Institute of Education Sciences
National Center for Education Statistics

NATIONAL INSTITUTE OF STATISTICAL SCIENCES

ADDENDUM TO WHITE PAPER

PROJECTIONS OF EDUCATION STATISTICS: PRESENTATION AND METHODOLOGY

TABLE OF CONTENTS

NATIONAL INSTITUTE OF STATISTICAL SCIENCES

ADDENDUM ON PROJECTIONS OF EDUCATION STATISTICS: PRESENTATION AND METHODOLOGY

EXECUTIVE SUMMARY

This document is an addendum to the "White Paper on NCES Projections of Education Statistics: Presentation and Methodology" (Karr, 2009) delivered to NCES by the National Institute of Statistical Sciences (NISS) and dated October 26, 2009. That white paper was written specifically in terms of Hussar and Bailey (2008). However it is substantially applicable to the more recent Hussar and Bailey (2009), as well as future versions of the *Projections of Education Statistics.*

This addendum addresses in detail two issues identified at a meeting of NCES and NISS personnel held on January 12, 2010:

1. Whether to employ alternating shading of groups of rows, in tables, which is sometimes termed "zebra striping."
2. The extent to which, and form in which, multiple scenarios are presented in projections or forecasts disseminated by other Federal statistical agencies.

Briefly, the principal recommendations in this addendum are that NCES:

1. Employ alternating shading of groups of one, two or three rows in tables, with the choice of grouping size determined by context. See Section 2.
2. In light of the investigation of the very limited use of scenarios by other agencies, consider seriously dropping the "Low" and "High" projections entirely, from both the on-line and PDF versions of the *Projections of Education Statistics*, for reasons and resulting in benefits discussed in Section 3.

Section 4 contains an amplification of comments in Karr (2009) regarding the methodology used to prepare the *Projections of Education Statistics.*

SECTION 1

Background

Following delivery of the White Paper that reviewed the presentation and the methodology used in the (2008) edition of *Projections of Education Statistics* on, NCES convened a meeting of NCES and NISS staff to discuss the White Paper and to consider elaboration of two specific findings. This Addendum provides details and examples and also amplifies reasoning behind these and other more general comments and recommendations.

Shading of Table Rows

Karr (2009, page 11) stated that:

> *[T]he dotted lines that appear in virtually every table are space-consuming, visually unattractive and less effective than alternatives such as that in Figure 8, which is a version of Table B-4 of Hussar and Bailey (2008). The shading for alternating years is unintrusive, yet distinguishes years perfectly. This table is physically smaller than Table B-4 of Hussar and Bailey (2008), and as well, the distance between labels and data is smaller.* For reference, Table B-4 of Hussar and Bailey is reproduced here as Figure 1, and Figure 8 of Karr (2009) as Figure 2. The numbers in the table are actual and projected college-age populations.

Year (July 1)	18-year-olds	18- to 24-year-olds	25- to 29-year-olds	30- to 34-year-olds	35- to 44-year-olds
Actual					
1992	3,354	26,282	20,591	22,564	40,046
1993	3,455	26,102	20,146	22,646	40,975
1994	3,428	25,821	19,809	22,648	41,877
1995	3,601	25,585	19,742	22,425	42,765
1996	3,650	25,376	19,927	21,996	43,605
1997	3,780	25,574	19,960	21,494	44,282
1998	3,984	26,155	19,863	20,999	44,802
1999	3,993	26,780	19,632	20,647	45,130
2000	4,076	27,393	19,357	20,579	45,235
2001	4,074	28,087	19,004	20,781	45,188
2002	4,033	28,601	18,997	20,878	44,869
2003	4,131	29,094	19,213	20,789	44,484
2004	4,128	29,408	19,625	20,528	44,178
2005	4,127	29,500	20,148	20,153	43,954
2006	4,190	29,610	20,800	19,764	43,748
Projected					
2007	4,272	29,809	21,313	19,713	43,379
2008	4,401	30,173	21,672	19,865	42,782
2009	4,384	30,536	21,878	20,213	42,109
2010	4,312	30,762	21,944	20,657	41,600
2011	4,250	30,894	21,981	21,205	41,318
2012	4,170	30,947	22,057	21,652	41,217
2013	4,126	30,884	22,205	22,000	41,222
2014	4,080	30,693	22,459	22,202	41,258
2015	4,007	30,297	22,783	22,271	41,270
2016	3,990	29,901	23,059	22,313	41,421
2017	4,018	29,607	23,260	22,394	41,754

Figure 1: Table B-4 of Hussar and Bailey (2008)

Year (July 1)	18-year-olds	18- to 24-year-olds	25- to 29-year-olds	30- to 34-year-olds	35- to 44-year-olds
Actual					
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Figure 2: Figure 8 of Karr (2009).

