
Howard Young  
*University of Michigan*

Barry Allen  
*Combined Insurance Company of America*

Eileen Crimmins  
*University of Southern California*

David Cutler  
*Harvard University*

Martin Holmer  
*HR&A*

Follow this and additional works at: [https://repository.upenn.edu/parc_working_papers](https://repository.upenn.edu/parc_working_papers)

Young, Howard; Allen, Barry; Crimmins, Eileen; Cutler, David; Holmer, Martin; Manunovich, Diane; Myers, Robert; Preston, Samuel H.; Steuerle, Eugene; Sze, Michael; Utgoff, Kathleen; Wiltse, Larry; and Wolfe, Barbara, "1994-95 Advisory Council on Social Security Technical Panel on Assumptions and Methods Final Report" (1996). *PARC Working Paper Series*. 52.  
[https://repository.upenn.edu/parc_working_papers/52](https://repository.upenn.edu/parc_working_papers/52)

This paper is posted at ScholarlyCommons.  
[https://repository.upenn.edu/parc_working_papers/52](https://repository.upenn.edu/parc_working_papers/52)

For more information, please contact repository@pobox.upenn.edu.
Abstract
The Panel's major conclusions are: The "intermediate" projection of the Trustees Report for the Old-Age, Survivors, and Disability Insurance (OASDI) program provide a reasonable evaluation of the financial status. Although the Panel suggests that modifications be considered in various specific assumptions, the overall effect of those suggestions would not significantly change the financial status evaluation. There should be evolutionary implementation of procedures to indicate more adequately the uncertainties involved in the projections. Even though such uncertainties are unavoidable, stochastic analysis should be used to examine more explicitly the probabilities of alternative projections. It is emphasized that there should be an extended period during which the new procedures would supplement, rather than replace, the current methods of considering high-cost and low-cost projections and individual assumption sensitivity analysis. Evaluation of the long-range financial status should put less emphasis on the "75-year actuarial balance" and the "test of long-range close actuarial balance." Prior to enactment of legislation reforming the program, primary emphasis should be on the projected date the Trust Fund Ratio would fall below 100 percent; when definitive legislative revisions are adopted, subsequent long-range evaluation should compare up-dated projections with the intended results of the legislation. There should be a substantial expansion of SSA's resources and its interaction with experts in related areas: increased recognition should be given to the interrelationships between OASDI and many public and private programs as well as other aspects of the economy. Social Security Administration (SSA) staff does high quality work, but is relatively small and works with inadequate resources. In addition to internal expansion, there should be greater use of outside consultants and contractual research; periodic comprehensive review by technical panels should be supplemented by ongoing arrangements for advice on specific matters.

Keywords
retirement, mortality, morbidity, fertility, marriage and divorce, immigration, economic assumptions, disability rates, OASDI program, Social Security Administration

Disciplines

Comments

Author(s)
Howard Young, Barry Allen, Eileen Crimmins, David Cutler, Martin Holmer, Diane Manunovich, Robert Myers, Samuel H. Preston, Eugene Steuerle, Michael Sze, Kathleen Utgoff, Larry Wiltse, and Barbara Wolfe

This working paper is available at ScholarlyCommons: https://repository.upenn.edu/parc_working_papers/52
1994-95 ADVISORY COUNCIL ON SOCIAL SECURITY
TECHNICAL PANEL ON ASSUMPTIONS AND METHODS
FINAL REPORT
# TABLE OF CONTENTS

I. Preface ................................................................. iii

II. Executive Summary .................................................. 1

III. General Comments .................................................. 7

IV. Uncertainty of Projections ............................................ 11

V. Demographic Assumptions ............................................. 17
   A. Mortality .......................................................... 17
   B. Fertility .......................................................... 23
   C. Marriage and Divorce ............................................. 29
   D. Immigration ....................................................... 32

VI. Economic Assumptions ............................................... 36
   A. Economic Assumptions for the Next 75 Years .................... 37
      i. Real Wage Growth .............................................. 37
      ii. Interest Rates and Inflation .................................. 41
      iii. Unemployment Rates ......................................... 43
      iv. Short-term Transition ......................................... 43
   B. Measurement Issues Associated with the CPI ..................... 44
   C. Additional Recommendations ...................................... 46

VII. Disability Rates .................................................... 47

VIII. Assumptions Regarding Retirement Age under Current Law .......... 51

IX. Presentation of Long Term Status of the Trust Funds .................. 54

X. Research and Other Matters .......................................... 60

Appendices

A. Stochastic Simulation -- Martin Holmer .......................... A-1
B. Stochastic Simulation -- Michael Sze ............................ B-1
C. Mortality ......................................................... C-1
D. Fertility Rate Illustration ......................................... D-1
E. Test of Short Range Financial Adequacy .......................... E-1
F. Supplemental Statement by Robert J. Myers ...................... F-1
G. Letter from Professor Merton C. Bernstein ....................... G-1
H. Long-Range OASDI Financial Effects of Panel
   Recommended Demographic and Economic
   Assumptions for the Social Security Trustees Report ......... H-1
I. PREFACE

On August 4, 1994, the Advisory Council on Social Security appointed the following experts to the Panel on Assumptions and Methods.

Howard Young, Chair, University of Michigan

Barry Allen, Combined Insurance Company of America

Eileen Crimmins, Andrus Gerontology Center, University of Southern California

David Cutler, Department of Economics, Harvard University

Martin Holmer, HR&A

Diane Macunovich, Department of Economics, Williams College

Robert Myers, Actuarial Consultant

Samuel Preston, Population Studies Center, University of Pennsylvania

Eugene Steuerle, Senior Fellow, The Urban Institute

Michael Sze, Partner, Hewitt Associates

Kathleen Utgoff, Groom & Nordberg

Larry Wiltse, Consultant Actuary, Buck Consultants, Inc.

Barbara Wolfe, Professor of Economics, Preventive Medicine and Public Affairs, University of Wisconsin - Madison

The Charter provided to the Panel was to:

[assist the 1994-95 Advisory Council by reviewing the assumptions and methodology used to project the future financial status of the old age, survivors, and disability insurance (OASDI) programs, including, if necessary, measures of the financial soundness of these programs.

Based on the work of the previous Technical Panels in 1989-91 and the work of the Public Trustees since then, the 1994-95 Technical Panel is requested to do the following:
• Provide expert scrutiny of key assumptions: mortality and morbidity and, to a lesser extent, fertility and immigration; disability incidence and duration; productivity and real wage growth, and the real interest rate. Provide expert opinion concerning the effect on these factors of changes (particularly increases) in national savings.

• Examine alternatives to 75-year forecasts to reflect better the long-run financial soundness of the program and to make the estimates less dependent on particular timeframes.

• Examine the use of administrative data to update assumptions (e.g., sampling methods used for determining the level of new benefits) and other methodology issues identified by the Office of the Actuary, and make recommendations concerning improvements.

• Examine the use of administrative and other data sets to do short-term (in particular, cash-flow) estimates of proposals for program changes (e.g., raising normal retirement age, changing retirement earnings test), and make recommendations concerning improvements.

• Examine labor force participation estimates, particularly those regarding women's lifetime earnings.

The Technical Panel also is encouraged to undertake its own review of the work of the 1989-91 Technical Panel and the work done for and by the Public Trustees and expand the above agenda as appropriate and feasible.

The Council also may ask members of this Panel to work with members of the Technical Panel on Trends and Issues in Retirement Policy to develop and assess policy and program alternatives.

