06	1.03	1.05	1.07	0.98
Saint Marys City	46	1.12	1.01	1.09	1.01	1.05	1.01
Unalaska City	47	1.05	1.14	1.08	1.15	1.17	1.05
Valdez City	48	1.01	1.02	0.98	1.01	1.02	1.00
Wrangell City	49	0.94	1.01	0.89	1.00	1.01	0.95
Yakutat City	50	1.09	0.97	0.97	0.97	1.00	0.97
Yukon Flats	51	0.93	1.03	1.06	1.02	1.06	0.97
Yukon Koyukuk	52	0.94	1.10	1.06	1.09	1.11	0.95
Tanana City	53	1.04	1.00	1.03	0.99	1.02	0.93
Yupit	54	0.98	1.06	1.08	1.05	1.09	0.99
Kashunamiut	55	1.02	1.08	1.14	1.08	1.12	1.03
Aleutians East Borough	56	1.10	1.14	1.12	1.13	1.15	1.05

Exhibit E-2. Correlations Between Final and Alternative Equations

Pearson Correlation Coefficients, N = 55²⁶
 Prob > |r| under H0: Rho=0

Correlation Between Primary Model and 2 Alternative Models for Teachers

	Teacher Regression: Salary	Teacher Tobit
Teacher Regression: Salary & Benefits	0.98881 <.0001	0.96753 <.0001

Correlation Between 2 Alternative Teacher Salary Models

	Teacher Tobit
Teacher Regression: Salary	0.98227 <.0001

Correlation Between Primary Model and Alternative Model for Administrators

	Admin Regression: Salary & Benefits
Admin Tobit	0.47594 .0002

²⁶ The 55 districts include the 53 districts in the study and the Alyeska and Mt. Edgecumbe school districts. In the study, the Alyeska school district receives the Anchorage index value, and the Mt. Edgecumbe school district receives the Sitka index value.

Appendix F.

Energy Prototypes

This appendix contains the basic characteristics that were used in developing the DOE2 prototype models for the Urban Cold Climate region of Alaska. The prototypes were primarily derived from plans and characteristics provided by the Anchorage School District. One model was derived from plans of West High School, which has characteristics and total fuel consumption typical of Anchorage high schools. The other model was based on plans of North Star Elementary School, which was determined to be typical of Anchorage elementary and middle schools.

West High School (Urban, Cold Climate, High School Prototype)

The West High School envelope characteristics obtained from construction plans are summarized in Table 1. These include area summaries by use zone for floor, gross wall, roof and window surfaces. It also includes the summary of exterior perimeter footing length and maps the observed use zones in to the zones utilized in the hourly computer model. The envelope area data was then scaled to a 100,000 square foot building model with seven thermal zones. Table 2 provides the summary of the floor and envelope areas scaled to the hourly model.

Additional envelope characteristics obtained from the plans are as follows:

- Wall insulation is R19 with metal stud framing.
- Roof insulation is R38 on flat roof.
- Windows are double pane with thermally broken aluminum frames.

Table 3 provides a summary of the lighting and miscellaneous equipment power densities used in the model. The lighting power densities were calculated from data obtained from the lighting plans of West High School. The equipment power densities were obtained from school prototype models based on previous work completed for the Pacific Northwest Region. These models utilized end-use metered data with extensive audit data to determine equipment power densities and consumption.

The HVAC systems include variable air volume air handlers serving the classroom zones with constant volume air handles serving other areas. There is a central plant with boilers that provide hot water for space heating, domestic water heating and swimming pool heating.

Tables 4 and 5 summarize the operational characteristics of the prototype for the regular school term and the summer school term, respectively. The operating hours are summarized by zone for lighting, miscellaneous equipment, occupants and HVAC occupied settings. The operating hours were obtained from the Operational Characteristics surveys completed by committee members representing eight school districts across the state. There were relatively small differences in operating hours reported in the surveys.

North Star Elementary School (Urban, Cold Climate, Elementary School Prototype)

The North Star Elementary School envelope characteristics obtained from construction plans are summarized in Table 6. These include area summaries by use zone for floor, gross wall, roof and window surfaces. It also includes the summary of exterior perimeter footing length and maps the observed use zones in to the zones utilized in the hourly computer model. The envelope area data was then scaled to a 100,000 square foot building model with six thermal zones. Table 7 provides the summary of the floor and envelope areas scaled to the hourly model.

Additional envelope characteristics obtained from the plans are as follows:

- Wall insulation is R15 with metal stud framing.
- Roof insulation is R38 on flat roof.
- Windows are double pane with thermally broken aluminum frames.

Table 8 provides a summary of the lighting and miscellaneous equipment power densities used in the model. The lighting power densities were calculated from data obtained from the lighting plans of North Star Elementary School. The equipment power densities were obtained from school prototype models based on previous work completed for the Pacific Northwest Region. These models utilized end-use metered data with extensive audit data to determine equipment power densities and consumption.

The HVAC systems include variable air volume air handlers serving the classroom and office zones with constant volume air handles serving other areas. Radiant baseboard heat supplements in the perimeter areas of the classroom and office spaces. There is a central plant with boilers that provide hot water for space heating and domestic water heating.

Tables 9 and 10 summarize the operational characteristics of the prototype for the regular school term and the summer school term, respectively. The operating hours are summarized by zone for lighting, miscellaneous equipment, occupants and HVAC occupied settings. The operating hours were obtained from the Operational Characteristics surveys completed by committee members representing eight school districts across the state. There were relatively small differences in operating hours reported in the surveys.

Table 1: West High School Building Envelope Areas

Use Zone:	Floor Area, sq. ft.	Floor Area, percent	Model Zone Name	Wall Area, sq. ft.	Roof Area, sq. ft.	Perimeter Length, ft.	Window Area, sq. ft.
Classroom	109,566	35.5%	Class	48,639	91,386	3,253	6,520
Office/admin	19,932	6.5%	Office	5,479	19,644	403	564
Gym/auditorium	26,912	8.7%	Auditorium	7,942	17,760	94	0
kitchen	2,720	0.9%	Kitchen	0	2,720	0	0
dining	10,920	3.5%	Auditorium	7,254	10,920	348	148
library	13,088	4.2%	Office	2,164	13,088	148	0
hall/corridor	53,444	17.3%	Hall	1,260	48,804	880	992
locker room/bathroom	13,789	4.5%	Hall	5,087	12,924	329	200
mechanical/electrical	13,018	4.2%	Storage	7,784	5,506	208	0
swimming pool	10,368	3.4%	Pool	8,200	10,368	192	32
Storage	15,204	4.9%	Storage	4,724	13,448	308	56
Theatre	20,048	6.5%	Auditorium	13,800	10,448	320	0
Total	309,009	100%		112,333	257,016	6,483	8,512

Table 2: High School Building Envelope Areas Scaled to Prototype Model

Model Zone	Floor Area, %	Floor Area, sq. ft.	Exterior Wall Area, sq. ft.	Roof Area, sq. ft.	Perimeter Length, ft.	Window Area, sq. ft.
Class	35%	35,000	15,740	29,574	1,053	2,110
Kitchen	1%	1,000	-	880	-	-
Auditorium	19%	19,000	9,384	12,662	247	48
Hall	22%	22,000	2,054	19,976	391	386
Pool	3%	3,000	2,654	3,355	62	10
Storage	9%	9,000	4,048	6,134	167	18
Total	100%	100,000	36,353	83,174	2,098	2,755

Table 3: High School Model Lighting and Equipment Power Densities

Model Zone	Lighting Watts per sq. ft.	Equipment Watts per sq. ft.
Class	1.94	1.0
Kitchen	1.30	35.0
Auditorium	1.20	1.0
Hall	0.63	1.0
Pool	1.80	1.0
Storage	0.66	1.0

Table 4: High School Operating Hours for Regular School Term

Model Zone	lights	Equipment	People	HVAC
Class	hrs 8-16	hrs 8-16	hrs 8-16	hrs 8-16
Office	hrs 8-17	hrs 8-17	hrs 8-17	hrs 8-17
Kitchen	hrs 8-16	hrs 8-16	hrs 8-16	hrs 8-16
Auditorium	hrs 8-22	hrs 8-22	hrs 8-22	hrs 8-22
Hall	hrs 8-22	hrs 8-22	hrs 8-22	hrs 8-16
Pool	hrs 8-22	hrs 8-22	hrs 8-22	hrs 8-22
Storage	hrs 8-16	hrs 8-16	hrs 8-16	hrs 8-16

Heating setpoint occupied: 71F; unoccupied: 71F

Table 5: High School Operating Hours for Summer School Term

Model Zone	lights	Equipment	People	HVAC
Class	hrs 8-12	hrs 8-12	hrs 8-12	hrs 8-12
Office	hrs 8-17	hrs 8-17	hrs 8-17	hrs 8-17
Kitchen	none	none	none	none
Auditorium	hrs 8-17	hrs 8-17	hrs 8-17	hrs 8-17
Hall	hrs 8-12	hrs 8-12	hrs 8-12	hrs 8-12
Pool	hrs 8-17	hrs 8-17	hrs 8-17	hrs 8-17
Storage	hrs 8-12	hrs 8-12	hrs 8-12	hrs 8-12

