Institute of Education Sciences
National Center for Education Statistics

NATIONAL INSTITUTE OF STATISTICAL SCIENCES
TECHNICAL EXPERT PANEL REPORT

NCES COMPARABLE WAGE INDEX

TABLE OF CONTENTS

NATIONAL INSTITUTE OF STATISTICAL SCIENCES

NCES COMPARABLE WAGE INDEX

EXECUTIVE SUMMARY

The National Institute of Statistical Sciences (NISS), at the request of the National Center for Education Statistics (NCES) convened a Panel of Technical Experts to review and make recommendations concerning the NCES' statistical tool: Comparable Wage Index (CWI). The CWI was developed by NCES to provide a geographical adjustment of local-level or state-level expenditure data (e.g., per-pupil expenditures) in allow comparisons across geographic units.

The Panel was charged specifically to identify the use cases and communities that already provide geographically adjusted education expenditure data and then to derive specifications for such indices based on these use cases. The Panel was then asked to evaluate how well the CWI meets these specifications and to propose (feasible) modifications or alternatives to improve or replace the CWI.

The Panel's initial deliberations outlined several research questions that were then undertaken by NISS with results referred to the Panel for further consideration. This research addressed the validity of a salary-based index as the basis for adjustment, the feasibility of constructing an index from public (compared to restricted access) data files and several technical issues in the model construction (variance estimation, selection of predictor variables, use of sampling weights).

Following discussion of research findings, the Panel's principal recommendation is that:

NCES annually produce geographical adjustment factors for educational expenditures:

- Using as input the internal, confidential microdata files from the American Community Survey, available only on a restricted-access basis subject to the U.S. Census Bureau's statutory mission requirements (U.S. Code Title 13).
- Employing modeling methodology based on the extant CWI base year methodology, with minor modifications to address technical issues.

The Panel included a number of more specific recommendations that address specific technical issues related to the formulation of geographical adjustment factors to ensure desirable statistical properties:

- Support cross-sectional and temporal comparisons;
- Document data sources, methodology and statistical uncertainties;
- Use one-year fine-scale data files and be reported promptly;
- Account for state-level random effects;
- Include industry and occupation classifications related to education and include field of degree as predictor variable; and
- Properly incorporate weights in model specification and all calculations.

Finally, the Panel indicated issues for future consideration by NCES.

NATIONAL INSTITUTE OF STATISTICAL SCIENCES
TECHNICAL EXPERT PANEL REPORT

NCES COMPARABLE WAGE INDEX

I. SUMMARY AND BACKGROUND

The National Institute of Statistical Sciences (NISS), at the request of the National Center for Education Statistics (NCES) convened a Technical Expert Panel (TEP) to review and make recommendations concerning NCES' Comparable Wage Index (CWI).

The CWI is a statistical tool developed by NCES for geographical adjustment of local education authority (LEA)-level or state-level expenditure data (for instance, per-pupil expenditures) in order to inform comparisons across units.

To date (released and unreleased) values of the CWI for approximately 800 labor markets have been calculated using a model of the systematic, regional variations in the salaries of college graduates who are not educators. Data files and documentation for the 2005 CWI are available on the NCES web site, at http://nces.ed.gov/edfin/adjustments.asp, and there is further documentation regarding the current methodology at http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2006865.

Principal data sources in the past were the University of Minnesota Population Center's Integrated Public Use Microdata Series (IPUMS) derived from 2000 Census Bureau Long Form data, and the Bureau of Labor Statistics' Occupational Employment Statistics (OES).

The charge to the TEP was to:

1. Articulate as precisely as possible the use cases and user communities for indices that provide geographical adjustment of (labor and other) expenditures by state education authorities (SEAs) or local education authorities (LEAs).
2. From these use cases, derive a set of functional specifications for such indices. Examples: level of disaggregation, treatment of uncertainties, predictive capabilities.
3. Assess the extent to which the current CWI fulfills the specifications.
4. In light of step 3 and taking account, propose modifications or alternatives to the current CWI that are sensible in light of current and prospective data sources or possible feasible modifications.

1.1 Panel Activities

The TEP met in person in Washington, on February 16-17, 2011. The agenda for the meeting is contained in Appendix A of this report.

At that meeting the TEP identified and agreed on:

1. Several items regarding NCES' construction and dissemination of geographical indices for expenditure adjustment;
2. A set of research issues to be addressed by NISS, using available data and current CWI methodology and code.