In order to facilitate its work, the Panel organized itself into four subpanels:

Demographic assumptions: Crimmins (chair), Allen, Macunovich, Preston, Sze and Wolfe

Economic assumption: Cutler (chair), Holmer, Myers, Steuerle and Wiltse

Uncertainty analysis: Utgoff (chair), Allen, Holmer, Sze and Wiltse

Other matters: Young (chair), Myers, Preston, Steuerle and Wolfe

This arrangement allowed simultaneous discussion of some topics during the Panel's meetings, and organized the follow-up activity between such meetings.
However, the Panel frequently met as a single group, and all conclusions in the body of this report reflect consensus of the full Panel unless specifically noted otherwise.

The Panel had five formal meetings, of two days each. Various groups of Panel Members participated in telephone conferences, and Panel Members did follow-up work (individually or in groups) which drew upon their professional expertise and contacts, as well as consultation with SSA staff and occasional visits to the SSA Office of the Actuary in Baltimore. Two oral presentations, regarding the Panel's preliminary conclusions, were made to the Advisory Council.

Various staff persons from the Advisory Council and SSA attended many of the Panel meetings. Staff presentations covered many of the procedural aspects of SSA's assumptions and methods; at the Panel's request, presentations regarding the needs and concerns of some other government agencies were made by Jane Ross of the General Accounting Office, Christine Schmidt Bayne of the Office of Budget, Department of Health and Human Services, and Paul Cullinan of the Congressional Budget Office. Those presentations were needed background; nevertheless, a substantial portion of the Panel's meeting time was used for discussion among the Panel Members themselves.

Of course, it was not feasible for the panel to give detailed consideration to all assumptions and methods that are (or reasonably could be) utilized by SSA. This report reflects the Panel's assessment of priorities, within the framework of its Charter. In addition to the substantive conclusions, the Panel notes the importance of ongoing research and review; the latter is a particular concern, because the traditional quadrennial Advisory Council mechanism (and the related technical reviews) is not included in the new independent SSA structure.

The Panel received only one inquiry: the 3/2/95 letter from Professor Merton Bernstein is reproduced in Appendix G. As to the Americans with Disabilities Act, the Panel did not anticipate an effect on an overall employment or wage levels that would be significant enough to impact the OASDI assumptions. Regarding Professor Bernstein's comment on mortality, the Panel believes that its conclusions on mortality - as detailed in this report - take sufficient account on attitudes toward "heroic" life extending efforts.

The Panel thanks the Advisory Council staff (especially Wayne Sulfridge for direct assistance), and SSA staff (particularly in the Office of the Actuary and the Office of Research and Statistics), as well as Jane Ross, Christine Schmidt Bayne, and Paul Cullinan for their input and assistance. Some others who provided useful advice to the Panel (but are not responsible for the Panel conclusions) are Gary Burtless, Brad DeLong, John Hambor, Ron Lee, and Douglas Massey.
II. EXECUTIVE SUMMARY

The Panel's major conclusions are:

The "intermediate" projection of the Trustees Report for the Old-Age, Survivors, and Disability Insurance (OASDI) program provide a reasonable evaluation of the financial status. Although the Panel suggests that modifications be considered in various specific assumptions, the overall effect of those suggestions would not significantly change the financial status evaluation.

There should be evolutionary implementation of procedures to indicate more adequately the uncertainties involved in the projections. Even though such uncertainties are unavoidable, stochastic analysis should be used to examine more explicitly the probabilities of alternative projections. It is emphasized that there should be an extended period during which the new procedures would supplement, rather than replace, the current methods of considering high-cost and low-cost projections and individual assumption sensitivity analysis.

Evaluation of the long-range financial status should put less emphasis on the "75-year actuarial balance" and the "test of long-range close actuarial balance." Prior to enactment of legislation reforming the program, primary emphasis should be on the projected date the Trust Fund Ratio would fall below 100 percent; when definitive legislative revisions are adopted, subsequent long-range evaluation should compare up-dated projections with the intended results of the legislation.

There should be a substantial expansion of SSA's resources and its interaction with experts in related areas: increased recognition should be given to the inter-relationships between OASDI and many public and private programs as well as other aspects of the economy. Social Security Administration (SSA) staff does high quality work, but is relatively small and works with inadequate resources. In addition to internal expansion, there should be greater use of outside consultants and contractual research; periodic comprehensive review by technical panels should be supplemented by ongoing arrangements for advice on specific matters.
Summaries of Individual Sections of the Report

Uncertainty of Projections

The Panel recommends evolutionary implementation of stochastic analysis procedures for presenting and evaluating the uncertainty in the OASDI projections. The current methods of considering high-cost and low-cost projections, and sensitivity analysis of individual variables, do not provide satisfactory indicators of the range of results and related probabilities that should be given consideration in evaluating program status.

It is emphasized that uncertainty about projections cannot be avoided, and that they must be based on assumptions (about the mean and variance of specific variables, and the correlations between them); in particular, there still will be the need to decide which past experience is most relevant. Nevertheless, such assumptions and the probability of resulting projections can be more explicitly examined than under current procedures.

Some interim arrangements are suggested for new procedures to supplement, rather than replace, the current methods of considering high-cost and low-cost projections and individual assumption sensitivity analysis. Illustrations of the stochastic analysis technique are provided in the appendices and are summarized later in this report.

Demographic Assumptions

This section discusses Mortality, Fertility, Marriage and Divorce, and Immigration. Emphasis is on the assumptions used for the "intermediate" projection. Although the Panel suggests that modifications be considered in various specific assumptions, the overall effect of those suggestions (including the economic assumptions discussed in the next section) would not significantly change the financial evaluation provided by the intermediate projection in the Trustees Report.

While the Panel has offered its best guesses as to the path of each demographic assumption for the 75-year period required for SSA projections, it is important to note the higher level of uncertainty in the latter part of the period.

Mortality

Alternative II (intermediate cost) projections should more closely reflect long-run past experience. The current Alternative II assumption is for a lower rate of mortality improvement than has been experienced in the near-term (20-year) or long-term (90-year) past: such a decrease in the rate of mortality declines appears unwarranted. A mid-range projection that reflected continued mortality declines at the level experienced over the past century would be more appropriate. The Panel recommends that the
average rate of decline in age-specific death rates observed over the period 1900-1989 be reflected in Alternative II year-to-year projected mortality changes beginning in about 20 years. The Panel is not recommending a change in the procedures used for the earlier years, but the above-stated change would imply faster declines during this period, as well, because they grade into faster "ultimate" rates of decline.

Alternative methods of projection should be investigated. Cause-specific projections tend to produce conservative projections (that is, projections with slow mortality declines) because slowly declining causes become more prominent. Cause-specific projections also ignore the tendency for medical research and health intervention efforts to be targeted at diseases that are relatively more prominent. The use of relational models that impose some plausible age-pattern of mortality change should also be investigated. Also there should be further investigation of the financial impact of alternative patterns of age-sex improvement factors.

Fertility

The Panel believes that fertility rates in the near future could be relatively volatile, and that the SSA should continue to monitor trends -- especially those among the younger age groups, to determine possible effects of birth-cohort size on fertility timing, and among baby-boom cohorts to identify trends in completed family size. In the meantime, the Panel recommends that the intermediate estimate of the long-term Total Fertility Rate be raised from its current level of 1.9 to 1.95. The high-cost and low-cost estimates of 1.6 and 2.2 are considered to provide an adequate range, in light of the stochastic effects of combining numerous demographic and economic assumptions. The Panel further recommends that an increase in the fertility rate should be assumed in the short-term, in the intermediate- and low-cost assumptions, before the long-term levels are reached.

Marriage and Divorce

The Panel recommends that the intermediate estimate of marriage rates should be raised from the current age-adjusted central rate of 5,730 to 6,000 per 100,000 unmarried of each sex, and that the estimate of divorce rates should be lowered from the current age-adjusted central rate of 2,140 to 2,000 per 100,000 married couples.