Heating setpoint occupied: 71F; unoccupied: 71F

Table 6: North Star Elementary School Building Envelope Areas

Use Zone:	Floor Area, sq. ft.	Floor Area, percent	Model Zone Name	Wall Area, sq. ft.	Roof Area, sq. ft.	Perimeter Length, ft.	Window Area, sq. ft.
Classroom	34,720	47.0%	Class	15,873	38,220	1,221	2,358
Office/admin	3,628	4.9%	Office	2,808	4,000	216	384
Gym/auditorium	6,776	9.2%	Auditorium	1,846	6,776	0	0
kitchen	1,512	2.0%	Kitchen	650	1,700	50	0
dining	4,488	6.1%	Auditorium	998	4,488	24	0
library	2,480	3.4%	Office	2,522	2,500	158	216
hall/corridor	12,168	16.5%	Hall	1,495	13,500	10	0
locker room/bathroom	2,592	3.5%	Hall	0	2,900	0	0
mechanical/electrical	2,794	3.8%	Storage	390	3,000	30	0
swimming pool		0.0%		0	0	0	0
Storage	2,636	3.6%	Storage	806	2,900	62	0
Theatre	0	0.0%		0	0	0	0
Total	73,794	100%		27,388	79,984	1,771	2,958

Table 7: Elementary School Building Envelope Areas Scaled to Prototype Model

Model Zone	Floor Area, %	Floor Area, sq. ft.	Exterior Wall Area, sq. ft.	Roof Area, sq. ft.	Perimeter Length, ft.	Window Area, sq. ft.
Class	47%	47,000	21,510	51,793	1,655	3,195
Office	8%	8,000	7,223	8,808	507	813
Kitchen	2%	2,000	881	2,304	68	-
Auditorium	15%	15,000	3,854	15,264	33	-
Hall	20%	20,000	2,026	22,224	14	-
Pool	0%	-	-	-	-	-
Storage	8%	8,000	1,621	7,995	125	-
Total	100%	100,000	37,114	108,388	2,400	4,008

Table 8: Elementary School Model Lighting and Equipment Power Densities

Model Zone	Lighting Watts per sq. ft.	Equipment Watts per sq. ft.
Class	1.61	1.0
Office	1.42	2.7
Kitchen	1.30	35.0
Auditorium	1.95	1.0
Hall	0.46	1.0
Pool	0.00	1.0
Storage	0.66	1.0

Table 9: Elementary School Operating Hours for Regular School Term

Model Zone	lights	Equipment	People	HVAC
Class	hrs 8-16	hrs 8-16	hrs 8-16	hrs 8-16
Office	hrs 8-17	hrs 8-17	hrs 8-17	hrs 8-17
Kitchen	hrs 8-16	hrs 8-16	hrs 8-16	hrs 8-16
Auditorium	hrs 8-22	hrs 8-22	hrs 8-22	hrs 8-21
Hall	hrs 8-22	hrs 8-22	hrs 8-22	hrs 8-16
Pool	n/a	n/a	n/a	n/a
Storage	hrs 8-16	hrs 8-16	hrs 8-16	hrs 8-16

Heating setpoint occupied: 72F; unoccupied: 72F

Table 10: Elementary School Operating Hours for Summer School Term

Model Zone	lights	Equipment	People	HVAC
Class	hrs 8-12	hrs 8-12	hrs 8-12	hrs 8-12
Office	hrs 8-17	hrs 8-17	hrs 8-17	hrs 8-17
Kitchen	none	none	none	none
Auditorium	hrs 8-16	hrs 8-16	hrs 8-16	hrs 8-16
Hall	hrs 8-12	hrs 8-12	hrs 8-12	hrs 8-12
Pool	n/a	n/a	n/a	n/a
Storage	hrs 8-12	hrs 8-12	hrs 8-12	hrs 8-12

Heating setpoint occupied: 72F; unoccupied: 72F

Appendix G. Detailed Analysis Of The Cost Of Goods

Chapter V discusses the approach to creating and the analysis of the various non-personnel indices. Here, we look at an example of how one would apply an equation used to calculate one of those indices. The example is of the index for any good. The general equation is the first equation found below. All calculations were made at the school level and then aggregated to the district level by pupil enrollment weights. The index for each good is calculated by taking the pupil-weighted values of each school, considering the proper proportion of times each method is used to ship the goods. In this discussion, "total cost" is the cost of the item plus the cost of shipping. The district value is then divided by the value of the Anchorage School District. The equation for each good is found below, where the subscript "i" represents the district for which the index value is generated, and subscript "A" stands for the base Anchorage School District. Any good is represented by subscript "k" in school "j."

$$\text{Good Index}_{ik} = \frac{\sum (\text{school enrollment})_{ij} \times \{[(\text{method \#1 total cost})_{ijk} \times (\% \#1)_{ijk}] + [(\text{method \#2 total cost})_{ijk} \times (\% \#2)_{ijk}]\}}{\sum (\text{school enrollment})_{ij}} \div \frac{\sum (\text{school enrollment})_{Aj} \times \{[(\text{method \#1 total cost})_{Ajk} \times (\% \#1)_{Ajk}] + [(\text{method \#2 total cost})_{Ajk} \times (\% \#2)_{Ajk}]\}}{\sum (\text{school enrollment})_{Aj}}$$

We now that this equation and use it in an example of how the equation is actually applied. First, we specify what the general terms, so that we can calculate the index value for the district in our example.

General term	Example
District <i>i</i>	District 57
School <i>j</i>	School 1 School 2 School 3
Good <i>k</i>	One case (10 reams) of white copier paper (8.5" by 11")

Next, look at the data for the district.

District #57

			One case (10 reams) of white copier paper (8.5" x 11")						
			Method #1 of purchasing item			Method #2 of purchasing item			
School ID	School Name	School Enrollment	Trans. Method code	Cost of one case	Cost of item plus shipping	Trans. Method code	Cost of item when bought using this method	Cost of item plus shipping	Percent of copier paper bought using this other method
570001	School 1	23	A_S	\$29.90	\$38.48	W	\$27.90	\$43.95	30%
570002	School 2	15	A_S	\$29.90	\$38.48	W	\$27.90	\$43.95	20%
570003	School 3	23	A_S	\$29.90	\$38.48	A_C	\$30.25	\$58.50	10%

To calculate the index for instructional and office supplies in district 57, let's look at one school at a time.

The general equation for each school in the district is:

$$\text{School}_{jk} = \{[(\text{method \#1 total cost})_{jk} \times (\% \#1)_{jk}] + [(\text{method \#2 total cost})_{jk} \times (\% \#2)_{jk}]\}$$

We start with School 1, and examine the data we are given for this school. School 1 uses two methods to get paper. Usually, the school receives paper via scheduled air delivery, which comes to a total cost of \$38.48 for the case of paper plus shipping. However, 30 percent of the time, School 1 must use a more costly method of obtaining paper. When School 1 ships via water, we see that the cost of the item is \$2 less, but the total cost of the item is \$43.95. School 1 uses this alternative method 30 percent of the time. The equation for the cost of paper at School 1 is:

$$\text{Average Cost of Paper for School 1} = \{[(\$38.48) \times (.70)] + [(\$43.95) \times (.30)]\} = \$40.12$$

As the data reveal, School 2 in District 57 has the same cost for shipping paper to it as School 1. However, School 2 ships paper via scheduled air 80 percent of the time. Therefore, our equation for the cost of paper at School 2 is:

$$\text{Average Cost of Paper for School 2} = \{[(\$38.48) \times (.80)] + [(\$43.95) \times (.20)]\} = \$39.57$$

School 3 has the same cost for method #1 as do the other two schools, but it utilizes this method 90 percent of the time. The alternative method for School 3 is via chartered air, which has a total cost of \$58.50. The average cost of School 3 is:

$$\text{Average Cost of Paper for School 3} = \{[(\$38.48) \times (.90)] + [(\$58.50) \times (.10)]\} = \$40.48$$

To aggregate these costs to the district level, we must consider how much each school consumes. The way we have chosen to do this is to weight the average cost at each school by the pupil enrollment. First, we sum the total enrollment of the three schools at District 57, which equal 61. Then, we weight the average cost of paper at each school by its enrollment divided by the district enrollment. This means that the average cost at School 1 is multiplied by 23/61 because it has 23 students. Since School 2 has only 15 students, the average cost of paper at this school is weighted by 15/61. School 3 also has 23 students, so its average cost receives the same weight as School 1.

Average Cost of Paper for District 57 = $\{[(\$40.12) \times (23/61)] + [(\$39.57) \times (15/61)] + [(\$40.48) \times (23/61)]\} = \$40.12$

This is the same as saying we multiply the average cost of paper at each school by its enrollment, then sum together these totals and divide by the district enrollment

$$\text{Average Cost of Paper for District 57} = \frac{\{[(\$40.12) \times (23)] + [(\$39.57) \times (15)] + [(\$40.48) \times (23)]\}}{61} = \$40.12$$

Finally, divide the Average Cost in District 57 by the base district Anchorage to get the instructional and office supplies index value for District 57. The average cost of paper in Anchorage is \$21.44.

[note: the average cost of paper for Anchorage is calculated using the same method as hypothetical District 57]

$$\text{Instructional Supplies Index for District 57} = \frac{\$40.12}{\$21.44} = 1.87$$

The final index value for instructional and office supplies is 1.87 for District 57.