Details are in the first Interim Report of the TEP (February 28, 2011), contained in Appendix B.

During the period February-June 2011. The findings are summarized in a second Interim Report dated June 7, 2011. Since then, the TEP has communicated by e-mail and other means to finalize the recommendations that are presented in this report.

1.2 Summary of Recommendations

The principal recommendation of the TEP is that NCES annually produce geographical adjustment factors for educational expenditures:

- Using as input the internal, confidential microdata files from the American Community Survey (ACS), available only on a restricted-access basis subject to the U.S. Census Bureau's statutory mission requirements (U.S. Code Title 13).
- Employing modeling methodology based on the extant CWI *base year* methodology, with minor modifications to address technical issues discussed in Section 2.1.

II. TEP RECOMMENDATIONS

This section contains the recommendations of the TEP.

2.1 Major Recommendations

The TEP recommends that NCES annually produce and release Geographical Adjustment Factors for Educational Expenditures (GAFEEs).

1. GAFEEs should:
   a. Support both cross-sectional and temporal comparisons;
   b. Be accompanied by detailed documentation of the data sources, methodology and statistical uncertainties in their values.
2. GAFEEs be based on one-year restricted-access data files produced by the American Community Survey (ACS), and be reported as rapidly as possible once date become available.
3. GAFEEs be calculated using a modification of the current CWI base year methodology that:
   a. Accounts properly for the state-level random effects, and estimates these effects correctly;
   b. Does not exclude industry and occupation classifications related to education;
   c. Includes the ACS field of degree variable as a predictor;
   d. Properly includes weights in the mixed model as well as in mean calculations across geography.
4. GAFEEs be reported to no more than two decimal places (x.yy).

2.2 Secondary Recommendations

The TEP further recommends:

1. NCES develop clear guidance regarding the use of the GAFEEs, in particular, identifying categories of educational expenditures for which a salary-based index is a valid means of adjustment.
2. NCES develop sound (but not lengthy) justification for basing GAFEEs only on salaries, rather than on salaries and fringe benefits.[1]
3. Should NCES be concerned about year-to-year volatility of GAFEEs produced from one-year ACS files, that it explores using ACS restricted-access data to reduce sampling error. If further smoothing is needed, NCES could explore the use of multi-year files to see whether there are defensible, useful methods for smoothing the single-year estimates.
4. NCES consider carefully whether, and if so in what form, it wishes to report or describe which intra-year and inter-year differences between GAFEEs are statistically significant, or, in the context of effect sizes, statistically meaningful.
5. NCES continue to use Labor Markets or similar geographic unit.

III. SUMMARY OF NISS RESEARCH

This section summarizes the findings and implications of the research conducted by NISS in support on the TEP. SAS code and datasets produced in the course of this research will be provided to NCES in conjunction with this report. Several "remaining issues" needing further consideration by NCES are also noted.

3.1 Financial Basis

Issue: For which categories of educational expenditures is a salary-based index a valid means of adjustment?

Finding: The use of instructional salary as a proxy for total salary expenditures and for total expenditures appears to be reasonable based on data from NCES 2005 LEA Finance Survey. Both variables are highly correlated with instructional salary. Instructional salary does not correlate as highly with other expenditure types. There is not an exact correspondence between instruction salary in the Finance Survey and the source data for the CWI since the Finance Survey does not classify employees based on degree.

Remaining Question: Should GAFEEs be based on salaries alone, as opposed to salaries and benefits, which some economic theory would suggest?[2] As noted in Section 2.2, complete benefits data are not available at the necessary geographical resolution in either the ACS or other potential data sources.

[1] The justification may simply be that ACS does not include complete information about fringe benefits, nor does any plausible alternative data source, at the CBSA level. See also Section 3.1.

[2] At least one TEP member and one other person whom NISS consulted argued strongly, albeit conceptually, for inclusion of benefits, which do vary geographically.

3.2 Construction of CWI from ACS Data

Issue: Is construction of adjustment factors from public use ACS datasets feasible?

Findings: ACS data are available from IPUMS in a format very similar to that used to construct the baseline CWI. NISS obtained the baseline CWI code and was able to reproduce the published baseline CWI. This code was modified without issue to run on ACS IPUMS 1-year data for 2005-2009.