With regard to the high-cost and low-cost estimates, the Panel believes that the range provided by the assumptions used in the current Trustees Report is adequate. Consideration should be given to the anomaly created by combining low marriage rates and high divorce rates, however, with high fertility rates in the low-cost estimate (Alternate I), and vice versa in the high-cost estimate (Alternative III). In addition, current high levels of labor force participation, even among married women, suggest that the assumed link between high marriage rates and high OASDI auxiliary benefits may be outdated.
Immigration

The Panel recommends no change in the current procedures used to make immigration assumptions. The procedures used by the SSA actuaries to update the assumptions seem appropriate. The level of the Alternative II projection seems appropriate.

Economic Assumptions

This section discusses Real Wage Growth, Real Interest Rates, Inflation, and Unemployment assumptions, with emphasis on the intermediate projection. Although the Panel suggests that modifications be considered in various specific assumptions, the overall effect of those suggestions (including the demographic assumptions discussed in the preceding section) would not significantly change the financial evaluation provided by the intermediate projection in the Trustees Report.

The Panel split in its recommendations about assumptions for ultimate annual Real Wage Growth (RWG) and Real Interest (RI) rates. Half the Panel recommends RWG of 0.8 percent and RI of 2.8 percent; the other half recommends continued use of the assumptions used in the current Trustees Report: RWG of 1.0 percent and RI of 2.3 percent.

The Panel does not recommend any change in the ultimate Inflation (4 percent) or Unemployment (6 percent) assumptions.

Regarding short-range assumptions, the Panel recommends that considerable weight be given to the forecasts in the budget submissions of the Administration. However, a procedure for use when the long-range assumption for a variable is significantly different from actual recent experience is suggested.

The Panel does not recommend any explicit adjustment in assumptions attributable to possible changes in measurement of the Consumer Price Indices; implicit allowance for improved measurement procedures is reflected in the conclusions about each variable. It is emphasized that modifications to benefit formulas (for example, CPI minus 1 percent) have a result different from that of measurement changes; arbitrary adjustments would produce changes in the real benefits of the program.

Suggestions for future research are indicated; these should be considered in conjunction with the subsequent section on Research and Other Matters.

Disability Rates

The Panel recommends periodic updating of the age-sex matrices used to project disability incidence and termination by recovery rates. In addition,
use of different matrices for major categories of disability should be considered. Analysis and projection of the factors, which reflect the overall levels of these rates, should give explicit recognition to the effect of unemployment and of claims administration practices.

Assumptions Regarding Retirement Age Under Current Law

The Panel recommends that the assumed pattern of retirement ages and the related benefits, and the sensitivity of the cost rates to such assumptions, be studied further and that detailed results be made available for review.

Presentation of Long-Term Status of the Trust Funds

Evaluation of the long-range financial status should put less emphasis on the "75-year actuarial balance" and the "test of long-range close actuarial balance."

The Panel does not recommend any change in the 75-year projection period, or in the concept of 100 percent Trust Fund Ratio (TFR) as an adequate contingency reserve.

The 75-year actuarial balance is an overall measure of changes in financial status, but should be less emphasized as a basis for evaluating the status of program or for designing reform proposals (especially if a substantial trust fund is to be accumulated).

The Panel suggests some revision in the presentation of annual balance projections (a different concept from the actuarial balance) and the treatment of trust fund interest.

Prior to enactment of legislation reforming the program, primary emphasis should be on the projected date the Trust Fund Ratio would fall below 100 percent.

When definitive legislative revisions are adopted, subsequent long-range evaluation should compare up-dated projections with the intended results of the legislation; based on the most frequently discussed proposals, such evaluation should consider whether the 75-year actuarial balance tends to deteriorate as the projection period moves forward; also whether the pattern of annual balances or TFR trend line departs significantly from legislative intent, or if the latter shows an apparent lack of stability beyond the 75-year valuation period. The Panel notes there is an important distinction between the financial adequacy tests appropriate for the Trustees Reports versus considerations for satisfactory legislative action.

Suggestions are also provided regarding indicators of future affordability of the program.
Research and Other Matters

The Panel recommends a substantial expansion of SSA’s research capabilities, using additional in-house resources as well as outside consultants and contractual research. The prior (1990-91) Panel suggested an extensive list of research topics, many of which are still relevant; therefore, just a few topics are highlighted in this report, but the important question of methodology is also discussed. The gradual erosion of support for the Office of the Actuary and the Office of Research and Statistics, in particular, pose fundamental problems to the system as a whole. These Offices operate with only a very small fraction of the resources that would be made available in private insurance companies and actuarial consulting firms to study matters of importance to clientele. Adequate funding and organizational support for these Offices is vital to the long-range status and effectiveness of the Social Security Administration.

To ensure periodic review and that the most appropriate assumptions and techniques are used for projections of the operations of the trust funds and other policy purposes, the Panel recommends that:

1. Technical panels be appointed periodically (at least once every 5 years) to conduct comprehensive reviews of the assumptions and methods;

2. An ongoing advisory committee of experts be established to provide, on an as-needed basis, advice on specific matters; and

3. The SSA develop procedures to enable the staff easily to contract for extramural research and expert analysis to supplement ongoing staff activities.
III. GENERAL COMMENTS

The financial projections done by SSA on the intermediate-cost basis provide reasonable conclusions about the overall status of the Old-Age and Survivors Insurance (OASI) and the Disability Insurance (DI) programs. Even though the Panel recommends changes in, or reexamination of, some assumptions and procedures, there would not be a significant change in the overall evaluation of the short- or long-range status.

The Panel concludes, however, that the low-cost and high-cost projections are not satisfactory indicators of the range of results that should be given consideration in evaluating program status. The Panel recommends that SSA should use new procedures to indicate the range of results and to estimate the probabilities involved. Recognizing the amount and complexity of the work needed to implement that, the Panel recommends an evolutionary approach.

Projection of the future is not solely a scientific procedure. The SSA actuaries have used both art and science in projecting what they see as the most likely state of the nation over the next 75 years. Evaluation of the SSA projections requires one to imagine how the world will change over the next 75 years and compare one’s view with that underlying the current SSA projections. No one knows the future; the Panel’s assessments result from a combination of best guesses about the future and a view as to how and why the past circumstances have occurred.

In all the Panel’s evaluation of assumptions -- both demographic and economic -- the major issue that must be addressed is how much the future will be like the past. In each area, the Panel had to evaluate how much of past experience is relevant for the future. Virtually every discussion of individual assumptions centered on how much the most recent past (relative to the long-term past) should weight current thinking. In some areas of discussion, panelists agreed that experience before a specific time has little or no relevance; in other areas, this was not the case.

Nevertheless, uncertainty should not paralyze decisionmaking. Even though the probability is very low (essentially zero) that any specific projection will exactly equal actual experience, program status can be evaluated, and policy decisions must be made on the basis of those projections. Despite all of the difficulties in preparing and evaluating long-term projections, it is commendable that the procedure has been done -- and that it has been taken into account in policy formulation -- during the entire existence of the Social Security program.

Usefulness of the projections (especially on the intermediate basis) is the result in large part of the high-quality work done by the SSA staff. The OASDI program is very complex in operation, not only because of the various legislative provisions, but also
because of the enormous variation of circumstances provided by covering practically everyone in the nation. Although members of the Panel are experts in various fields (and learned much from each other), the Panel found it educational to learn from the SSA staff the techniques that have been developed for the program. The Panel commends the staff for their expertise and their cooperative approach to this periodic examination of their activity. They are a relatively small staff working with generally inadequate resources, especially in relation to the magnitude and importance of their work. The Panel urges additional internal capability, as well as additional utilization of outside resources, and a continuation and expansion of the interaction with technical panels.