Appendix H. Detailed Analysis Of The Cost Of Travel

The costs of non-personnel services, such as travel costs, are examined in Chapter V of the report. District-wide professional development would entail travel from each school site to the district office. To calculate the cost of such professional development, we developed a set of equations described below. Here, we use the example of hypothetical District 57. The general equation is the first equation found below. All calculations were made at the school level and then aggregated to the district level by weighting by the teacher full-time equivalents (FTE) at each school. The trip index considers whether or not the school is located in a remote area of the district. A school is termed "remote" if travel to the school site from the district office requires an overnight stay. Travel to remote schools is more costly due to required lodging and additional meals. The addition of a \$450 per diem calculated into the cost of lodging and meals. This per diem figure of \$450 was determined through a series of conversations with the TWG. The district value is then divided by the value of the Anchorage School District. The equation for this cost index is found below, where the subscript "i" represents the district for which the index value is generated, and subscript "A" stands for the base Anchorage School District. Any school "j" found within a district is denoted by the subscript "r" if it is a remote school, while non-remote schools contain the subscript "n."

$$\text{Trip Index}_i = \frac{\text{Trip Cost}_{ir} + \text{Trip Cost}_{in}}{\frac{\sum (\text{school FTE})_{Aj} \times (\text{roundtrip cost from school to d.o.})_{Aj}}{\sum (\text{school FTE})_{Aj}}}$$

where

$$\text{Trip Cost}_{ir} = \frac{\sum (\text{school FTE})_{jr} \times (\text{roundtrip cost from school to d.o.})_{jr} + (450)_{jr}}{\sum (\text{school FTE})_{jr}}$$

and

$$\text{Trip Cost}_{in} = \frac{\sum (\text{school FTE})_{jn} \times (\text{roundtrip cost from school to d.o.})_{jn}}{\sum (\text{school FTE})_{jn}}$$

We now look at the general equation and use it in an example of how the equation is actually applied. First, we specify what the general terms, so that we can calculate the index value for the district in our example.

General term	Example
District <i>i</i>	District 57
Remote School <i>jr</i>	School 3
Non-remote Schools <i>jn</i>	School 1
	School 2

Next, look at the data for the district.

District #57						
			School to District Office Travel			
School ID	School Name	School FTE	Trans. Method code	One-way travel time (hh:mm)	Roundtrip cost	Overnight stay required
570001	School 1	3	A_S	2:00	\$939	N
570002	School 2	1	A_S	1:30	\$840	N
570003	School 3	2	A_C	5:00	\$1,210	Y

To calculate the index for travel between each school and the district office in district 57, let's look at one school at a time.

First, we must see if each school is a "remote" school or a "non-remote" school. By looking in the data column titled "Overnight stay required," we see that only School 3 is a remote school. Schools 1 and 2 are non-remote.

Therefore, the equation for School 3 must be that of a remote school, which adds the per diem of \$450.

$$\text{Cost of Travel from District Office to School 3} = \$1,210 + \$450 = \$1,660$$

Schools 1 and 2 do not require an overnight stay, so their equations follow the non-remote general form.

$$\text{Cost of Travel from District Office to School 1} = \$939$$

$$\text{Cost of Travel from District Office to School 2} = \$840$$

To aggregate these costs to the district level, we must consider how many trips are made from each school to the district office. The way we have chosen to do this is to weight the average cost at each school by the pupil enrollment. First, we sum the total enrollment of the three schools at District 57, which equal 61. Then, we weight the average cost of a trip from each school by its enrollment divided by the district enrollment. This means that the average cost of \$1,660 at School 3 is multiplied by 3/61 because it has 3 of the district's 61 FTEs. Since School 2 has only 1 FTE, the average cost of a trip from this school is weighted by 1/61. School 3 has 2 FTEs, so its average cost receives a weight of 2/61.

$$\text{Average Cost of Travel to D.O. for District 57} = \{[(\$1,660) \times (3/61)] + [(\$939) \times (1/61)] + [(\$840) \times (2/61)]\} = \$1267$$

This is the same as saying we multiply the average cost of a trip from each school by its FTE, then sum together these totals and divide by the district FTE.

$$\text{Average Cost of Travel to D.O. for District 57} = \frac{\{[(\$1660) \times (2)] + [(\$939) \times (1)] + [(\$840) \times (3)]\}}{6} = \$1,267$$

Finally, divide the Average Cost in District 57 by the base district Anchorage to get the instructional and office supplies index value for District 57. The average cost of a trip from the district office to a school in Anchorage is \$6.50.

[note: the average cost of a trip from the district office to a school for Anchorage is calculated using the same method as that used for hypothetical District 57]

$$\text{Index for Travel between Schools and District Office for District 57} = \frac{\$1,267}{\$6.50} = 195$$

The final index value for travel between schools and the district office is 195 for District 57.

Appendix I. Calculation of the GCEI

Index Calculation and Formulas

Fixed-Market-Basket (FMB) Approach

Briefly, the FMB index approach makes the assumption that the public school district purchases the *same inputs* over time to produce educational services for the students enrolled. It makes use of data about the prices and quantities of these inputs (e.g., teachers and instructional aides). Exhibit I-A illustrates how a fixed-market-basket index may be constructed for a public school district. In this simple example, it is assumed that there are only two inputs utilized by this school district: namely, teachers and instructional aides. Obviously, a real public school district uses many inputs to produce educational services, and the GCEI presented in this report reflects these other inputs. However, for the purposes of illustration, this simple two-input model of a public school district may be used to demonstrate one of the problems that arises in the construction of price indexes. The problem is that the combinations of inputs (i.e., market-baskets) used to produce a given level of services or outputs are not fixed, and the estimated index of cost differences (whether geographic or inflationary) will depend upon which observation is chosen as a base for purposes of calculating the index.

Exhibit I-A shows the budget or expenditures of a two-input school under alternative assumptions for two different districts, A and B, designated in column 1. *[The reader should note that districts A and B can either be the same district at two points in time or different districts at a single point in time. The analysis and interpretation will be the same]* Columns 2 through 5 represent the prices (S, W) and quantities (T, A) of the two inputs -- teachers and aides -- purchased by districts A and B. The first six columns are relatively self-explanatory. In district A, district A paid annual wages amounting to \$31,000 per full-time-equivalent (FTE) teacher and employed 0.0500 FTE teachers per pupil (i.e., 1 teacher for every 20 students). In addition, district A paid an average price of \$15,000 per FTE instructional aide and employed 0.0125 FTE aides per pupil (i.e., 1 FTE aide for every 80 students). In district B, the annual wage of a full-time teacher is \$33,000 (10 percent higher than district A) and the district employed 0.0550 FTE teachers per pupil (i.e., 1 FTE teacher for every 18.2 pupils). FTE salaries for instructional aides are \$15,500 in district B (3.3 percent higher than in district A) and the district employed 0.02 FTE aides per pupil (i.e., 1 for every 50 students).

The total in column 6 is the actual per pupil budget of each district. Based on these figures, district A spends \$1,688 per pupil and district B spends \$2,125 or 25.93 percent more than district A. But how much of this increase in the budget was due to inflation in the prices of school inputs, and how much was due to increases in the quantities of school inputs purchased?

Exhibit I-A. Hypothetical Example of a Fixed-Market-Basket Public School District Price Index

District (1)	Average Annual Teacher Wage (2)	FTE Teachers per Pupil (3)	Average Annual Wage for Aides (4)	FTE Aides per Pupil (5)	Total Budget per Pupil (6)	Simulated Budgets Using Inputs From:		Alternative FMB, CEIs Using Inputs From:	
						District A (7)	District B (8)	District A (9)	District B (10)
A	\$30,000	0.0500	\$15,000	0.0125	\$1,688	\$1,688	\$1,950	100.00	91.76
B	\$33,000	0.0550	\$15,500	0.0200	\$2,125	\$1,844	\$2,125	109.26	100.00
Index: B/A	1.1000	1.1000	1.0333	1.6000	1.2593	1.0926	1.0897	1.0926	1.0897
% Diff.	10.00%	10.00%	3.33%	60.00%	25.93%	9.26%	8.97%	9.26%	8.97%

Columns 7 and 8 simulate the budget for these sample districts under alternative assumptions about the market basket of school inputs purchased. Column 7 simulates what the each district's budget would have been if it had purchased the same quantities of school inputs as district A. Column 8 simulates what the district budget would have been in each year if it had purchased the same quantities of school inputs as did district B.

Comparison of these simulated budgets using the fixed-market-baskets of inputs permits one to develop estimates of price inflation between the two years, since the only differences between the two budgets presented in each column are the differences in prices of the inputs. For example, using district A purchases of inputs as the base, one defines the *CEI* to be 100.00 for district A (the base district), and computes an index of 109.26 (the ratio of \$1,844 to \$1,688) for district B. Since the quantities of inputs are fixed, the only difference between these two simulated budgets are in the prices paid for the inputs. An estimate of inflation between the two years using year 1 as the base is calculated as follows:

$$\begin{aligned}\text{Estimate of price inflation} &= 100 \times (1,844 - 1,688)/1,688 \\ &= 9.26\%\end{aligned}$$

If districts A and B are simply the same district in two different years and A represents the first year of the series and B represents a subsequent year of the series, this representation of the *CEI* would be referred to as a *Laspeyres index* (which is defined as the index based purchases in the earliest year in the series of data).

The problem that arises becomes apparent when a different base district (or year) is selected to calculate the FMB index. If district B purchases of inputs are used as the base (see columns 8 and 10), the *CEI* for district A is 91.76 and the *CEI* for district B is 100.00. Once again, since the quantities of inputs are fixed, the only difference between these two simulated budgets are in the prices paid for the inputs. An estimate of inflation between the two districts using district B as the base is calculated as follows:

$$\begin{aligned}\text{Estimate of price inflation} &= 100 \times (\$2,125 - \$1,950) / \$1,950 \\ &= 8.97\%\end{aligned}$$

In both cases, the ratio is the difference, divided by district A's simulated budget. Again, if this comparison is of the same district at two points in time, the *CEI* calculated based on the later year's purchases of inputs (district B in this case) is commonly referred to by economists as a *Paasche index*.

Both of these indexes represent fixed-market-basket public school district price indexes. Each essentially represents a weighted average of the price inflation for the two school inputs where the weights are the quantities of inputs purchased. These weights simply measure the importance of each input in the overall budget for school services. It is no surprise that the two indexes result in different estimates of inflation because each uses a different set of weights. The *Laspeyre index*, which uses district A (i.e., year 1) budget shares, in this instance provides a higher estimate of inflation (9.26 percent) than the *Paasche index* (8.97 percent), which uses district B (i.e., year 2) budget shares.