While the 1-year ACS data are sufficiently representative for the broad geography variables used in the CWI, the precision of the 5-year data are more comparable to the Census Long Form. Estimates using the one-year data are less accurate due to smaller sample sizes, and more volatile across years; however, they are timelier. Other issues with the ACS include that it is collected on an ongoing basis, so that income variables do not necessarily correspond precisely to the year represented. This is a greater issue with 1-year data than with 3-year and 5-year data.

The model coefficients estimated from one-year ACS data are comparable to those published in the CWI documentation. The corresponding CWI calculated using the current baseline methodology, with some modifications as described below, appear reasonable and it seems feasible that the limitations of ACS can be overcome.

The CWIs calculated by NISS from the ACS show greater variability over time than those published by NCES, illustrated in Figures 1 and 2. This is expected in part because of the larger sample sizes and updating methodology used in Figure 2, which uses external OES data to update the 2000 IPUMS sample, so the difference between 2004 and 2005 comes from OES data. On the other hand, Figure 1 uses smaller non-overlapping samples from 2004 and 2005 IPUMS data.

Remaining Question: Should smoothed versions be created that are less volatile over time? The use of overlapping multi-year ACS data as the primary data source presents complications,[3] but could potentially be used to smooth the single-year estimates.[4] Another possibility is to obtain more precise estimates from non-overlapping 3-year or 5-year ACS data in combination with other data sources to obtain annual values. This would, however, entail development of an "updating methodology" other than the one used in the past.

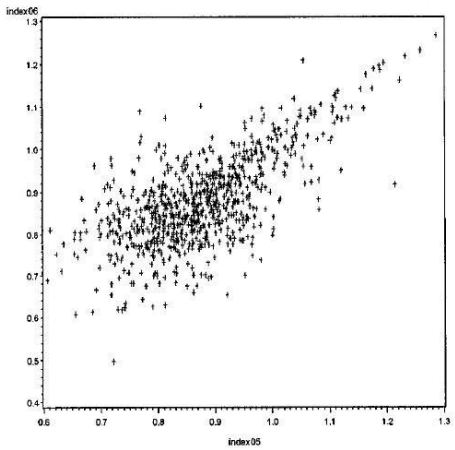

Figure 1: 2006 ACS-based CWI plotted against 2005 CWI from ACS data.

[3] In particular, the "rolling" nature of the five-year releases inhibits temporal comparisons.

[4] http://www.psc.isr.umich.edu/dis/acs/handouts/Compass_Appendix.pdf

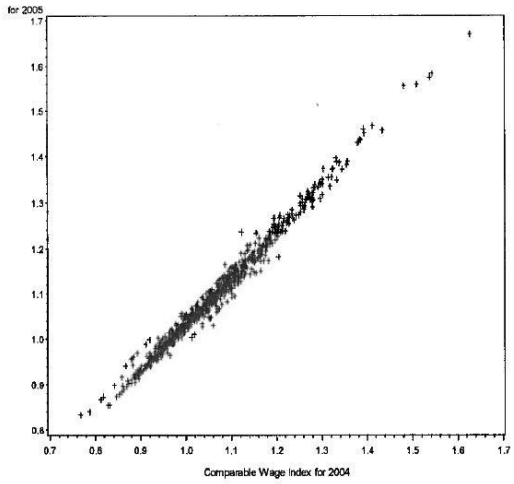

Figure 2: 2005 published CWI plotted against 2004 published CWI.

3.3 Modeling Methodology

A number of questions were addressed by NISS. Because of the recommendation that GAFEEs be based on one-year ACS datasets, none of these questions addressed the methodology previously used to produce updated CWI's by combining base year CWI's derived from IPUMS Long Form data and the later-year versions of the OES.

Question: Does the CWI methodology account properly for variances in calculation of standard errors?

Finding: The standard error methodology appears to be appropriate for the methods used, although details at the state level were not checked exhaustively. However, the state-level random effects are not included in the estimation of CWI's. The labor market estimates are predicted population margins and are based only on fixed effects (in SAS, **ls means msa/OM**).