The practice of shading alternate rows in tables is widespread. It is discussed in Tufte (1990). For instance, both Apple Computer's iTunes® and Mozilla's Thunderbird® e-mail client employ it, and the Java programming language provides native support for it. The evidence regarding its effectiveness is not uniformly positive, however (Enders, 2007).

A different alternative appears in Figure 3. It has the advantage that type is not obscured by shading, but on the basis of limited, informal surveys, seems inferior to the version in Figure 2.

Year (July 1)	18-year-olds	18- to 24-year-olds	25- to 29-year-olds	30- to 34-year-olds	35- to 44-year-olds
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Figure 3: A second alterative to Table B-4 of Hussar and Bailey (2008).

It is not logically necessary that zebra striping be applied to alternating rows, as in Figure 2, although this is overwhelmingly the case in practice. Figure 4 shows a version in which alternating pairs of rows are shaded, and Figure 5, one in which rows are shaded in sets of three.

Year (July 1)	18-year-olds	18- to 24-year-olds	25- to 29-year-olds	30- to 34-year-olds	35- to 44-year-olds
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Figure 4: Version of Table B-4 of Hussar and Bailey (2009) in which pairs of rows are shaded.

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Figure 5: Version of Table B-4 in Hussar and Bailey (2009) in which rows are shaded in sets of three.

Each of the alternatives in Figures 2, 4 and 5 may be preferred to the others in certain circumstances, for esthetic or functional reasons. To illustrate the latter, consider two "table tasks:"

1. For a given row, finding the entry in a given column (row first-column second location). In the case of Figure 2 would mean, for instance, finding the projected 25-29-year-old population in 2015. All three alternatives appear to support this task well.
2. Comparing the entries in two (possibly rather distant) rows for a given column (column first-row second location). For example, this would mean comparing the actual 30-to-34- year-old population in 1996 to the projected population in the same age group in 2016. For this task, the alternative in Figure 2 may be the least effective: remembering one of a lot of unshaded bars is more difficult than remembering one of fewer shaded groups plus a position-within-group.

On more abstract grounds, if there were to be a single default choice, the alternative in Figure 2 is probably the most sensible. People are widely familiar with it (even if they are not always aware of its being employed) and there is no possibility of mistaking the shading for grouping of rows. The alternative in Figure 5 may be the most functional for some tasks, but as that figure illustrates, can appear unevenly in tables with small numbers of rows.

Based on this further investigation, it seems clear that a {context/task/user community}- dependent selection among the alternatives in Figures 2, 4 and 5 is superior to the current practice.

Scenarios

There are several clearly identifiable issues associated with the use of multiple scenarios in its *Projections of Education Statistics*, including:

1. The scenario names of "low," "middle" and "high" are uninformative. In fact, the scenarios represent differing economic assumptions, which is explained only in Appendix A of Hussar and Bailey (2009).
2. The differences among the scenarios are in many cases less than the uncertainty bounds, which in a technical sense renders them not statistically significant. In this case, presenting the scenarios may be inconsistent with NCES' Statistical Standards. Of course, as noted in Section 4, the available uncertainty bounds are imprecise. What does seem clear, however, is that scenario differences are exceeded by forecast errors.
3. It is possible that some readers misinterpret the scenarios as uncertainty bounds. Hussar and Bailey (2009) seems almost to invite confusion: on page 84 there it is stated that "These alternatives reveal the level of uncertainty in making projections, was well as the sensitivity of projections to the assumptions on which they are based." However, well- recognized shortcomings in knowledge of users and uses of Projections of Education Statistics leave this issue as substantially speculative.
4. The scenarios cause significant problems with formatting of tables in Hussar and Bailey (2009), which are discussed in Section 2.3.1 of Karr (2009).

Were NCES simply to eliminate the scenarios from future editions of *Projections of Education Statistics*, these issues would all be resolved.

Based on discussions at the January 12, 2010, meeting, an informal but rather complete survey was taken of US federal agency (and selected other) web sites to gain a sense of:

1. Whether they produce and disseminate projections.
2. If projections are produced, whether they depict are multiple scenarios.
3. Whether projections are accompanied by uncertainty bounds.