It should also be noted that in this simple example the *quality* of school inputs is assumed to be constant between districts A and B. Consequently, salary differences in this simple example are assumed to reflect differences in the prices of comparable teachers and aides.

Because data are simply not available on all of the detailed quantities and prices of the individual items actually purchased by school districts, it is necessary to use an alternative expression to define the FMB *CEI*. That is, data on the quantities and prices of books and computers and even different categories of personnel (administrators, teachers, custodians, and aides) are not available in the simple form expressed in Exhibit I-A. The data that are available are generally expressed in the form of shares of school district budgets allocated to different categories of inputs and different indexes from various sources on the changes in the prices paid for individual inputs.

The FMB *CEI* presented above can be expressed in the following form:

$$\text{Eq. I-1} \quad \text{FMB-CEI} = \text{TCI}_B \times \text{TSHARE}_A + \text{ACI}_B \times \text{ASHARE}_A$$

where

TCI_B = the teacher cost index for district B (the ratio of FTE teacher salaries for district B to FTE teacher salaries in the base district A in this case);

TSHARE_A = the proportion of school district budgets allocated to teachers salaries in the base district A (i.e., the *budget share* for teachers);

ACI_B = the instructional aide cost index for district B (the ratio of FTE aide salaries for district B to FTE aide salaries in the base district A in this case);

$ASHARE_A$ = the proportion of school district budgets allocated to instructional aides in the base district A (i.e., the *budget share* for aides).

Using the data from table 1, one can calculate the *Laspeyre index* as follows:

$$TCI_B = 100 \times \$33,000/\$30,000 = 110.00$$

$$TSHARE_A = \$30,000 \times 0.0500/\$1,688 = .89$$

$$ACI_B = 100 \times \$15,500/\$15,000 = 103.33$$

$$ASHARE_A = \$15,000 \times 0.0125/\$1,688 = .11$$

$$Eq. I-2 \text{ Laspeyre Index (comparing B to A)} = 110.00 \times .89 + 103.33 \times .11 = 109.26$$

The *Laspeyre index* is the one most commonly used for the development of price indexes and is currently the methodology used by the Bureau of Labor Statistics (BLS) for the calculation of the consumer price index. However, it should be noted that the BLS does change the budget weights (shares) corresponding to each component about every ten years to account for differences in spending patterns over time.

Using the data from table 1, one can calculate the *Paasche index*, which uses district B as the base district, as follows:

$$TCI_A = 100 \times \$30,000/\$33,000 = 90.91$$

$$TSHARE_B = \$33,000 \times 0.0550/\$2,125 = .85$$

$$ACI_A = 100 \times \$15,000/\$15,500 = 96.77$$

$$ASHARE_B = \$15,500 \times 0.0200/\$2,125 = .15$$

$$Eq. I-3 \text{ Paasche Index (comparing A to B)} = 90.91 \times .85 + 96.77 \times .15 = 91.76.$$

Inverting this *Paasche index* to compare district B to district A, the index of relative cost differences is 108.97 ($=100 \times 100/91.76$).

It can be seen that whichever way the indices are calculated (i.e., using actual quantities or budget shares as weights), the *Laspeyre* and *Paasche* indices are different because each uses a different base measurement. While both indices purport to measure the true cost difference between district A and B, it can be shown that the *Laspeyre* index over-estimates the rate of inflation (using district A and B to represent the same district at two points in time), while the *Paasche* index under-estimates the rate of inflation. The reason for this lies in the fact that neither of these FMB indexes account for the substitution of one input for another that occurs as

relative prices of the inputs change. This is commonly referred to as *commodity substitution* in the literature on the development of price indices.

The notion underlying commodity substitution is easily understood, though more difficult to measure. It is simply the notion that one can produce the same level of educational quality (or consumer satisfaction) with various combinations of the inputs, i.e., teachers and aides. Using the example in table 1, the relative price of teachers is higher in district B. There are two ways to illustrate this. First, district B pays 10 percent higher teachers salaries than district A, while district B pays only 3.3 percent higher salaries for aides. Second, the ratio of teacher salaries to aide salaries is higher in district B (i.e., $2.13 = 33,000/15,500$) than district A (i.e., $2.00 = 30,000/15,000$).

Whichever way one measures it, one might expect that district B could produce the same quality educational services as district A by substituting teachers aides for teachers. But it is precisely this impact on quality of educational services that one cannot measure. In fact, in the simple example in table 1, one can see that there has been a substitution away from teachers to aides in district B relative to district A. That is, the ratio of teachers to teacher aides is higher in district A (i.e., ratio of teachers to aides is $4.0 = 0.0500/0.0125$) than in district B (i.e., ratio of teachers to aides is $2.75 = 0.0550/0.0200$). But district B purchases more of both inputs because it simply has greater revenues to spend on educational services. While the FMB *CEI* controls for the level of usage of teachers and aides in calculating the impact of inflation, it does not account for the possibility of this substitution between inputs that may tend to occur in educational production. Substituting purchases away from the relatively more costly input will tend to reduce the difference in expenditure required to achieve a given level of educational output (or quality).

Superlative Indexes and Commodity Substitution Bias

Recognizing this problem, how does one deal with the commodity or input substitution bias that occurs with the FMB estimates of the *CEI*. Economists for years contended that the only way of resolving this problem required detailed knowledge of the parameters that underlie the input-output relationships in education. As Caves, Christensen, and Diewert (November, 1982) state it:

Comparisons based on econometric estimates of the structure of production have often been viewed as being more desirable than index number comparisons; this view is based on the belief that index numbers are consistent only with restricted structures of production. Our results show that this belief is erroneous; in fact, the structures of production, which we have considered in this paper are so general that they would be difficult to estimate econometrically. (p. 1411)

What Caves, Christensen, and Diewert show is a way to estimate the differences in the costs of living between two individuals at a point in time or for the same individual between two points in time using exclusively observed information on prices and quantities purchased. They show that an index number originally proposed by Tornqvist (1936) can be used to measure the geometric mean of two cost of living indexes based on the utility functions of two different consumers facing different prices, purchasing different quantities, and with differences in taste. This is the equivalent of saying that this Tornqvist index can be used to compare the costs of education between two districts with differing perceived technologies for producing educational services and facing different prices and purchasing different quantities of school inputs. Formally, this index may be written as follows:

$$\text{Eq. 1-4.} \quad \ln TCEI(B,A) = \sum_r (1/2) \cdot (P_r(B) + P_r(A)) \cdot [\ln (CI_r(B,A))]$$

where $TCEI(B,A)$ = the *Tornqvist* cost-of-education index between districts B and A,

$\sum_r$ = the sum over all school inputs, r

$CI_r(B,A)$ = the cost index for the r^{th} school input (e.g., teachers, school administrators, teachers' aides, books, supplies and materials) comparing districts B relative to A;

$P_r(B), P_r(A)$ = the average proportion of total expenditures allocated to the r^{th} school input in districts B and A, respectively.²⁷

One of the critical features of this formula relative to that of the FMB CEI is that to calculate the superlative index requires information on the budget shares for each input from each observation included in the analysis as well as relative price differences. Again, districts A and B may represent a single district at two points in time or two districts at the same point in time.

Expanding the comparisons of two districts A and B to a multilateral setting necessitates the use of a benchmark district. In Alaska, that benchmark district is Anchorage. In the formula above, district A is Anchorage and district B represents any other district in the state. Each school district in turn is compared to the Anchorage.²⁸

²⁷ The Tornqvist index assumes a translog production technology with identical second-order coefficients on the school input prices. This equality also requires expenditure-minimizing behavior and permits only the identification of the geometric averages of the true indexes rather than each individual index derived from the perspective of each district. Diewert (1976) showed that the Tornqvist index is exact for the homogeneous translog form and is, for this reason, regarded as a *superlative index*. A *superlative index* is defined as one that is exact for a 'flexible' aggregator functional form (Diewert, 1976).

²⁸ The use of the arithmetic mean value of the various statistics in equation 6 preserves the transitivity of the index in comparisons across more than two districts. For a more complete discussion of the issues involved in multilateral comparisons, the reader is referred to Caves, Christensen, and Diewert (March 1982).

Exhibit I-B illustrates the steps involved in calculation of the Tornqvist's superlative cost-of-education index (SCEI) between district B and the hypothetical district A. New columns 4 and 7 have been added to Exhibit I-A to present the budget shares needed to calculate the SCEI in equation 6. The natural log ($\ln$) of the cost index for each input component (i.e., teachers and aides) is presented below columns 2 and 5. The average budget share for each input, which is required to calculate the SCEI is presented below columns 4 and 7. The natural log of the SCEI is calculated as follows:

$$0.08727 - 0.09531 \cdot 0.8715 + 0.03279 \cdot 0.1285$$

Exhibit I-B. Hypothetical Example Comparing the Tornqvist Index to the Fixed-Market-Basket Index for Public Schools

District	Teachers			Aides			Total Budget per Pupil	Simulated Budgets Using Inputs From:		Alternative FMB, CEIs Using Inputs From:	
	Average Annual Wage	FTE per Pupil	Budget Share	Average Annual Wage	FTE per Pupil	Budget Share		District A	District B	District A	District B
A	\$30,000	0.0500	\$1,500 88.89%	\$15,000	0.0125	\$188 11.11%	\$1,688	\$1,688	\$1,950	100.00	91.76
B	\$33,000	0.0550	\$1,815 85.41%	\$15,500	0.0200	\$310 14.59%	\$2,125	\$1,844	\$2,125	109.26	100.00
Index Calculations											
<i>C/(B,A)</i>											
<i>C/(B,A)</i>	1.1000			1.0333			1.2593	1.0926	1.0897	1.0926	1.0897
Tornqvist Index											
			<i>Avg Share</i>			<i>Avg Share</i>	<i>ln TCEI(B,A)</i>	<i>Tornqvist Index</i>			
<i>ln C/(B,A)</i>	0.09531		87.15%	0.03279		12.85%	0.097276518	1.0912			

Finally, the SCEI - $\ln(0.08727) = 1.0912$ which falls between the Layspayre or district A-based index of 1.0926 and the Paasche or district B-based index of 1.0897 calculated previously.