The mixed effects model is represented by the equation $y = X\beta + Zy$, with $X\beta$ representing the fixed effects component and Zy representing the random effects component. The labor market margins are estimated using $L\hat{\beta}$ where L is the coefficient matrix associated with the least squares mean and $\hat{\beta}$ is the vector of estimated fixed effects coefficients.[5]

The state and national estimates are averages of these margins, weighted for number of sample persons in each labor market. Another approach would be to output predictions, including fixed and random effects, that is, $X\hat{\beta} + Zy$, for each individual, and then to average these predictions over labor market, state, and nation, using sample weights, to obtain estimated wages for each geographic division.[6]

[5 & 6] For details see
http://support.sas.com/documentation/cdl/en/statug/63033/HTML/default/viewer.htm#statug_mixedsectO14.htm
The interpretation of the predicted wage levels is different under this approach than in Taylor (2006, p.9). Here, the predicted wage level is the average predicted wage given the demographics in the labor market or state. In Taylor's, the predicted wage for a labor market is what a 'nationally representative person' would be expected to earn in that labor market. If the interpretation of the Taylor approach is desired, the resulting computation including random effects for states increases the computational burden as well as the complexity, as if a person moves between labor markets, they may move between states as well.

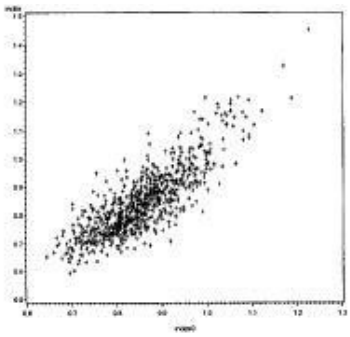

Figure 3: Comparison of CWI calculated with and without random effects.

Figure 3 illustrates the difference in labor market CWI obtained using the two approaches. As the realized random effects appear to be an important source of geographic variation, this approach is recommended.

The standard error calculation for this approach is not easily obtained in SAS; however, it may be computed using replicate weights.

Question: How sensitive are results to the occupational and industry exclusions?

Finding: The sensitivity is minimal, as shown in Figure 4.

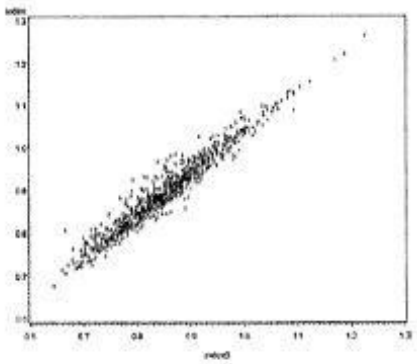

Figure 4: CWI with no industry or occupation exclusions plotted against CWI with exclusions.

Question: Can the methodology be improved by including interactions among predictors?

Finding: Based on NISS investigations in which interactions were added, doing so appears to have little effect.

Question: Can the methodology be improved by including *field of degree*, a new variable added to ACS in 2009?

Finding: This was done in the model for 2009. Some degree fields have significant effects, and the resulting labor market CWIs differed slightly from those computed without field of degree. There are approximately 35-degree categories, and it may be prudent to combine some of them.

Question: How might the models improve if restricted-access ACS data were used in place of IPUMS data?

Finding: NISS cannot resolve this question on its own. However, there appear to be three major possibilities:

a) Improved accuracy due to larger sample sizes, and potentially better geographic modeling as geography is identified down to the Census block.

b) Including additional labor market characteristics, such as urban-rural status. Public use ACS data include only limited urbanicity information, in order to protect the geographic variables that have been coarsened for confidentiality purposes. Labor market characteristics could still be obtained from external sources or at the unit level in the restricted-access ACS.

c) Inclusion of more accurate income data. Income in IPUMS is rounded to the nearest $100 for incomes of $1,000-$49,999, and to the nearest $1000 for incomes of $50K and greater. It is also top- coded (at $175K in 2000 long-form, $200K in 2000-2002 ACS, and the 99.5th percentile within state for 2003-on), with higher values replaced by the state mean of values above the cutoff.

Question: What is the effect of incorporating weights in the model?

Finding: The 5% IPUMS sample used is a weighted sample; however, weights are not used in the CWI construction. Including the weights does not substantially alter the CWI. Nevertheless, it is appropriate and correct to use the weights in the mixed model as well as the mean calculations across geography. Figure 5 shows the correspondence between the CWI computed with weights and the CWI computed without weights.