As specified in its Charter, the Panel examined the OASI and DI programs within the boundaries of their legislated functions. However, the need to assess the status of these programs (individually and on a combined basis) should not foreclose recognition that they interact with, are affected by, and have effects on, many public and private programs and other aspects of the economy. To list just a few examples:

- OASDI provisions affect employment levels, national savings rates, and other important determinants of economic activity that in turn affect the projected and actual status of the OASDI program.
- Medicare eligibility and benefit provisions can impact individual decisions about retirement benefit commencement.
- OASDI provisions enter into the considerations used by designers of private benefit plans, and the specifics of those plans affect individual decisions about options available under OASDI.

The Panel strongly urges additional analysis of these interactions.

Even though the OASI and DI programs are legally distinct, in practice their financial statuses are quite interrelated. Therefore, the Panel generally considered the combined OASDI results, and the comments in this report relate to that combined status unless specifically indicated otherwise. Most of the Panel's work was based on consideration of the 1994 Trustees Report and the related procedures used by SSA.

Even though the 1995 Trustees Report was being worked on concurrently with the Panel's activity, SSA staff believed they were not at liberty to share with the Panel the preliminary results or other aspects of the 1995 report preparations. Fortunately, as noted in more detail below, few significant changes occurred in the assumptions and methods
for the 1995 Trustees Report, so that the Panel's work was not seriously affected by that report.

Because a similar concurrence of events could easily create inconsistencies and wasted effort in the future, the Panel recommends that SSA staff be authorized to share relevant ongoing intra-governmental discussions and results with outside experts who serve in advisory and evaluative capacities. Of course, those experts would have to agree to appropriate confidentiality procedures.

As the remainder of this Report generally reflects the 1994 assumptions, procedures, and results, here is a summary of notable 1995 revisions:

The long-range financial status of the OASDI program as shown in the 1995 Trustees Report was virtually the same as shown in the previous Report. Specifically, the year when the trust fund balance under the intermediate-cost estimate becomes exhausted is 2030 in the 1995 Report, as against 2029 in the 1994 Report.

Further, the long-range actuarial imbalance in the 1995 Report is 2.17 percent of taxable payroll, as compared with 2.13 percent in the 1994 Report. The one year shift in the 75-year valuation period increased the long-range imbalance by 0.07 percent of taxable payroll; thus, the combined effect of all other causes decreased that imbalance by only 0.03 percent of taxable payroll.\(^1\)

Accordingly, it is not surprising that few significant sizable changes in methodology and assumptions exist between the two reports. In line with previous practice, however, several small changes were made on the basis of the developing experience.

Several demographic assumptions were modified. First, the starting U.S. population was updated to reflect revised estimates by the Bureau of the Census, which showed fewer people at the high ages than earlier estimates. Second, projected mortality rates were increased, reflecting the latest data. Third, net annual other-than-legal immigration was increased, based on recent analysis by the Immigration and Naturalization Service. These three modifications resulted in a decrease in the long-range imbalance of 0.12 percent of taxable payroll.

\(^1\) The Panel considers this year-to-year comparison of actuarial imbalance a reasonable measure of change in program status, even though as discussed more fully later, the Panel is concerned about relying on the Actuarial Balance -- or in this case the actuarial imbalance -- to evaluate the program or various reform proposals.
Ultimate economic assumptions were not changed. However, revised short-range economic assumptions, including substantially higher growth in the labor force, real GDP, and average real earnings, plus slower growth in prices, resulted in a decrease of 0.02 percent of taxable payroll in the long-range imbalance.

Projections of the number of disabled beneficiaries were increased for years following the short-range period for two reasons. First, lower ultimate recovery rates were used, in recognition of continuing low recovery rates. Second, disabled-worker death rates were lowered, decreasing at about the same rate as general-population death rates. These changes resulted in an increase in the long-range actuarial deficit of 0.05 percent of taxable payroll.

Several significant improvements were made in the methods used to project the outgo and income. Updated sample data for benefit awards in 1993 were used as the starting point for projecting the level of average benefits for future beneficiaries. Modifications were made in the method for projecting future changes in the level of average benefits from those represented in the sample. The maximum levels for projected female labor force participation rates at some ages were raised, based on the latest observations of these caps. Also, reductions in the rate at which insured individuals claim retirement benefits resulted in a lower starting number of beneficiaries than previously assumed. The net effect of these changes in methodology was an increase in the actuarial imbalance of 0.07 percent of taxable payroll.

Comparison of projected Trust Fund Ratios (TFRs) also shows little change between the 1994 and 1995 Reports. Projected TFRs in the 1995 Report are somewhat higher, and as indicated previously would fall below zero one year later, than the corresponding 1994 Report results.
IV. UNCERTAINTY OF PROJECTIONS

The Panel recommends evolutionary implementation of stochastic analysis procedures for presenting and evaluating the uncertainty in the OASDI projections. The current methods of considering high-cost and low-cost projections, and sensitivity analysis of individual variables, do not provide satisfactory indicators of the range of results and related probabilities that should be given consideration in evaluating program status.

It is emphasized that uncertainty about projections cannot be avoided, and that they must be based on assumptions (about the mean and variance of specific variables, and the correlations between them); in particular there still will be the need to decide which past experience is most relevant. Nevertheless, such assumptions and the probability of resulting projections can be more explicitly examined than under current procedures.

Some interim arrangements are suggested for new procedures to supplement, rather than replace, the current methods of considering high-cost and low-cost projections and individual assumption sensitivity analysis. Illustrations of the stochastic analysis technique are provided in the appendices and are summarized in this section.

This section discusses the procedure for presenting and evaluating the uncertainty in the OASDI projections. Comments about the specific assumptions, which enter into the projections and are the unavoidable cause of the uncertainty, appear in other sections of this report.

SSA’s procedure is to make three sets of projections; intermediate, low-cost and high-cost. The intermediate basis is put forth as the best estimate (and, as previously noted, the Panel concluded that it does provide reasonable conclusions about the overall financial status); the other two bases are intended to indicate a range of results "under a variety of plausible economic and demographic conditions." (1995 Trustees Report p. 55).

In addition to showing the results of using the low- or high-cost alternatives for all of the variables, the Trustees Report provides "sensitivity analysis" for various individual variables. That is done by using the low- or high-cost basis for that particular variable, in combination with the intermediate basis for all other variables.

In a purely statistical sense, the probability is very low (essentially zero) that any specific projection will exactly equal actual experience. The more relevant issue is to estimate the range of plausible projection results. In this context, the intermediate
projection may be characterized as providing the best estimate of the middle of that range of plausible results. As an example, the intermediate projections, indicating that the Trust Funds could be exhausted by the year 2029 or 2030, really mean that exhaustion before or after that time is estimated to be equally likely; however, there is no estimate of the probability that exhaustion could occur within any specific time interval (for example, what is the probability of exhaustion between 2025 and 2035?).

The Panel concludes that the low- and high-cost projections (and the sensitivity analysis) are not the most appropriate indicators of the range of results that should be given consideration in evaluating program status. Some reasons for that are as follows:

1. No analysis is made of the estimated probabilities associated with the high-cost and low-cost projections. Thus, no estimates are available about the probability that actual future experience will exceed the high-cost projection or be more favorable than the low-cost one, or will fall in the high-cost to low-cost range; nor about the comparative probabilities of the intermediate to high-cost vs. the intermediate to low-cost range.

2. Similar questions about the individual variable sensitivity analysis cannot be answered with respect to any particular variable or between variables; for example, what is the probability of the range indicated for mortality improvement, as compared with that for the wage increase rate?