The results of that survey appear in Appendix A. In addition to US government agencies, three international sources were also included. Many agencies, of course, produce projections, a number of specific examples of which appear in Appendix A. Other agencies, however, appear not to; these include BJS, BTS & NCHS. NASS produces only (short-term) forecasts, for example, of current year crop production prior to harvest, given information about plantings & subsequent weather. BLS & Census produce multiple projections. EIA is discussed below.

Virtually without exception, the projections described in Appendix A are *not accompanied by uncertainty bounds*. In some cases, accompanying technical documentation contains discussion of uncertainties, but primary tables and graphs do not depict uncertainties. It appears clear that there is no case for including uncertainties in the main tables and graphs *Projections of Education Statistics.* (One interesting example of the presentation of uncertainties associated with projected world population appears at the end of

Appendix A. It comes from International Institute for Applied Systems Analysis.)

Among the surveyed agencies, *scenarios are clearly the exception*, and when they do appear, they are, save in one instance, simply described, and not used within models that generate the projections. Statistics Canada exemplifies this: population projections are made for six scenarios defined by differing values of fertility, life expectancy, immigration and inter-provincial migration, but all that is presented is the resulting different population estimates.

The EIA stands as a clear special case. The Annual Energy Outlook (AEO) contains forecasts of energy prices and consumption for multiple scenarios, referred to as "Low Economic Growth," "Reference Case," and "High Economic Growth," as well as cases corresponding to high and low oil prices. There are, however, important differences from *Projections of Education Statistics:*

1. The projections are produced by a complex, well-validated and publicly available model - the National Energy Modeling System.[1] This cannot be said of the mythology underlying the *Projections of Education Statistics.*
2. The differences among the scenarios are endogenous to the modeling system.
3. The results from the multiple scenarios are, in general, reported separately, in some cases in different PDF documents. This helps minimize confusion between scenarios and uncertainty bounds. Primary reports contain only the reference case.

The results from the multiple scenarios are, in general, reported separately, in some cases in different PDF documents. This helps minimize confusion between scenarios and uncertainty bounds. Primary reports contain only the reference case.

Many other EIA forecasts, including primary forecasts of consumption, do not contain scenarios, and almost none of its forecasts - one exception is noted in Appendix A - contain uncertainty bounds.

Given both the issues noted at the start of this section and the results of the survey, and especially in light the absence of knowledge of how, if at all, the multiple scenarios are used, the recommendation that NCES seriously consider dropping the low and high scenarios from its Projections of Education Statistics stands. If NCES wishes to retain scenarios, the EIA's AEO can provide a model for how to so.

Methodology

At the January 12, 2010, meeting, there was discussion of the relative paucity of recommendations in Karr concerning the methodology underlying the *Projections of Education Statistics*. As noted there, this paucity large reflects the degree to which the "description of it in Appendix A [of Hussar and Bailey (2009)] is cryptic and incomplete." That the methodology has significant shortcomings identified in Karr (2009), including:

1. Not being based on structural models;
2. Lack of coherence, even in following the "project a base and proportions" principle;
3. Inability to model (exogeneous) shocks to the system;
4. Inability to provide principled measures of uncertainty;

[1] http://www.eia.doe.gov/oiaf/aeo/overview/index.html

is sharpened by comparison with the detail underlying EIA's AEO (see Section 3). However, in light of the near-universal absence of uncertainty bounds, item 3 may be less acute.

There are several ways in which NCES can move forward regarding methodology, depending on its assessment of the severity of the shortcomings, the impact on users, and available resources:

1. A minimal approach would be to provide comprehensive and comprehensible documentation of the methodology, and especially to clarify what Karr (2009) termed the "parts of the description [that are] are undecipherable."
2. A complete re-doing of the methodology, which was estimated in Karr (2009) to require "a two-year project involving senior researchers and a full-time postdoctoral fellow, with deep engagement of relevant NCES staff."
3. An attempt to "patch" the methodology to address specific issues, most notably the inability, noted above, to accommodate exogenous shocks. There is, of course, no assurance that such an effort would succeed; it could instead cause an already fragile structure to collapse.

Choosing among these or other alternatives seems difficult without implementing the recommendation in Karr (2009) that NCES employ "focus groups or an expert task force to understand how the projections are used," as well as explore existing and alternative sources of data. This is the appropriate path to move forward. A concrete first step would be to place a voluntary survey of users on the Projections of Education Statistics web site, which could yield important and hitherto lacking information about the Projections of Education Statistics user community and how it employs this very important product of NCES. This survey could be designed, implemented and yield useful insights within a matter of months.