Budget Matrix

Below is the budget matrix corresponding to the function and objects of expenditure included in the operating budget reported by Alaska school districts to the ADEED. Each cell contains a symbol corresponding to the school input cost index that will be assigned to that share of the budget. Under an FMB-GCEI, we would use the Anchorage budget data to calculate the appropriate standardized budget shares against which the index would be calculated for every school district. Under the SGCEI approach, we would use the budget share data for each district relative to the budget shares for Anchorage as in Equation I-4 to calculate the overall cost index.

Legend to the budget matrix on the following page:

- *teachers* is the budget share allocated to teachers only, which are those cells associated with direct instruction within the operating codes ranging from 100 to less than 400
- *classified* is for all classified staff at the school or district level
- *teach/class* refers to the benefits section of the budget share being divided among teachers and classified staff, with the weighting determined by the proportion of salaries given to each group within an operating fund
- *admin* is for administrators from schools and the district office, as well as certified staff not coded as teachers (e.g., specialists, guidance counselors)
- *admin/class* refers to the benefits section of the budget share being divided among administrators and classified staff, with the weighting determined by the proportion of salaries given to each group within an operating fund
- *energy* is the amount spent on energy and utility services
- *paper* is the amount spent on instructional materials and office supplies (the cost of purchasing and transporting a case of paper is used as a proxy of this cost, and that is why the budget share is named as such)
- *food* is the amount spent on food supplies (the cost of purchasing and transporting a case of milk cartons is used as a proxy of this cost, and that is why the budget share is named as such)
- *window* is the amount spent on maintenance (the cost of purchasing and transporting a window is used as a proxy of this cost, and that is why the budget share is named as such)
- *travel_1* is for teacher professional development to the district office and to Anchorage (with 50 percent of the total going to each budget share)
- *travel_2* is between schools and the district office (which may include specialists, other itinerant staff, district administrator support, or travel for personnel)
- *travel_3* is for school administrators
- *travel_4* is for district administrators
- *travel_5* is for maintenance and operation, what is referred to as purchased services in Chapter 5

Exhibit I-1. Budget Matrix

ALASKA DEPARTMENT OF EDUCATION AND EARLY DEVELOPMENT
FY00 AUDITS
these codes correspond with the 1996 C.O.A.

Date: 11/6/2000

School District

	100	200	220	300	350	400	510	550	600	700		Total Including Instruction
Operating Fund	Instruction	Spec. Ed. Instruction	Spec. Ed. Support	Support Students	Support Instruction	School Admin.	District Admin.	Dist. Admin Support	Operations & Maint.	Student Activities		
Certified Salaries	teacher	teacher	teacher	teacher	teacher	admin	admin	admin	admin	admin		0
Non-Certified Salaries	classified	classified	classified	classified	classified	classified	classified	classified	classified	classified		0
Employee Benefits	teacher/class	teacher/class	teacher/class	teacher/class	teacher/class	admin/class	admin/class	admin/class	admin/class	admin/class		0
Professional/Tech Services	admin	admin	admin	admin	admin	admin	admin	admin	admin	admin		0
Staff Travel	travel_1	travel_2	travel_2	travel_2	travel_2	travel_3	travel_4	travel_2	travel_5	travel_2		0
Student Travel	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		0
Utilities Services	energy	energy	energy	energy	energy	energy	energy	energy	energy	energy		0
Other Purch. Svcs./Insurance	travel_1	travel_2	travel_2	travel_2	travel_2	travel_3	travel_4	travel_2	travel_5	travel_2		0
Supplies, Materials, Media	paper	paper	paper	paper	paper	paper	paper	paper	energy	paper		0
Tuition and Stipends	teacher	teacher	teacher	teacher	teacher	admin	admin	admin	admin	admin		0
Other/Indirect	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		0
Capital Outlay/EQ/Property												0
TOTALS	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0		\$0

												Special Ed.
Special Rev. Funds	Transportation	Food Service	Teacher Housing	Community Service	Title 1	Title 1 Carryover	Title VI	Title VI Carryover	Other Special Revenue Funds		Title VI-B	Title 1 Migrant Ed
					Title 1 Instruction	Title 1 Support	Title VI Instruction	Title VI Support	Instruction	Support		
Expenditures:												
Certified Salaries	admin	admin	admin	admin	teacher	teacher	teacher	teacher	teacher	teacher	teacher	teacher
Non-Certified Salaries	classified	classified	classified	classified	classified	classified	classified	classified	classified	classified	classified	classified
Employee Benefits	admin/class	admin/class	admin/class	admin/class	teacher/class	teacher/class	teacher/class	teacher/class	teacher/class	teacher/class	teacher/class	teacher/class
Professional/Tech Services	admin	admin	admin	admin	admin	admin	admin	admin	admin	admin	admin	admin
Staff Travel	travel_2	travel_2	travel_2	travel_2	travel_2	travel_2	travel_2	travel_2	travel_2	travel_2	travel_2	travel_2
Student Travel	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Utilities Services	energy	energy	energy	energy	energy	energy	energy	energy	energy	energy	energy	energy
Other Purch. Svcs./Insurance	travel_2	food	travel_2	travel_2	travel_2	travel_2	travel_2	travel_2	travel_2	travel_2	travel_2	travel_2
Supplies, Materials, Media	paper	food	paper	paper	paper	paper	paper	paper	paper	paper	paper	paper
Tuition and Stipends	admin	admin	admin	admin	teacher	teacher	teacher	teacher	teacher	teacher	teacher	teacher
Other/Indirect	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Capital Outlay/EQ/Property												
TOTALS	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0

Exhibit I-2. Listing of the Budget Shares and Their Corresponding Indexes for use in the SGCEI and FMB-GCEI

<i>Budget Share</i>	<i>Index</i>
Budget Share: ADMINS	Index: Administrators (Tobit)
Budget Share: CLASSIFIED	Index: Classified Staff (Regression)
Budget Share: ENERGY	Index: Energy
Budget Share: SUPPLIES: Food	Index: Food
Budget Share: Amount with NO CODE	"Index value of 1"
Budget Share: SUPPLIES: Instructional and Office	Index: Office and Teaching Supplies
Budget Share: TEACHERS	Index: Teachers (Salary & Benefits Regression)
Budget Share: TRAVEL: District Admins	Index: Superintendent P.D. in ANC Travel
Budget Share: TRAVEL: Maintenance	Index: Maintenance Travel
Budget Share: TRAVEL: School Admins	Index: School Oversight Travel
Budget Share: TRAVEL: Schools to D.O.	Index: Schools to D.O. Travel
(0.5) * Budget Share: TRAVEL: Teachers	Index: Teachers P.D. to D.O. Travel
(0.5) * Budget Share: TRAVEL: Teachers	Index: Teachers P.D. to ANC Travel
Budget Share: SUPPLIES: Maintenance	Index: Maintenance Supplies