3. The logical interaction between variables is deliberately ignored in order to maximize the effect of the low- or high-cost alternative: for example, in the low-cost projection, marriage rates are decreased, divorce rates are increased, and fertility rates are increased, as compared with the intermediate assumptions. That combination is quite unlikely, as is the corresponding one for the high-cost projection.

4. Even if some probability estimates could be associated with the current three-alternatives procedure, the result would not be adequate for people concerned about different probability ranges, and for considering the implications of various levels of risk tolerance (for example, in connection with proposals to change trust fund investment policy).

Another shortcoming of the current procedure is that it uses deterministic analysis; for each projection, a set of assumptions is developed and then used as if those assumptions will occur each year in the future. (The short-range projections anticipate some year-to-year variation, using predetermined values.) Even if the assumptions are the best ones regarding the average (or mean) values expected to occur in the future, some year-to-year variation from those mean values is almost
certain to occur. Such variation is likely to affect subsequent years, in addition to the year in which it occurs. The result of that cannot be indicated by, or estimated from, the low- or high-cost alternatives; each of those assumes that the variation for each variable is in the specified direction (low or high) every year in the future.

The Panel investigated another method called "stochastic analysis" (some work in that area was done previously by the SSA actuaries; also it was referred to by the previous Panel) - which develops projected year-by-year values, based on assumptions about the probability distributions of future events. It is emphasized that uncertainty about future projections cannot be avoided. The stochastic technique makes this uncertainty and some of its causes more explicit, and provides some estimates of the probabilities associated with various possible results. Nevertheless, the results are still based on assumptions (regarding mean value and variance of specific variables, and the correlations between them) - in particular, there still is the need to decide which past experience is most relevant.

The Panel recommends that SSA use that method. Recognizing the amount and complexity of the work needed to implement that, however, the Panel recommends an evolutionary approach. At least two interim arrangements might be useful:

1. Employ relatively simple stochastic techniques to help decide on the packages of assumptions to be used in the deterministic projections; and

2. Publish periodic Actuarial Studies, which describe the evolving techniques as they are being developed, and compare their projections with the deterministic results.

Note that computer capabilities, which already are widely available, would allow SSA to contract with outside researchers in helping to develop such techniques. Also, SSA could make the evolving techniques available in computer-processable form for uncompensated experimentation by many people.

Another reason for recommending an evolutionary approach is the need to develop effective methods for communicating the results of such analysis to policy makers and others concerned with evaluation of the program. Although it may be most appropriate, from a technical point of view, to place expected results in a range with an associated probability measure (and especially cautioning that those measures are based on assumptions), decision makers often need more definitive characterizations of results. Conversely, new developments that may be incorporated in the program (for example, alternative investment procedures, such as those considered by the Advisory
Council) may increase the importance of understanding the implications of stochastic analysis.

Two members of the Panel produced relevant illustrations of the stochastic technique; these are fully described in Appendices A and B and are summarized here. It is not suggested that either of these illustrations, which reflect quite different approaches, indicate the specific approach that SSA should use in the future. Also the specific results shown in the illustrations should not be considered as indicative of the Panel's (or the individual member's) estimate of future projections. Instead, the illustrations do indicate the feasibility and eventual utility of the underlying technique.

These illustrations were done as special studies by the two members, working individually. They were specially constructed to reflect the general characteristics of the OASDI program and projection model; each of the illustrations includes "validation results" which show that results roughly equivalent to the SSA projections can be produced. Thus, even though these illustrations do not include all the details that would be required for a satisfactory OASDI projection procedure, the Panel believes that the feasibility of using stochastic analysis has been demonstrated. The illustrations also indicate how stochastic analysis results can be communicated.

The Holmer model (see Appendix A) focuses on the fertility, immigration, and mortality variables, using the SSA intermediate basis as the assumed mean for future years. Unlike the deterministic technique, however, the value for each future year is not simply set at the mean; instead, it is treated as a random variable with that mean and a specified standard deviation. (That random variable should often be quite close to the mean, but it also can be substantially larger or smaller than the mean in some years.)

The illustration has two admittedly arbitrary assumptions regarding the standard deviation. In Section 3 of this appendix, it is assumed that the SSA low- to high-cost range for each variable covers approximately a 95 percent probability range (four standard deviations), and in Section 4 that range is assumed to reflect about a 67 percent probability range (two standard deviations). As Holmer emphasizes, these are merely arbitrary assumptions for purposes of the illustration; there is no analysis in the illustration or from SSA that indicates the probability range of the low- and high-cost alternatives.

In addition, for each of the standard deviation assumptions, there are three (again arbitrary) sets of assumptions about the correlations among the variables. Thus, the illustration actually reflects six different long-range environments. For each of those six, a scenario covering 78 years, from 1993 to 2070, is run 1,000 times; i.e. a single scenario involves selecting random values of the three variables for each of the 78 years and calculating certain results. That process is repeated 1,000 times (for each of
the six environments), and the range of results is interpreted as indicating their probability distribution.

The results shown in that illustration are in terms of population levels, as well as age and total dependency ratios. As previously indicated, however, the specific results shown are merely intended to illustrate the technique, and they have no other significance.

The Sze model (see Appendix B) also involves 1,000 runs (called tracks) to produce a range of results that is interpreted as indicating their probability distribution. This illustration focuses on seven variables, and analyzes six results; these are listed below. The SSA intermediate basis is again used as the assumed mean for future years. The standard deviation for each variable and the correlations among variables are derived from historical data. The SSA intermediate projections for each future year are also used as reference values.

The variables are: inflation rate, real wage increase, real interest rate, employment level, labor force increase, mortality, and fertility.

The measures analyzed are: trust fund interest rate (nominal), tax income vs. expenditures (as percent of payroll), net of tax and investment income less expenditures (as percent of payroll), trust fund ratio, actuarial balance, and probability of negative balance in the trust fund.

Thus, for each track, the technique is to simulate values, for each of the seven variables, for each of the years in the projection period; based on these simulated values, annual adjustments are made to the SSA intermediate projection, and data for the measures to be analyzed are stored. The process is repeated 1,000 times. These measures are then analyzed and probabilities are estimated. As previously indicated, the specific estimates shown are merely intended to illustrate the technique, and have no other significance.

Some sensitivity analysis is done by doing additional full simulations (that is, 1,000 new tracks) with a different assumed mean value for a specific variable. The standard deviations and correlations among variables are not changed.

A final comment regarding these illustrations and the stochastic technique more generally: The technique shows the range of fluctuations that may occur during the projection period, rather than the results of some specific alternatives. When examining the summary of stochastic projection results, it is important to remember that each set of percentile results is not intended to represent any consecutive time-path of
occurrence. For example, there is 90 percent probability that a particular time-path will
occur somewhere in the range defined by the 5th and 95th percentile results.
V. DEMOGRAPHIC ASSUMPTIONS

This Section discusses Mortality, Fertility, Marriage and Divorce, and Immigration. Emphasis is on the assumptions used for the "intermediate" projection. Although the Panel suggests that modifications be considered in various specific assumptions, the overall effect of those suggestions (including the economic assumptions discussed in the next section) would not significantly change the financial evaluation provided by the intermediate projection in the Trustees Report.

While the Panel has offered its best guesses as to the path of each demographic assumption for the 75-year period required for SSA projections, it is important to note the higher level of uncertainty in the latter part of the period.