APPENDICES

Appendix A: References

Enders, J. (2007). Zebra Striping: Does it Really Help? OzCHI 2007 Proceedings, pages 319-322.

Hussar,W. J., and Bailey, T. M. (2008). Projections of Education Statistics to 2017. Publication 2008-078, National Center for Education Statistics. Available on-line at http://nces.ed.gov/programs/projections/projections2017/.

Hussar,W. J., and Bailey, T. M. (2009). Projections of Education Statistics to 2018. Publication 2009-062, National Center for Education Statistics. Available on-line at http://nces.ed.gov/programs/projections/projections2018/.

Karr, A. F. (2009). White Paper on NCES Projections of Educations Statistics: Presentation and Methodology. Unpublished report, National Institute of Statistical Sciences.

Tufte, E. R. (1990). Envisioning Information. Graphics Press, Cheshire, CT.

Appendix B: Addendum

Representative Projections Available on Fed Stats and Related Websites

Copies of all PDF documents cited here are available from the author on request.

Bureau of Labor Statistics (BLS)

Three sets of projections are:

1. EPP Employment Projections Program (EPP): http://www.bls.gov/emp/
2. Occupational Outlook Handbook: http://www.bls.gov/oco/oco2003.htm
3. Occupational Employment Projections: http://www.bls.gov/opub/mlr/2009/11/art5full.pdf

In all cases, there are neither scenarios nor uncertainty bounds.

Bureau of Justice Statistics (BJS)

No projections were readily identifiable

Bureau of Transportation Statistics (BTS)

The document http://www.volpe.dot.gov/infosrc/highlts/pdf/dec08.pdf cites EIA projections crude oil prices that refer to scenarios termed the "EIA High Case, Base Case, and Low Case." See the discussion of EIA below. Otherwise, no projections were identified.

Census Bureau

Examples of population projections are:

1. http://www.census.gov/population/www/projections/index.html
2. http://www.census.gov/population/projections/SummaryTabA1.pdf
3. http://www.census.gov/population/projections/34PyrmdNC1.pdf

None of these contains scenarios or uncertainty bounds.

Employment projections are exemplified by

1. http://www.census.gov/compendia/statab/2010/tables/10s0605.pdf, which contains neither scenarios nor uncertainty bounds.

Centers for Medicare and Medicaid Services (CMS)

This agency in the Department of Health and Human Services produces detailed projections of health care expenditures:

1. https://www.cms.gov/NationalHealthExpendData/downloads/proj2009.pdf.

Neither scenarios nor uncertainty bounds are presented, but there is a detailed, separate document describing the methodology:

https://www.cms.gov/NationalHealthExpendData/downloads/projections-methodology.pdf

Energy Information Administration (EIA)

Some EIA forecasts provide neither scenarios nor uncertainty bounds; examples are:

1. Energy Consumption: http://www.eia.doe.gov/oiaf/forecasting.html
2. Petroleum Consumption: http://www.eia.doe.gov/oiaf/aeo/excel/aeotab_12.xls
3. The following forecast of World Crude (Oil) Price contains a base case with a 95% confidence interval http://www.eia.doe.gov/pub/oil_gas/petroleum/presentations/2001/national_governors_association/sld019.htm

The Annual Energy Outlook (AEO) provides forecasts of energy prices and consumption for multile scenarios, referred to as "Low Economic Growth," "Reference Case," and "High Economic Growth." These cases are defined in http://www.eia.doe.gov/oiaf/aeo/pdf/trend_1.pdf. Elsewhere, there are also cases corresponding to high and low oil prices. In http://www.eia.doe.gov/oiaf/analysispaper/retrospective/retrospective_review.html, it is stated that

> "The analysis in the *AEO* primarily focuses on a Reference case, lower and higher economic growth cases, and lower and higher oil price cases. However, approximately 30 alternative cases are generally included in the *AEO*. Readers are encouraged to review the full range of cases, which address many of the uncertainties inherent in long-term projections."

The word "uncertainties" here does not appear to connote statistical uncertainties. Examples of documents containing such forecasts are::

1. http://www.eia.doe.gov/oiaf/aeo/pdf/appb.pdf
2. http://www.eia.doe.gov/oiaf/ieo/pdf/ieorefcase.pdf
3. http://www.eia.doe.gov/oiaf/ieo/pdf/ieohecon.pdf
4. http://www.eia.doe.gov/oiaf/ieo/pdf/ieolecon.pdf
5. http://www.eia.doe.gov/oiaf/ieo/pdf/highlights.pdf, which contains the reference case only.
6. None of these contains uncertainty bounds. Note that items 2-4 separate the scenarios into distinct documents.