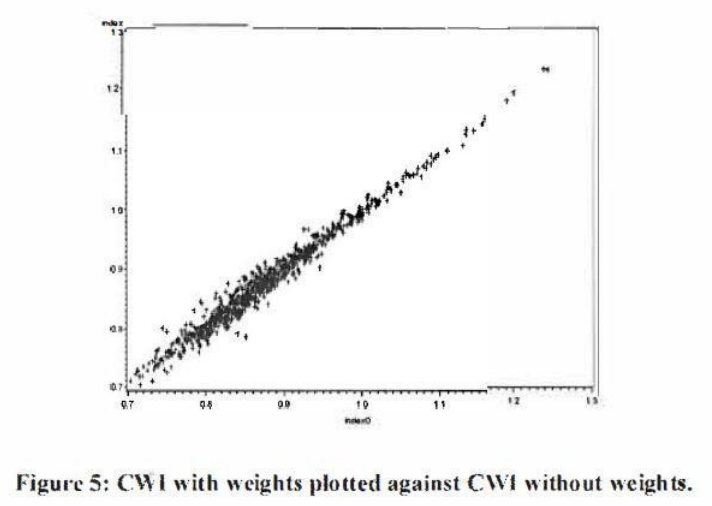

Figure 5: CWI with weights plotted against CWI without weights.

Question: Is the method used to calculate state-level CWI's sound?

Finding: The CWI modeling methodology for wages includes a random effect for *State* to account for labor markets that cross state lines. NISS found an apparent typographical error in the code, indicating that this was done incorrectly. Instead of estimating random effects for a categorical variable with 51 levels for each state, a single random effect was estimated for a continuous numeric variable with 51 discrete values. This does have a notable impact on the resulting CWI, illustrated in Figure 6, and of course is easily corrected.

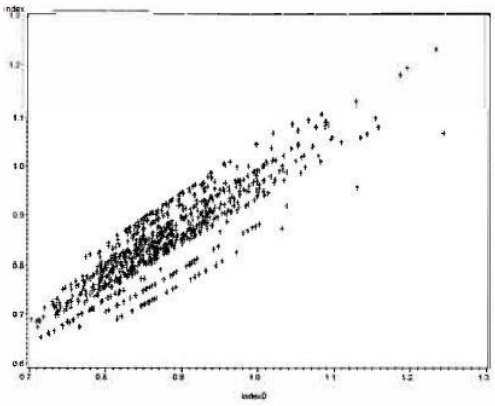

Figure 6: CWI calculated with correct treatment of random effects for state plotted against CWI calculated with incorrect treatment of random effects for state.

APPENDICES

Appendix A: Agenda

Appendix B: Meeting Participants

Appendix C: Charge to Panel

Appendix D: Interim Report on February 28, 2011

Appendix E: Expert Panel Biosketches

Appendix A: Agenda

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NISS/NCES TECHNICAL EXPERT PANEL ON CWI MEETING

February 16-17, 2011

NCES Conference Center, 1990 K Street, NW, Washington, DC

AGENDA

Wednesday, February 16

9:00 am	Welcome & Introductions
9:15	Task Force Charge & NCES Goals
9:45	Current CWI Methodology & Data Sources, Satkartar Kinney (NISS)
10:45	Break
11:00	Panel Discussion: List of Questions & Concerns
12:00 N	Lunch / Continuing Discussion
1:00 pm	Discussion Focusing on Uses & Users of Current CWI
2:30	Break
3:00	Discussion Focusing on Modeling, David Powers, Michelle Jiles, Don Luery (Census Bureau)
5:00	Adjourn for the Day

Thursday, February 17

8:00 am	Initial Formulation of Specifications
10:00	Break
11:15	Discussion: Plans, Action Items for NISS
12:00 N	Adjourn

Appendix B: Meeting Participants

Panel Members

John Abowd	Cornell University
Dan Black	University of Chicago
John Eltinge	Bureau of Labor Statistics
Dan Goldhaber	University of Washington
Jennifer Madans	National Center for Health Statistics

NCES Attendees

Marie Stetser	NCES
Marilyn Seastrom	NCES
Andrew White	NCES
Others TBD	NCES

Other Attendees

Michelle Jiles	Census Bureau
Don Lurey	Census Bureau
David Powers	Census Bureau
Lori Taylor	Texas A&M University (via video-conference)

National Institute of Statistical Sciences

Alan Karr	NISS
Satkartar Kinney	NISS Support

Appendix C: Charge to Panel

1. Articulate as precisely as possible the use cases and user communities for indices that provide geographical adjustment of (labor and other) expenditures by state education authorities (SEAs) or local education authorities (LEAs).
2. From these use cases, derive a set of functional specifications for such indices. Examples: level of disaggregation, treatment of uncertainties, predictive capabilities.
3. Assess the extent to which the current CWI fulfills the specifications.
4. In light of step 3 and taking account, propose modifications or alternatives to the current CWI that are sensible in light of current and prospective data sources or possible feasible modifications.