A. MORTALITY

Alternative II (intermediate cost) projections should more closely reflect long-run past experience. The current Alternative II assumption is for a lower rate of mortality improvement than has been experienced in the near-term (20-year) or long-term (90-year) past; such a decrease in the rate of mortality decline appears unwarranted. A mid-range projection that reflected continued mortality declines at the level experienced over the past century would be more appropriate. The Panel recommends that the average rate of decline in age-specific death rates observed over the period 1900-1989 be reflected in Alternative II year-to-year projected mortality changes beginning in about 20 years. The Panel is not recommending a change in the procedures used for the earlier years, but the above-stated change would imply faster declines during this period, as well, because they grade into faster "ultimate" rates of decline.

Alternative methods of projection should be investigated. Cause-specific projections tend to produce conservative projections (that is, projections with slow mortality declines) because slowly declining causes become more prominent. Cause-specific projections also ignore the tendency for medical research and health intervention efforts to be targeted at diseases that are relatively more prominent. The use of relational models that impose some plausible age-pattern of mortality change should also be investigated. Also, there should be further investigation of the financial impact of alternative patterns of age-sex improvement factors.

Because the actuarial balance of the Social Security program is quite sensitive to the simulated range of uncertainty about the future course of mortality and the prior Technical Panel recommended further review, and because there have been significant subsequent research results, this Panel gave special attention to mortality projections.

(All tables and figures referred to in this section are in Appendix C; also see that Appendix for background information on SSA's mortality projection method.)
How do the SSA assumptions for the next 25 years and the ultimate rates compare to past progress?

The Past. Because no one knows how mortality will change in the future, the custom has been to project the future from the past. This is the science part of making projections. The question is what is the relevant past, and the answer is the art of making projections. The SSA actuaries have provided comparisons of the rates of mortality change used in current projections with observed past rates of change (see Table 1). What one notices immediately is that there have been large fluctuations in the rates of mortality decline over this century. In each period shown, mortality declined, with the exception of the 1954-68 period for men, but the speed varied greatly.

The rapidity of mortality decline has varied over time because of the technological progress made against specific diseases during the different periods. For instance, decline was relatively rapid, especially among the young, during the early decades of this century. This result was attributable to public health measures and medical advances that reduced deaths from certain infectious diseases and from causes that were concentrated among infants and children.

From the 1930s through the 1950s, mortality decline was very rapid because most deaths from infectious diseases were eliminated through the development of sulfa drugs and antibiotics. After this period, there was a 15-year stagnation in mortality, in part because of increases in smoking and few major breakthroughs in the treatment or prevention of diseases.

During the 1960s, when deaths from infectious diseases had been virtually eliminated, science and medicine turned their attention to the chronic diseases of old age. Up to this point, the high rates of death from infectious diseases had led to concentration on the cure and prevention of these diseases that could kill healthy people in a few days. Not until these more shocking causes of death were eliminated did researchers turn to the harder work of uncovering the causes and prevention of the slower-acting and less-shocking chronic diseases.

Such work began to pay off in the late 1960s. Rapid rates of mortality decline were observed from 1968 into the early 1980s for almost all of the major chronic diseases, with the exception of cancer. From 1968 to 1982, the mortality decline among the old proceeded at a pace similar to that of the rest of the adult population and more rapidly than in the past. Since 1968, the mortality decline differs from declines in earlier periods in that it is attributable to declines in death rates from chronic diseases, and it is more concentrated among the old than in the past.
Substantial decrease in the rate of decline in mortality occurred in the 1980s, most significantly among older women. The years from 1982 through 1989 were years of relatively slow progress in reducing death rates. Over the decade of the 1980s, there were years of virtual stability in the death rates from cerebrovascular diseases, pulmonary diseases, septicemia, cancer, homicide, and AIDS. In the past few years, the cerebrovascular death rate, the septicemia death rate, and the cancer death rate appear to be declining again.

**Age factors.** Because death rates at young ages are so low, the future of mortality change depends substantially on what happens at older ages. Critical for projections are death rates above age 65: 85 percent of females and 74 percent of males survive to this age according to the U.S. Life Tables for 1990 (National Center for Health Statistics, 1994). Further data on mortality decline at the older ages is shown in Table 2 (from the Office of the Actuary). This table indicates that the rapid decline between 1968 and 1982 occurred at all the older ages, even up to age 95. It also indicates that the recent slowdown in the 1980s was pronounced across the ages for women and above age 80 for men. Preliminary information for the past few years (1989-93) indicates that the slowdown in the rate of decrease for these age groups continues through 1993 (Table 3).

Even though future changes in the mortality rates at the younger ages will have little direct effect on mortality measures, the financial implications for OASDI can be substantial, because of the implications for workforce size and numbers of future retirees. Therefore, further analysis of the financial effect of mortality improvement patterns at younger ages should not be neglected.

**Projected Rates of Change Versus Past Rates of Change.** The size of the Alternative II projected rates of change relative to those experienced throughout the century are shown in Tables 1 and 2. For females, all projected rates of change are considerably lower than those experienced in the past. For all ages combined, the rates for 1989-2017 are about 45 percent of the rates during the past century, and the projected rates for 1989-2067 are even lower. For males, the rates of decline between 1989 and 2017 are expected to exceed those of the long run past from ages 45 through 80. For all ages combined, male rates of decline are expected to be about 79 percent of the rates observed over the past century. Over the longer projection period, rates for males above age 60 will be close to those experienced over the century, and for all ages combined, the expectation is that the rates will be about 61 percent of those experienced over the past century.

Comparing the projected rates of mortality decline to the shorter-term past (1968-88), the period of chronic-disease decline, the projected rates of
decline are relatively even lower (Table 4). For males (all ages combined), the rates of change over the next two decades are expected to be about half of that over the past two decades, and the long run change is expected to average about one-third of that experienced over the recent past. For females, the figures are even lower, with both averaging about one-third of recent rates of change.

Thus, the Alternative II projection is for slower change in mortality than has been observed over the past century for most age-sex groups and for significantly slower change than has been observed for all age-sex groups in the past 20 years. When compared with the period since 1982, however, the male declines at ages 55 and over projected until 2017 are at roughly the same pace, and female declines are substantially faster than in the past 12 years.

Looking particularly at the older population, the Alternative II projection is for male mortality at older ages to decline at rates close to those experienced over the past century and at about half the level of the recent past. Female old-age mortality is expected to decline at rates that are about half of those over the last century, and only one-third as fast as in recent years.

Demographers' Views on the Future of Life Expectancy. In the past, numerous demographers have argued that SSA has been too conservative in estimating mortality declines. Historically, that contention has been the case. In the past decade, the SSA has revised the projections so that they are more optimistic about longer life expectancy than past projections. But are current projections appropriately optimistic? (See Appendix C for additional information about SSA life-expectancy projections.)

The largest challenge to SSA projections has been mounted by Ronald Lee and Lawrence Carter. In an article published in the Journal of the American Statistical Association in 1992, they modeled mortality change in the United States during the 20th century with a two-parameter relational model. One of the parameters, reflecting the pace of age-specific mortality change, was highly linear throughout the century. If this linear trend were to continue into the future, life expectancy would grow much faster than in Alternative II projections. By 2030, their projections would show a life expectancy 3 years higher than SSA's, which would fall outside the Lee-Carter 95 percent confidence interval. By 2065, the difference is 5 to 6 years.

The National Research Council called a two-day meeting on Forecasting Life Expectancy in March 1992. It was attended by approximately 50 eminent demographers, statisticians, epidemiologists, and medical researchers. The Lee-Carter paper became the principal organizing device for the meeting and received a great deal of attention. According to the NRC-reviewed meeting summary, "Most participants thought that the Lee-Carter model was empirically more realistic than the
Social Security model and represented a reasonable baseline model upon which to begin discussions about future medium-term mortality." (Stoto and Durch, PDR, Sept. 93) It should be noted that the Lee-Carter model does not occupy the high end of projected life expectancies. Separate projection exercises by Vaupel/Ahlburg and Guralnick project much faster mortality declines than Lee/Carter. The U.S. Census Bureau, the other federal agency with responsibility for population projection, has moved closer to the Lee-Carter projections in its medium series. By 2050, the latest projection year, life expectancy at birth in the Census series is 82.1, compared with 79.9 in the SSA series (mean, male and female) and approximately 84.5 for Lee/Carter.