Exhibit I-3. Budget Shares

District Name	Budget Share: ADMINS	Budget Share: CLASSIFIED	Budget Share: ENERGY	Budget Share: Amount with NO CODE	Budget Share: SUPPLIES: Instructional and Office	Budget Share: TEACHERS	Budget Share: TRAVEL: District Admins	Budget Share: TRAVEL: Maintenance	Budget Share: TRAVEL: School Admins	Budget Share: TRAVEL: Schools to D.O.	Budget Share: TRAVEL: Teachers	Budget Share: TRAVEL: Teachers Half	Budget Share: SUPPLIES: Maintenance
Alaska Gateway	10.54%	17.57%	17.11%	-0.53%	4.02%	46.15%	0.38%	2.44%	0.03%	0.90%	0.39%	0.19%	0.99%
Aleutian Region	33.95%	9.94%	5.16%	3.30%	7.82%	27.93%	6.29%	1.45%	0.03%		0.81%	0.40%	3.33%
Aleutians East Borough	8.50%	12.95%	8.83%	3.03%	3.80%	49.33%	1.52%	3.05%	0.10%	2.52%	5.13%	2.56%	1.20%
Anchorage	5.69%	23.51%	4.20%	-0.01%	3.14%	57.79%	0.02%	3.58%	0.02%	0.49%	0.15%	0.08%	1.41%
Annette Island	10.24%	19.86%	7.16%	2.19%	2.71%	52.04%	0.98%	1.12%	0.18%	2.83%	0.64%	0.32%	0.04%
Bering Strait	6.39%	22.73%	11.32%	1.73%	3.55%	44.63%	0.96%	1.02%		1.84%	4.60%	2.30%	1.22%
Bristol Bay Borough	8.07%	17.49%	9.93%	2.40%	2.02%	51.19%	0.15%	3.91%	0.16%	0.66%	3.57%	1.78%	0.48%
Chatham Region	13.83%	15.14%	10.81%	2.23%	2.74%	49.61%	1.73%	1.40%	0.35%	0.62%	0.59%	0.30%	0.94%
Chugach	9.89%	15.90%	9.54%	-0.70%	6.23%	40.60%	2.30%	1.99%		4.75%	1.74%	0.87%	7.77%
Copper River	8.55%	20.82%	7.86%	-0.03%	6.77%	45.90%	0.79%	1.51%	0.09%	2.30%	0.61%	0.31%	4.82%
Cordova City	7.15%	19.41%	7.65%	0.16%	4.14%	54.56%	0.39%	2.10%	0.05%	1.84%	1.12%	0.56%	1.43%
Craig City	9.53%	17.08%	4.66%	2.64%	4.46%	50.97%	0.55%	1.89%	0.02%	2.47%	4.71%	2.36%	1.04%
Delta Greely	8.31%	18.58%	8.10%	0.72%	2.74%	54.59%	0.35%	2.51%	0.13%	0.91%	1.16%	0.58%	1.89%
Denali Borough	8.65%	20.91%	10.86%	1.17%	7.24%	47.40%	0.85%	1.44%	0.04%	0.62%	0.40%	0.20%	0.43%
Dillingham City	7.10%	17.92%	5.94%	3.95%	3.82%	55.18%	0.58%	1.04%	0.06%	3.12%	0.36%	0.18%	0.92%
Fairbanks North Star Borough	5.79%	21.97%	4.63%	0.28%	3.56%	60.83%	0.09%	0.77%	0.01%	1.14%	0.74%	0.37%	0.21%
Galena City	6.50%	14.23%	9.64%	1.80%	30.96%	24.29%	0.97%	1.87%	2.13%	1.52%	1.33%	0.67%	4.76%
Haines Borough	10.27%	19.05%	7.46%	1.55%	2.06%	57.62%	0.82%	0.65%	0.07%	0.02%	0.15%	0.08%	0.27%
Hoonah City	10.31%	19.98%	10.36%	0.50%	3.83%	44.21%	0.24%	5.98%	0.08%	2.36%	1.41%	0.71%	0.74%
Iliadburg City	14.21%	12.08%	8.29%	3.57%	15.67%	36.85%	0.89%	4.42%	0.17%	0.66%	0.26%	0.13%	2.94%
Iditarod Area	5.07%	22.01%	17.61%	-0.27%	6.58%	42.72%	0.98%	0.83%	0.22%	0.95%	2.00%	1.00%	1.31%
Juneau Borough	5.55%	25.31%	3.69%	-0.48%	3.20%	59.29%	0.08%	0.82%	0.08%	1.35%	0.76%	0.38%	0.36%
Kake City	10.16%	17.98%	9.74%	2.74%	3.53%	47.97%	0.78%	3.60%	0.02%	2.81%	0.07%	0.04%	0.59%
Kashunamiut	13.99%	19.58%	7.52%	2.34%	7.56%	40.73%	1.37%	0.75%	0.16%	1.08%	1.28%	0.64%	3.65%
Kenai Peninsula Borough	5.87%	16.31%	5.72%	0.45%	2.28%	58.16%	0.08%	8.15%	0.08%	0.56%	0.51%	0.25%	1.82%
Ketchikan Gateway Borough	7.56%	19.49%	6.88%	0.99%	3.30%	57.85%	0.13%	1.13%	0.07%	0.88%	0.23%	0.12%	1.48%
Klawock City	10.54%	16.25%	8.87%	2.70%	3.62%	53.88%	1.83%	0.66%	0.30%	0.22%	0.68%	0.34%	0.45%
Kodiak Island Borough	8.01%	19.68%	7.89%	1.14%	2.85%	56.78%	0.18%	0.76%	0.20%	0.37%	0.39%	0.19%	1.76%
Kuspuk	7.44%	24.97%	11.26%	1.26%	2.87%	47.39%	0.76%	1.38%	0.16%	1.54%	0.04%	0.02%	0.93%
Lake And Peninsula	4.63%	14.64%	16.46%	3.03%	4.79%	47.04%	1.30%	2.15%	0.17%	3.59%	0.08%	0.04%	2.13%
Lower Kuskokwim	7.88%	30.58%	9.45%	-0.46%	3.58%	41.87%	0.21%	1.36%	0.26%	2.49%	1.59%	0.79%	1.18%
Lower Yukon	8.73%	18.53%	10.97%	0.91%	2.64%	52.27%	1.39%	1.17%	0.21%	1.73%	0.13%	0.06%	1.34%
Matanuska-Susitna Borough	5.19%	20.76%	4.95%	-0.05%	3.00%	63.36%	0.05%	1.35%	0.03%	0.34%	0.24%	0.12%	0.79%
Nenana City	8.48%	12.10%	7.24%	2.23%	26.64%	31.97%	0.64%	1.88%	0.09%	0.97%	1.00%	0.50%	6.75%
Nome City	4.74%	20.75%	9.70%	0.66%	2.34%	56.66%	0.31%	1.34%	0.25%	1.21%	0.48%	0.24%	1.56%
North Slope Borough	4.09%	35.19%	8.67%	1.75%	3.84%	40.93%	0.45%	0.64%	0.08%	1.27%	0.47%	0.23%	2.62%
Northwest Arctic	7.50%	22.15%	14.30%	-0.31%	4.80%	41.33%	0.60%	4.80%	0.18%	2.78%	0.35%	0.17%	1.52%
Pelican City	12.61%	28.29%	7.78%	5.19%	6.50%	29.19%	0.23%	2.18%		0.64%	0.51%	0.25%	6.90%
Petersburg City	6.63%	17.40%	10.42%	1.06%	3.11%	58.83%	0.22%	1.20%	0.11%	0.42%	0.05%	0.03%	0.55%
Pribilof Island	9.30%	22.41%	10.62%	2.02%	3.91%	43.47%	1.42%	1.37%	0.10%	1.54%	0.96%	0.48%	2.89%
Saint Marys City	12.31%	15.82%	10.20%	2.97%	4.23%	42.23%	2.87%	1.83%	0.28%	0.55%	0.66%	0.33%	6.05%
Sitka Borough	9.63%	12.73%	4.67%	0.41%	2.89%	64.72%	0.45%	3.25%	0.08%	0.28%	0.38%	0.19%	0.51%
Skagway City	8.51%	20.02%	7.52%	3.33%	5.33%	47.87%	0.33%	2.05%	0.08%	0.33%	0.16%	0.08%	4.47%
Southeast Island	8.57%	20.44%	7.52%	0.51%	4.35%	49.48%	0.84%	4.80%	0.01%	1.60%	1.18%	0.59%	0.70%
Southwest Region	8.41%	17.48%	9.01%	0.46%	7.01%	49.66%	0.88%	2.16%	0.13%	1.13%	1.33%	0.67%	2.33%
Tanana City	21.56%	17.76%	19.98%	3.00%	4.41%	30.45%	0.69%	1.40%		0.32%	0.02%	0.01%	0.40%
Unalaska City	13.25%	14.94%	8.98%	4.58%	3.38%	49.89%	1.04%	1.63%	0.07%	0.35%	0.38%	0.19%	1.50%
Valdez City	8.24%	20.16%	6.27%	1.48%	2.39%	59.17%	0.21%	0.82%	0.18%	0.37%	0.04%	0.02%	0.68%
Wrangell City	7.42%	20.78%	6.07%	1.57%	4.16%	55.77%	1.03%	0.80%	0.09%	0.38%	0.51%	0.26%	1.42%
Yakutat City	11.84%	18.62%	9.61%	0.39%	4.28%	48.46%	1.74%	0.95%	0.49%	0.92%	0.70%	0.35%	2.00%
Yukon Flats	11.05%	17.39%	22.95%	1.66%	4.71%	35.19%	1.85%	2.41%	0.08%	0.80%	0.12%	0.06%	1.81%
Yukon Koyukuk	11.77%	14.84%	16.79%	-0.59%	4.69%	43.38%	2.07%	2.00%	0.46%	2.07%	1.02%	0.51%	1.51%
Yupit	10.37%	27.66%	6.69%	1.59%	7.69%	35.75%	2.20%	1.52%	0.04%	2.44%	1.59%	0.79%	2.48%