Appendix D: Interim Report on February 28, 2011

NISS/NCES Technical Expert Panel on CWI
Interim Report February 28, 2011

1. The panel met on February 16-17, 2011, at NCES. Members present for at least part of the meeting were John Abowd, Dan Black, John Eltinge, Alan Karr and Jennifer Madans. Dan Goldhaber joined some panel members and NCES personnel for dinner on February 16, and was briefed informally at that time. The agenda for the meeting accompanies this report.
2. The panel reached consensus on several items regarding NCES' construction and dissemination of geographical adjustment factors for educational expenditures:
    a) That NCES can and should produce and release such factors, together with detailed documentation of the data sources and methodology.
    b) The factors should support both cross-sectional and temporal comparisons.
    c) The factors should be produced annually, and as rapidly as possible in light of availability of the data on which they are based.
    d) If investigations by NISS provide justification, basing the factors on salaries/wages is acceptable.
    e) The appropriate labor market units are CBSAs and, for locations not in a CBSA, places of work as defined by the Census Bureau.
    f) Reporting adjustment factors to two decimal places (x.yy) is appropriate.
    g) Using the ACS as the sole data source is preferred over the current approach.
3. The panel identified several research issues to be addressed by NISS, using available data and current CWI methodology and code:
    a) **Financial Basis**. To what extent does the percentage of expenditures comprising personnel (salaries, wages and benefits) vary across LEAs? The goal is to inform a finding that basing the adjustment factors on salaries alone is or is not sound.
    b) **Proof of Concept**. Is construction of adjustment factors from (public use) ACS datasets feasible? NISS will construct factors for three years (2007-09), and assess a variety of issues such as year-to-year volatility. [Potential additional question: to what extent would the results differ if restricted ACS data were employed instead?]
    c) **Methodology**. Several points are to be addressed, some of which will require minor modifications of the CWI code:
        i. Are (estimated) variances accounted for properly?
        ii. How sensitive are results to the occupational and industry exclusions?
        iii. How much do results change if interactions among demographic characteristics are included in the model?
        iv. What is the effect of adding the ACS "Field of Study" variable?
        v. What is the effect of incorporating weights in the model?
        vi. Is the method used to calculate state-level adjustments sound?
        vii. Does it make sense to model some labor market characteristics (such as "ruralness"), and if so, what are the effects?

Appendix E: Expert Panel Biosketches

John Abowd, *Ph.D.*

Title: Edmund Ezra Day Professor of Economics, Cornell University

John M. Abowd is the Edmund Ezra Day Professor of Economics, Professor of Statistics and Information Science at Cornell University. He is also Research Associate at the National Bureau of Economic Research (NBER, Cambridge, MA), Research Affiliate at the Centre de Recherche en Economie et Statistique (CREST, Paris, France), Research Fellow at the Institute for Labor Economics (IZA, Bonn, Germany), and Research Fellow at IAB (Institut für Arbeitsmarkt-und Berufsforschung, Nürnberg, Germany). Abowd is the Director of the Labor Dynamics Institute (LDI) at Cornell. He is a Fellow of the Society of Labor Economists, a Fellow of the American Statistical Association,an Elected Member of the International Statistical Institute, and a Fellow of the Econometric Society. He has served as a Distinguished Senior Research Fellow at the United States Census Bureau since 1998. He also currently serves on the National Academies' Committee on National Statisticsand on the American Economic Association's Committee on Economic Statistics. Previously he was Director of the Cornell Institute for Social and Economic Research (CISER) from 1999 to 2007.