Another discussion of views on the future of mortality was held by the Public Trustees of the OASDI Trust Funds in September 1993. They sponsored a panel of three prominent demographers representing the range of demographic opinion about mortality decline. Their views can be categorized as "the SSA projections are extremely conservative," James Vaupel; the SSA projections are "somewhat conservative," John Wilmoth; and the SSA projections are "reasonable," Jay Olshansky. (See Appendix C for further details.)

While it would be difficult to get demographers to agree on a number that is the most likely value of life expectancy at birth in 2030 or 2070, the majority of those specializing in mortality would probably agree with the statement that "SSA projections of mortality are too conservative." They would agree because acceptance of the intermediate projection assumes that annual progress in reducing death rates over the next 20 years will fall to half that of the 1968-88 period for men and just over one-third for women. After that, it will be reduced even more. Only for older men will the long-range future progress be comparable to the improvements over the past century. The SSA actuaries have argued that their projection is likely because there will be no more breakthroughs in public health and because future mortality declines will be so expensive that society will be unable to afford them. While this outcome is certainly possible, it is also possible that understanding of the role that genes and cellular change play in mortality will provide the knowledge for a revolution equally as important as past public health developments. This revolution will be in the treatment and prevention of the diseases of old age. There are likely to be major medical advances implemented that are only now on the horizon, such as cancer vaccines. Some of the most major developments may prove to be serendipitous. For instance, the use of hormone replacement therapy to prevent osteoporosis has become common in the last two decades among some groups of women. The past year has seen the suggestion that this long-term hormone replacement therapy may lead to declines in heart disease death rates of from 25 to 50 percent and to decreases in the rate of Alzheimer's disease. There is also considerable potential for declining mortality through better personal health care practices. Kenneth Manton has estimated that life expectancy
could reach the mid 90s through life-style changes alone. The most important breakthroughs in the treatment of many diseases in the near future will be their prevention or the delay of their progression, rather than end-stage treatment, through pharmaceutical and biomedical treatments. The development of such treatments may be expensive, but it is unlikely to be as costly as the treatment of end-stage diseases that is so common now.

Other factors will likely lead to further mortality improvements. Each successive cohort reaching the older ages is better educated and has had better health conditions in childhood than its predecessor. The biomedical research establishment is deeply entrenched and extraordinarily productive. It enjoys enormous support through the National Institutes of Health. New information about behavioral mechanisms influencing health is continuously generated and finds a highly receptive audience. Although the SSA actuaries have expressed concern that increasing health care costs may reduce the rate of mortality decline, there is no evidence that increase in the price or availability of medical services plays a major role in trends in mortality levels. For example, the introduction of Medicare in 1966 did not create any evident disjunctions in mortality trends at age 65, and was accompanied by a widening in social class mortality differentials for men aged 65 and over. While many of these factors are likely to influence future mortality trends, their influence is difficult to quantify.

International Mortality Trends

The Panel agrees with the SSA actuaries' use of population-based trend analysis as the starting point for projections. This analysis would also profit from the introduction of trend data from other nations, many of which have much better data than the United States on old-age mortality (Kannisto, 1994). A major project to assemble and evaluate international data on mortality at older ages is underway in Denmark. The project uses primarily "extinct-generation" methods, which are relatively reliable because they rely on death records to avoid numerator/denominator inconsistencies. Figure 1 (Appendix C) presents a graph of mean annual rates of improvement in death rates for single years of age for an aggregate of 13 countries, with good data over the period from 1965 to 1985 (Kannisto et al., 1993). Rates of improvement are much higher than those recently observed in, or projected for, the United States, especially for females.

Table 5 presents data on rates of mortality decline at older ages in Sweden during the 20th century. Rather than decelerating, the declines have accelerated in nearly all age intervals for both sexes.

The United States appears to be an anomaly in its relatively slow mortality improvement in recent years. One reason may be that its level of mortality rates at ages 75 and over is among the lowest in the world. Another reason may be that data
improvements at older ages, especially among African Americans, are obscuring some of the actual declines that are taking place. Placing U.S. mortality trends in a broader context would be a useful goal for the SSA actuaries.

Methods of Projection

The SSA projects mortality by projecting age-sex-cause specific death rates using recent past trends and educated guesses as to the ultimate rates of change. The justification for the "ultimate" rates of decline assumed for each major cause of death is not given. Actuarial Studies No. 106 and 107, and the annual Trustees Reports, all use the same language to describe the procedure. After citing many factors that may influence mortality trends in the future (most of them pertaining to several or many causes of death), the reports say, "After considering how these and other factors might affect mortality, we postulated three alternative sets of ultimate annual percentage reductions in death rates by sex, age group, and cause of death for the years after 2015 (or 2016 or 2018)." This language is vague and leaves unclear how the ultimate rates of decline are determined. In the distant past, a panel of experts was apparently queried about their views regarding likely progress against various causes of death. But this procedure has not been used in recent years and is no longer cited as justification for the estimates. Discussions with the SSA actuaries indicated that the method of determining ultimate rates of decline was not highly systematic. If projections continue to be based on causes of death, it is important that more detail be provided on how the ultimate rates of decline by cause are chosen, especially for Alternative II, because they deviate so radically from historical experience.

The SSA actuaries should experiment with alternative methods of making projections. Recent work by Wilmoth (1994) has suggested that cause-specific estimates result in less mortality change than rates that are not based on cause-specific information. In addition, recently developed extrapolative methods of mortality projection that rely on relational models (Lee and Carter, 1992) or functional parametric models (McNown and Rogers, 1989, 1992) reduce the complicated and sometimes inconsistent mortality schedules resulting from projecting mortality separately for each age group (for example, projecting the male death rate at age 43 as eventually exceeding that at age 46).

B. FERTILITY RATES

The Panel believes that fertility rates in the near future could be relatively volatile, and that the SSA should continue to monitor trends -- especially those among the younger age groups, to determine possible effects of birth-cohort size on fertility timing, and among baby-boom cohorts to identify trends in completed family size. In the meantime, the Panel recommends that the intermediate
estimate of the long-term Total Fertility Rate (TFR)\(^2\) be raised from its current level of 1.9 to 1.95. The high-cost and low-cost estimates of 1.6 and 2.2 are considered to provide an adequate range, in light of the stochastic effects of combining numerous demographic and economic assumptions. The Panel further recommends that an increase in the fertility rate should be assumed in the short-term, in the intermediate estimate and low-cost assumptions, before the long-term levels are reached.

Assumptions regarding future fertility have significant effect on OASDI projections. In the medium term they indicate how many workers will be available to support current workers as they retire, and in the long run they also indicate how many retirees must be supported. Thus, for example, the 1994 Trustees Report states that a change of the Total Fertility Rate assumption from 1.9 to 2.2, holding all other factors constant at the intermediate-estimate level, would reduce the projected OASDI long-range deficit from 2.13 percent of taxable payroll to 1.70 percent (1994 Trustees Report, p. 131).

The Total Fertility Rate (TFR)

The SSA uses a standard measure of fertility, the Total Fertility Rate (TFR), to express fertility assumptions. This is a summary measure used to indicate how many children a hypothetical woman would bear in her entire childbearing career if she experienced each year of her life the age-specific fertility rates for a particular year. It is important to note that this measure does not describe the actual completed fertility of any group of women.