Exhibit I-4. Index Values

District Name	Superlative Index Value	FMB Index Value	Index: Administrators	Index: Classified Staff	Index: Energy	Index: Maintenance Travel	Index: Office and Teaching Supplies	Index: Teachers P.D. to D.O. Travel	Index: Teachers P.D. to ANC Travel	Index: Schools to D.O. Travel	Index: Superintendent P.D. in ANC Travel	Index: School Oversight Travel	Index: Teachers	Index: Maintenance Supplies
Alaska Gateway	1.28	1.29	0.97	1.09	3.79	1.87	1.54	2.21	10.60	2.21	1.89	2.21	1.05	4.95
Aleutian Region	1.46	2.90	1.25	1.23	4.97	5.20	1.87	276.38	30.02	222.60	3.22	166.27	1.17	2.42
Aleutians East Borough	1.49	1.67	1.10	1.12	3.23	3.62	1.45	77.08	14.10	52.08	2.27	25.89	1.14	2.75
Anchorage	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Annette Island	1.03	1.05	0.95	0.93	0.75	1.06	1.50	1.00	12.71	1.00	2.30	1.00	1.08	1.71
Bering Strait	1.55	2.37	1.05	1.19	4.09	4.96	1.57	186.23	19.68	150.48	2.06	113.05	1.11	4.43
Bristol Bay Borough	1.19	1.20	1.01	1.03	2.96	2.12	1.82	1.00	9.14	1.00	1.64	1.00	1.03	2.51
Chatham Region	1.20	1.58	1.05	0.92	3.72	2.27	5.24	74.36	9.92	49.55	1.54	23.57	0.95	2.50
Chugach	1.29	1.40	1.11	0.98	1.43	1.94	2.82	74.34	6.08	44.89	1.00	14.04	0.96	2.89
Copper River	1.15	1.15	0.99	1.05	2.37	1.39	1.43	1.67	7.03	1.67	1.25	1.67	0.99	4.08
Cordova City	1.07	1.07	0.99	0.96	1.64	0.99	1.40	1.00	8.82	1.00	1.60	1.00	1.04	2.27
Craig City	1.09	1.08	0.95	0.90	1.87	1.15	1.31	1.00	22.46	1.00	4.07	1.00	1.02	2.80
Delta Greely	1.09	1.11	0.94	0.98	2.33	1.09	2.01	1.00	6.07	1.00	1.10	1.00	1.00	2.32
Denali Borough	1.09	1.08	0.97	1.01	1.66	1.36	1.58	1.89	7.91	1.89	1.41	1.89	1.00	1.79
Dillingham City	1.13	1.16	1.02	1.05	2.16	1.10	1.24	1.00	9.20	1.00	1.67	1.00	1.08	3.39
Fairbanks North Star Borough	1.08	1.09	0.97	1.04	1.61	1.05	1.22	1.00	8.34	1.00	1.50	1.00	1.06	1.56
Galena City	1.26	1.21	0.97	1.14	2.87	1.33	1.40	1.00	10.74	1.00	1.94	1.00	1.04	4.11
Haines Borough	1.03	1.06	0.94	0.90	1.80	1.52	1.58	1.00	9.82	1.00	1.78	1.00	0.99	2.16
Hoonah City	1.12	1.16	1.06	0.93	4.62	1.28	1.35	1.00	12.09	1.00	2.19	1.00	0.95	2.13
Hydaburg City	1.10	1.07	1.00	0.91	1.23	1.35	1.63	1.00	11.41	1.00	2.07	1.00	1.02	3.32
Iditarod Area	1.40	2.47	0.93	0.98	5.12	5.13	1.73	236.19	18.62	182.40	1.74	126.07	1.01	1.65
Juneau Borough	1.02	1.03	0.99	1.02	0.74	1.02	1.45	1.00	9.82	1.00	1.77	1.00	1.01	1.89
Kake City	1.09	1.11	1.09	0.93	2.38	2.35	1.16	1.00	12.27	1.00	2.22	1.00	0.97	2.41
Kashunamiut	1.25	1.29	1.02	1.14	2.76	2.72	1.49	1.00	12.95	1.00	2.34	1.00	1.08	4.41
Kenai Peninsula Borough	1.03	1.04	0.97	1.03	1.34	1.15	1.05	3.63	6.92	3.63	1.20	3.63	0.96	2.50
Ketchikan Gateway Borough	1.01	1.03	0.99	0.92	0.75	0.91	1.12	1.00	10.22	1.00	1.85	1.00	1.04	2.65
Klawock City	1.04	1.05	1.05	0.91	1.87	1.02	1.35	1.00	11.66	1.00	2.11	1.00	0.97	2.65
Kodiak Island Borough	1.12	1.21	0.97	1.03	1.95	1.31	1.10	19.98	10.07	12.65	1.78	4.97	1.03	4.55
Kuspuk	1.21	1.44	0.99	1.07	1.67	1.87	2.54	40.21	13.33	40.21	1.83	40.21	1.06	4.22
Lake And Peninsula	1.46	2.08	0.96	0.99	4.62	4.14	1.71	165.38	13.56	111.59	1.84	55.26	1.04	6.35
Lower Kuskokwim	1.39	1.61	1.04	1.23	3.43	2.52	1.62	67.95	10.62	46.04	1.67	23.10	1.07	4.47
Lower Yukon	1.40	2.36	1.02	1.13	3.17	5.34	4.08	169.94	21.54	146.50	2.22	121.96	1.09	4.09
Matanuska-Susitna Borough	0.99	1.01	0.96	0.96	1.06	1.07	0.98	1.49	6.09	1.49	1.08	1.49	0.98	2.61
Nenana City	1.17	1.09	0.93	0.98	1.81	1.21	1.60	1.00	8.14	1.00	1.47	1.00	0.99	4.15
Nome City	1.16	1.17	1.03	1.12	2.40	1.31	1.28	1.00	12.80	1.00	2.31	1.00	1.05	2.63
North Slope Borough	1.58	2.16	1.17	1.48	9.31	4.25	1.57	96.64	17.02	70.35	2.56	42.82	1.18	1.45
Northwest Arctic	1.48	1.56	1.07	1.24	4.93	2.99	1.23	33.45	12.76	26.58	2.06	19.39	1.14	1.18
Pelican City	1.14	1.38	1.03	0.90	1.28	0.91	13.57	1.00	13.96	1.00	2.53	1.00	0.95	2.55
Petersburg City	1.01	1.02	0.94	0.91	1.24	0.92	1.10	1.00	12.86	1.00	2.33	1.00	1.01	2.14
Pribilof Island	1.29	1.34	1.25	1.22	1.31	3.89	1.96	3.18	16.08	3.18	2.87	3.18	1.13	2.96
Saint Marys City	1.28	1.29	1.12	1.09	3.94	2.55	1.96	1.00	12.27	1.00	2.22	1.00	1.01	3.79
Sitka Borough	1.03	1.09	1.00	0.93	0.91	0.95	1.61	1.00	9.82	1.00	1.78	1.00	1.02	5.97
Skagway City	1.00	1.00	1.04	0.90	1.65	1.46	1.07	1.00	10.43	1.00	1.89	1.00	0.95	1.09
Southeast Island	1.07	1.15	1.01	0.87	1.12	1.52	4.11	16.77	14.76	14.33	2.51	11.77	0.94	1.14
Southwest Region	1.26	1.37	0.97	1.03	3.41	1.51	1.54	20.45	10.83	20.45	1.67	20.45	1.06	5.64
Tanana City	1.29	1.27	1.04	1.03	4.67	1.53	2.17	1.00	11.04	1.00	2.00	1.00	1.00	4.24
Unalaska City	1.19	1.21	1.05	1.08	1.89	1.42	1.59	1.00	14.76	1.00	2.67	1.00	1.14	2.82
Valdez City	1.05	1.07	1.01	0.98	1.61	1.02	1.35	1.00	8.29	1.00	1.50	1.00	1.02	2.65
Wrangell City	1.00	1.02	0.94	0.89	1.05	1.52	0.98	1.00	10.23	1.00	1.85	1.00	1.01	1.75
Yakutat City	1.17	1.24	1.09	0.97	3.39	2.10	1.33	15.09	11.18	11.82	1.92	7.98	0.97	3.09
Yukon Flats	1.46	1.94	0.93	1.06	5.43	2.81	2.57	146.14	14.76	92.35	2.34	36.02	1.03	2.95
Yukon Koyukuk	1.44	1.66	0.94	1.06	4.73	2.20	1.73	65.48	11.71	53.82	1.56	41.60	1.10	3.77
Yupik	1.31	1.34	0.98	1.08	3.58	2.25	2.47	6.43	10.48	6.43	1.81	6.43	1.06	4.54