Dan A. Black, *Ph.D.*

Title: Professor, Irving B. Harris Graduate School of Public Policy Studies, University of Chicago

Dan A. Black is a professor at the University of Chicago Harris School of Public Policy. He also serves as a senior fellow at the National Opinion Research Center. Black is the project director for the National Longitudinal Survey of Youth and is on the editorial board of the Journal of Labor Economics, Labour Economics, and Journal of Urban Economics. His research focuses on labor economics and applied econometrics. His papers have appeared in the top journals in economics, statistics, and demography. He has served on panels for the Census Bureau, the Department of Education, the Environmental Protection Agency, the National Science Foundation, and the National Academy of Science. He has served as a consultant for the New Zealand and Australian governments as well as state and city governments. Before joining Harris, he was on faculty at the University of Kentucky and Syracuse University, held visiting appointments at the University of Chicago, Australian National University, and Carnegie Mellon University. Black holds a BA and MA in history from the University of Kansas and an MS and PhD in economics from Purdue University.

John L. Eltinge, *Ph.D.*

Title: Associate Commissioner for Survey Methods Research, Bureau of Labor Statistics

Dr. John L. Eltinge is the Associate Commissioner for Survey Methods Research and Senior Mathematical Statistician at the Bureau of Labor Statistics. John was previously associate professor with tenure in the Department of Statistics at Texas A&M University, where he supervised numerous doctoral and masters' students. He is a member of the Federal Committee on Statistical Methodology; a fellow of the American Statistical Association; an associate editor for the Journal of Official Statistics; and a member of the Committee on Fellows of the American Statistical Association. He previously served as the President of the Washington Statistical Society; the overall program chair for the 2003 Joint Statistical Meetings; and an associate editor for the Journal of the American Statistical Association and for The American Statistician.

Dan Goldhaber, Ph.D.

Title: Director, CALDER at American Institutes for Research & Director, CEDR at the University of Washington

Dr. Dan Goldhaber is the Director of the Center for Analysis of Longitudinal Data in Education Research (CALDER) at the American Institutes for Research and the Director of the Center for Education Data & Research (CEDR) at the University of Washington. His work focuses on issues of educational productivity and reform at the K-12 level, the broad array of human capital policies that influence the composition, distribution, and quality of teachers in the workforce, and connections between students' K-12 experiences and postsecondary outcomes. Topics of published work in this area include studies of the stability of value-added measures of teachers, the effects of teacher qualifications and quality on student achievement, and the impact of teacher pay structure and licensure on the teacher labor market. His research has been regularly published in leading peer-reviewed economic and education journals such as: American Economic Review, Journal of Human Resources, Journal of Policy and Management, Economics of Education Review, Education Finance and Policy, and Educational Evaluation and Policy Analysis. The findings from these articles have been covered in more widely accessible media outlets such as National Public Radio, the New York Times, the Washington Post, USA Today, and Education Week.

Jennifer H. Madans, *Ph.D.*

Title: Acting Director, National Center for Health Statistics

She is the NCHS Associate Director for Science, where she is responsible for the overall plan and development of NCHS's data collection and analysis programs. Since Dr. Madans joined the Center, she has concentrated her research efforts on data collection methodology, measurement of health and functioning and health services research. She is a founding member and has been the chair of the steering committees for three UN sponsored initiatives to develop internationally comparable measures of disability and health, including the Washington Group on Disability Statistics, a city group under the auspices of the UN Statistical Commission. Dr. Madans is a graduate of Bard College (B.A.) and the University of Michigan (M.A. and Ph.D., Sociology). She completed a Postdoctoral Fellowship in the Department of Epidemiology and Public Health at Yale University. She has served as an adjunct Associate Professor in the Division of Biostatistics and Epidemiology, Department of Community and Family Medicine, Georgetown University School of Medicine and in the Department of Demography at Georgetown. She is a Fellow of the American Statistical Association and an elected member of the International Statistical Institute and served as a Vice President of the International Association of Official Statistics.

Alan Karr, *Ph.D.*

Title: Director of the National Institute of Statistical Sciences

Dr. Alan Karr is the Director of the National Institute of Statistical Sciences. He also holds the position of Professor, Statistics & Operations Research and Biostatistics, University of North Carolina at Chapel Hill (UNC). Currently he also holds an adjunct faculty appointment at Carnegie Mellon University. Dr. Karr has published over 150 scientific papers and written two books. He has also served on the Army Science Board and has been an associate editor for the Operations Research Letters, Mathematics of Operations Research and the SIAM Journal on Applied Mathematics. He is a Fellow of the American Statistical Association, a Fellow of the Institute of Mathematical Sciences, and an elected member of the International Statistical Institute and the Johns Hopkins Society of Scholars.