Environmental Protection Agency (EPA)

Examples of projections containing scenarios are:

1. For high global warming potential gases, http://www.epa.gov/highgwp/projections.html, where the scenarios represent the implementation or not of certain "voluntary programs."
2. For climate change, http://www.epa.gov/climatechange/science/futuretc.html, with scenarios corresponding to "high growth," " moderate growth," and "low growth."

No uncertainty bounds are presented, although in item 2, "variability between [*sic*] models" appears in at least one graph.

National Agricultural Statistics Service (NASS)

1. http://usda.mannlib.cornell.edu/usda/ers/LDP-M//2010s/2010/LDP-M-05-19-2010.pdf
2. For crop forecasts, http://www.nass.usda.gov/Education_and_Outreach/Understanding_Statistics/pub1554.pdf

Neither scenarios nor uncertainty bounds are provided.

National Center for Health Statistics (NCHS)

According to Lawrence Cox, former Associate Director for Research and Methodology, NCES does not produce projections, which is consistent with searching the NCES web site. NCHS' parent organization, the Centers for Disease Control and Prevention (CDC), produces short-term forecasts, for example of the number of flu cases in a "flu season," but seems to produce few if any long-term projections. An example of a major CDC report in which projections are absent is

1. http://www.cdc.gov/nchs/data/hus/hus08.pdf.

For completeness, two non-US organizations were checked as well.

Eurostat

Population projections appear at

1. http://epp.eurostat.ec.europa.eu/portal/page/portal/product_details/dataset?p_product_code=TPS00002

There are no multiple scenarios, although it is stated that "Eurostat's population projections is one of several possible population change scenarios based on assumptions for fertility, mortality and migration." There are no uncertainty bounds.

Statistics Canada

Population projections are presented in

1. http://www.statcan.gc.ca/pub/91-520-x/91-520-x2005001-eng.pdf, which contains low-, medium-, high-fertility scenarios. Elsewhere in the same document, there appear six scenarios based on fertility, life expectancy, immigration and inter-provincial migration. Uncertainty bounds are absent.

Other Organizations

The International Institute for Applied Systems Analysis (IIASA) provides on its web site population projections with medians, 10^{th} and 90^{th} percentiles:

1. http://www.iiasa.ac.at/Research/POP/proj07/index.html?sb=6. Figure 6 shows a similar projection with other percentiles.

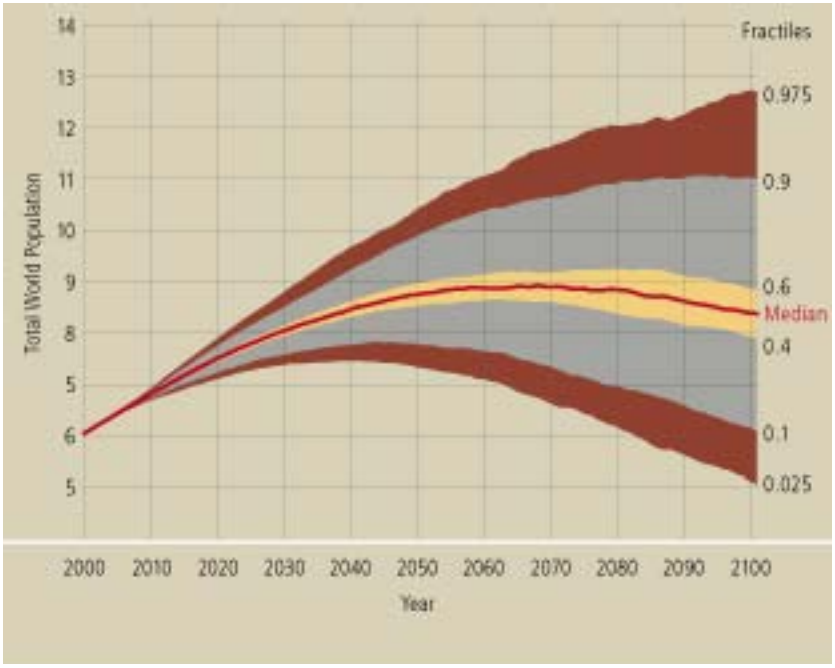

Figure 6: Population Projection by IIASA containing various percentiles.

Appendix C: Author

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