Exhibit I-5. Categorical Information

District Name	Total District Operating Fund: FY00	District Enrollment	MSA Code	Geographic Region Name	Size	Distance from D.O. to nearest center of commerce	Classroom Teachers (Full- Time Equiv)
Alaska Gateway	\$5,373,281.00	490	75	South Central	2 250-999	4 At least 100 miles	9.30
Aleutian Region	\$1,228,458.00	61	58	Southwest	1 0 to <250	5 At least 500 miles	2.00
Aleutians East Borough	\$5,464,362.00	301	57	Southwest	2 250-999	5 At least 500 miles	11.48
Anchorage	\$311,273,670.00	49526	62	South Central	5 10,000+	1 Less than 10 miles	44.74
Annette Island	\$3,677,542.00	331	93	Southeast	2 250-999	2 At least 10 miles	9.20
Bering Strait	\$23,419,588.00	1735	34	Far North	3 1000-2499	5 At least 500 miles	11.98
Bristol Bay Borough	\$2,904,805.00	277	55	Southwest	2 250-999	4 At least 100 miles	10.96
Chatham Region	\$2,704,458.00	248	80	Southeast	1 0 to <250	3 At least 50 miles	8.25
Chugach	\$1,713,906.00	177	75	South Central	1 0 to <250	3 At least 50 miles	3.04
Copper River	\$5,765,693.00	700	75	South Central	2 250-999	4 At least 100 miles	9.32
Cordova City	\$3,797,526.00	478	75	South Central	2 250-999	4 At least 100 miles	16.64
Craig City	\$3,193,801.00	543	93	Southeast	2 250-999	3 At least 50 miles	16.25
Delta Greely	\$6,420,459.00	850	46	Interior	2 250-999	3 At least 50 miles	13.98
Denali Borough	\$2,875,143.00	312	47	Interior	2 250-999	3 At least 50 miles	10.47
Dillingham City	\$5,426,491.00	578	50	Southwest	2 250-999	4 At least 100 miles	20.61
Fairbanks North Star Borough	\$108,243,790.00	15659	44	Interior	5 10,000+	1 Less than 10 miles	37.76
Galena City	\$15,147,510.00	3340	41	Far North	4 2500-9999	4 At least 100 miles	16.73
Haines Borough	\$3,552,705.00	402	85	Southeast	2 250-999	3 At least 50 miles	10.96
Hoonah City	\$3,041,735.00	226	80	Southeast	1 0 to <250	2 At least 10 miles	9.45
Hydaburg City	\$1,505,246.00	91	93	Southeast	1 0 to <250	2 At least 10 miles	4.25
Iditarod Area	\$6,252,546.00	656	41	Far North	2 250-999	4 At least 100 miles	5.20
Juneau Borough	\$36,362,688.00	5494	86	Southeast	4 2500-9999	1 Less than 10 miles	41.05
Kake City	\$1,909,779.00	166	91	Southeast	1 0 to <250	3 At least 50 miles	6.15
Kashunamiut	\$3,210,513.00	313	51	Southwest	2 250-999	4 At least 100 miles	21.30
Kenai Peninsula Borough	\$73,233,548.00	9925	71	South Central	4 2500-9999	1 Less than 10 miles	22.68
Ketchikan Gateway Borough	\$17,489,593.00	2517	95	Southeast	4 2500-9999	1 Less than 10 miles	21.12
Klawock City	\$2,118,136.00	191	93	Southeast	1 0 to <250	3 At least 50 miles	7.14
Kodiak Island Borough	\$22,517,580.00	2743	73	South Central	4 2500-9999	4 At least 100 miles	23.53
Kuspuk	\$6,627,779.00	474	52	Southwest	2 250-999	4 At least 100 miles	4.58
Lake And Peninsula	\$8,895,930.00	528	59	Southwest	2 250-999	4 At least 100 miles	4.86
Lower Kuskokwim	\$44,153,971.00	3695	52	Southwest	4 2500-9999	4 At least 100 miles	14.73
Lower Yukon	\$18,551,676.00	1898	51	Southwest	3 1000-2499	4 At least 100 miles	15.71
Matanuska-Susitna Borough	\$79,543,329.00	13008	61	South Central	5 10,000+	2 At least 10 miles	32.85
Nenana City	\$4,027,766.00	1889	41	Far North	3 1000-2499	4 At least 100 miles	14.84
Nome City	\$6,455,807.00	761	34	Far North	2 250-999	5 At least 500 miles	22.87
North Slope Borough	\$40,696,630.00	2187	31	Far North	3 1000-2499	5 At least 500 miles	25.45
Northwest Arctic	\$25,815,962.00	2188	33	Far North	3 1000-2499	5 At least 500 miles	19.41
Pelican City	\$597,493.00	23	80	Southeast	1 0 to <250	3 At least 50 miles	3.40
Petersburg City	\$4,964,592.00	678	91	Southeast	2 250-999	4 At least 100 miles	15.70
Pribilof Island	\$1,914,471.00	144	58	Southwest	1 0 to <250	5 At least 500 miles	7.84
Saint Marys City	\$1,658,111.00	143	51	Southwest	1 0 to <250	4 At least 100 miles	12.50
Sitka Borough	\$11,760,802.00	1640	87	Southeast	3 1000-2499	3 At least 50 miles	27.42
Skagway City	\$1,647,449.00	132	80	Southeast	1 0 to <250	3 At least 50 miles	11.90
Southeast Island	\$3,212,107.00	285	93	Southeast	2 250-999	1 Less than 10 miles	4.91
Southwest Region	\$9,916,963.00	771	50	Southwest	2 250-999	4 At least 100 miles	12.55
Tanana City	\$1,176,712.00	80	41	Far North	1 0 to <250	4 At least 100 miles	6.00
Unalaska City	\$3,952,718.00	355	58	Southwest	2 250-999	5 At least 500 miles	14.07
Valdez City	\$8,040,397.00	863	75	South Central	2 250-999	4 At least 100 miles	19.41
Wrangell City	\$4,043,265.00	497	91	Southeast	2 250-999	3 At least 50 miles	10.94
Yakutat City	\$2,022,629.00	168	79	Southeast	1 0 to <250	4 At least 100 miles	13.63
Yukon Flats	\$6,229,257.00	349	41	Far North	2 250-999	4 At least 100 miles	8.36
Yukon Koyukuk	\$8,179,716.00	495	41	Far North	2 250-999	4 At least 100 miles	6.25
Yupit	\$5,242,263.00	404	52	Southwest	2 250-999	4 At least 100 miles	11.34

Exhibit I-6. Comparison of the AIR GCEI and the Current Alaska Cost Index
 (data are sorted alphabetically by district name)

District Name	Superlative GCEI	Current Alaska Cost Index	Difference between the Superlative GCEI and the Current Index	Districts with an absolute difference ≥ 0.15 (=1)	Districts with an absolute difference ≥ 0.10 (=1)	Districts with an absolute difference < 0.05 (=1)
Alaska Gateway	1.28	1.29	(0.01)	0	0	1
Aleutian Region	1.46	1.74	(0.28)	1	1	0
Aleutians East Borough	1.49	1.42	0.07	0	0	0
Alyeska	1.00	1.00	-	0	0	1
Anchorage	1.00	1.00	(0.00)	0	0	1
Annette Island	1.03	1.01	0.02	0	0	1
Bering Strait	1.55	1.53	0.03	0	0	1
Bristol Bay Borough	1.19	1.26	(0.08)	0	0	0
Chatham Region	1.20	1.12	0.08	0	0	0
Chugach	1.29	1.29	(0.00)	0	0	1
Copper River	1.15	1.18	(0.02)	0	0	1
Cordova City	1.07	1.10	(0.02)	0	0	1
Craig City	1.09	1.01	0.08	0	0	0
Delta Greely	1.09	1.11	(0.01)	0	0	1
Denali Borough	1.09	1.31	(0.22)	1	1	0
Dillingham City	1.13	1.25	(0.13)	0	1	0
Fairbanks North Star Borough	1.08	1.04	0.04	0	0	1
Galena City	1.26	1.35	(0.09)	0	0	0
Haines Borough	1.03	1.01	0.02	0	0	1
Hoonah City	1.12	1.06	0.07	0	0	0
Hydaburg City	1.10	1.09	0.02	0	0	1
Iditarod Area	1.40	1.47	(0.07)	0	0	0
Juneau Borough	1.02	1.01	0.02	0	0	1
Kake City	1.09	1.03	0.07	0	0	0
Kashunamiut	1.25	1.39	(0.14)	0	1	0
Kenai Peninsula Borough	1.03	1.00	0.03	0	0	1
Ketchikan Gateway Borough	1.01	1.00	0.01	0	0	1
Klawock City	1.04	1.02	0.03	0	0	1
Kodiak Island Borough	1.12	1.09	0.03	0	0	1
Kuspuk	1.21	1.43	(0.22)	1	1	0
Lake And Peninsula	1.46	1.56	(0.10)	0	1	0
Lower Kuskokwim	1.39	1.49	(0.10)	0	1	0
Lower Yukon	1.40	1.44	(0.04)	0	0	1
Matanuska-Susitna Borough	0.99	1.01	(0.02)	0	0	1
Mt. Edgecumbe	1.03	1.00	0.03	0	0	1
Nenana City	1.17	1.27	(0.10)	0	1	0
Nome City	1.16	1.32	(0.16)	1	1	0
North Slope Borough	1.58	1.50	0.07	0	0	0
Northwest Arctic	1.48	1.55	(0.07)	0	0	0
Pelican City	1.14	1.29	(0.15)	1	1	0
Petersburg City	1.01	1.00	0.01	0	0	1
Pribilof Island	1.29	1.42	(0.13)	0	1	0
Saint Marys City	1.28	1.35	(0.07)	0	0	0
Sitka Borough	1.03	1.00	0.03	0	0	1
Skagway City	1.00	1.14	(0.14)	0	1	0
Southeast Island	1.07	1.12	(0.05)	0	0	0
Southwest Region	1.26	1.42	(0.16)	1	1	0
Tanana City	1.29	1.50	(0.21)	1	1	0
Unalaska City	1.19	1.25	(0.05)	0	0	0
Valdez City	1.05	1.10	(0.04)	0	0	1
Wrangell City	1.00	1.00	0.00	0	0	1

District Name	Superlative GCEI	Current Alaska Cost Index	Difference between the Superlative GCEI and the Current Index	Districts with an absolute difference ≥ 0.15 (=1)	Districts with an absolute difference ≥ 0.10 (=1)	Districts with an absolute difference < 0.05 (=1)
Yakutat City	1.17	1.05	0.13	0	1	0
Yukon Flats	1.46	1.67	(0.21)	1	1	0
Yukon Koyukuk	1.44	1.50	(0.06)	0	0	0
Yupiit	1.31	1.47	(0.16)	1	1	0
Mean value	1.19	1.24	-0.04			
Standard deviation	0.17	0.21	0.09			
Minimum value	0.99	1.00	-0.28			
Maximum value	1.58	1.74	0.13			
Number of districts with significant differences in index values				9	17	24

The personnel index reported in *Alaska School District Cost Study: Volume I – Summary of Results* reflects a district-level aggregation of all three personnel indices. To arrive at this index value, one must consider only the budget share spent by the district on personnel. Each of the three personnel budget shares (i.e., teachers, administrators and other certified, and classified) is then divided by the sum of the personnel budget for that district. This provides us with the new budget shares to calculate this aggregate personnel index, which will give us the overall cost of personnel considering the usage of each of the three groups of employees comprising this category. Each of the three personnel indices is weighted by its appropriate budget shares, as derived by taking the average recalculated budget shares of the district and the base district Anchorage. This creates a Tornqvist cost-of-personnel index, similar to the Tornqvist cost-of-education index described in greater mathematical detail earlier in this appendix.

The other indices presented in *Alaska School District Cost Study: Volume I – Summary of Results* – that is, the energy index, the cost-of-goods index, and the travel index – were all created similarly, using the methods described above. The energy index considers only the index value for energy, so its aggregate is the same as the energy index presented in this volume of the study. The cost-of-goods index uses the appropriately-rescaled budget share weights of the index values for instructional supplies and small capital items in its aggregate construction. The rescaling of the budget weights for the aggregate goods index uses the sum of the instructional supplies budget share and small capital items budget share as the denominator. The aggregate travel index uses the appropriately-rescaled budget share weights of the index values for any and all travel indices considered in this volume of the study, using the sum of the travel budget shares as the denominator when rescaling.

The tables on the following pages present the four aggregate indices, along with a breakdown of their individual index components. The columns next to the individual index components show the appropriately-rescaled budget weight for the corresponding index component. To calculate the overall index for that category, one would sum the logarithm of each component index, each weighted by the respective budget weight. Then, take the exponential of the logarithmic form. This will generate the overall index value for that particular aggregate – the value presented in the column after the district name.