Because the TFR is a synthetic measure, it can fluctuate tremendously even if completed family size in the population remains unchanged -- and it traditionally fluctuates much more widely than measures of completed actual fertility. This fluctuation occurs because of changes in the timing of births in the population, and consequent overlaps of childbearing among older and younger women (see Appendix D for an example).

Selecting a Long-Term Average Level of Fertility

The SSA actuaries wish to avoid timing effects, like those the nation has experienced over the past 40 years, in making long-term projections -- namely, by determining an average long-term level of completed fertility and simply projecting that flat rate without any cycles. This desire for simplification is understandable, but it brings with it the need to analyze recent patterns of fertility very closely in order to separate out effects of changes in timing from the effects of changes in completed family size.

\(^2\)TFR, as used in this section, refers to Total Fertility Rate and should not be confused with TFR as used in other sections of this report where it refers to Trust Fund Ratio. When used to refer to Total Fertility Rate it will be italicized.
The sensitivity of the TFR to changes in the timing of births must be borne in mind when judging whether or not recent levels of the TFR are a good indication of long-term average levels of completed fertility. That is, the low TFRs over the past two decades appear to have been due, at least in part, to simple timing phenomena. If this is the case, then one must look also to patterns of desired completed fertility, to see how much they appear to be changing for successive cohorts of women.

The TFR has risen from a low of 1.74 in 1976, to 2.05 in 1992 and 1993. The SSA intermediate estimate of 1.9 as the average TFR over the next 75 years is consistent with an assumption that we are currently very near the peak TFR in the current timing cycle. The assumed average of 1.9 could then be interpreted as an attempt to average the peak and trough values. Alternatively, the SSA 1.9 long-term average could be interpreted as the average of a long-term downward linear trend with respect to desired completed family size, which would cause the average of TFR cycles to decline over time.

The reasoning behind the assumed 1.9 long-term average is based on many 'stylized facts': namely, "Future fertility rates may be expected to remain close to recent levels. The recent historical and projected trends in certain population characteristics are consistent with a continued relatively low fertility rate. These trends include the rising percentages of women who have never married, of women who are divorced, and of young women who are in the labor force." The SSA actuaries were forced to draw on stylized facts -- at least for marriage and divorce statistics -- because no official statistics on marriage and divorce have been published in the United States since 1988, because of budget cuts.

Evidence Does Not Support Decline in Long-term Trend

In fact, however, the proportions of young men and women working fulltime aged 20-22 who are married began a sustained rise in 1988, after 20 years of steady decline. The divorce rates for all males and females in this age group finally appear to have topped out, and have declined since 1988. Similarly, the proportions of young women aged 20-24 who are either in the labor force or enrolled in school has topped out as well during this same period (Macunovich, 1994). And during this period, the age-specific fertility among these same young women has risen. All of these recent developments fit well with the relative-cohort-size hypothesis, which indicates that all of these series passed the turning point of a long cycle in the late 1980s.

---

The 1.9 TFR was selected despite data cited\(^4\) in the 1991 Report of the SSA Technical Panel indicating that "Lifetime birth expectations for women aged 18 to 34 have averaged between 2.0 and 2.1 births per woman annually since 1979, indicating that a continued decrease in fertility may not occur." A statement prepared by the SSA Office of the Actuary dated September 27, 1994 cites data indicating that "when comparing past birth expectation surveys with actual experience, birth expectations have tended to be higher. Single women and childless married women have consistently had fewer births than they expected."\(^5\) But it should be noted that cohorts aged 18-34 during 1979-1981 were baby-boom cohorts who would already have lowered their desired family sizes in light of poor labor market experiences. This revision is entirely consistent with the relative-cohort-size hypothesis, which assumes that large birth cohorts meet unfavorable labor market circumstances that cause them to delay/forgo family formation.\(^6\)

The completed family level that is achieved in practice depends on the labor market experiences of each cohort. Some will achieve higher levels (like the baby-bust cohorts of the 1930s), and some will achieve less (like the baby-boom cohorts). Cohorts are encountering increasingly favorable labor market experiences, as reflected in the fact that the stated expected average lifetime births for women aged 25-29 has risen from a low of 2.01 in 1981 (when that age group represented the peak of the


\(^6\) Surveys of Williams College students carried out in 1990 and 1994 indicate that the desired family size prior to experience of the labor market, even in a "career-oriented" female population, averages more than 2.5 both for men and for women (Macunovich, 1995b). This figure has, as an underlying average, remained remarkably steady over the past 60 years. For example, Easterlin (1980) states "a notable consensus exists on two-three-and four-child families. This is shown by surveys of American women conducted between 1936 and 1972 on their ideal family size -- throughout this period, the proportion favoring two to four children is always 85% or more." (p.52) Crimmins, Easterlin and Saito (1991) report that the average number of children desired by high school seniors in 1976 was 2.63 and in 1986 it was 2.37. The proportion desiring two to four children was 77.8% in 1976 and 78.2% in 1986. These figures do show some tendency toward a secular decline in desired average family size, but only a very gradual one.
One argument for lower average TFRs is the assumption that increasing female wages exert a downward pressure on fertility, by raising the opportunity cost of time which a woman might spend in childcare. However, the primary study which is used as a basis for this stylized fact (Butz and Ward, 1979) has since been shown to have used faulty data for the female wage and other factors. When those data are corrected, the Butz-Ward model based on strong negative price effects of the female wage no longer fits the data (Macunovich, 1995a). More recent work has shown that over time the female wage has begun to exert a stronger positive "income effect" on fertility, as purchased substitutes for a mother's time in the home have become more available and socially acceptable. In this type of culture, childbearing does not mean that a woman must stay home and forgo her higher wages; she can use those wages to purchase a replacement for herself in the home, while she goes out into the market. Thus, future increases in the female wage could lead to increases, rather than decreases, in fertility (Macunovich, 1994). This appears to be the primary effect on childbearing of the change in attitudes that leads more women to desire careers outside the home; most assume that they will temporarily revert to part-time jobs, and that they will purchase market replacements for their time in the home.

**Pooling the Evidence**

At a September 27, 1994, hearing on fertility assumptions scheduled by the Public Trustees of the OASDI Trust Funds, four demographers and one demographic economist testified on expected future levels of fertility. Two of these (Preston and Macunovich) foresaw an imminent rise in the TFR as the baby bust enters childbearing years, and as baby boomers who delayed childbearing continue to make up for missed births. Preston estimated a high of 2.3 for cohort completed fertility during these years, while Macunovich estimated a long-term average TFR (which would be equivalent to the average completed fertility of cohorts in the long term) of 2.4 to 2.5.

Two others on the panel (Morgan and Rindfuss) were not averse to the idea of significant variations over the next 10-15 years. Their reasoning reflected the idea of variations in timing causing another overlap of the fertility of older and younger women,

---


8 Female students at Williams College reported an intention to work an average of 44 hours per week outside the home prior to childbearing, but then to work an average of only 17.67 hours per week outside the home when children under 3 are present. (Macunovich, 1995b).
similar to that seen in the 1950s. Only one (Bumpass) foresaw continued marked declines in fertility, due to most of the stylized facts listed previously. He expected to see TFRs in the United States "not unlike those currently experienced in Europe" (i.e., 1.2-1.5).

Hence the majority in that discussion expected significant fertility increases in the next decade. When asked for a best estimate range for the 75-year period, most said that the current SSA projections were adequate; however, that conclusion appears to be inconsistent. If the TFR rises substantially once again over the next decade, then estimates of the long-term trend have been downward biased, and the intermediate estimate requires some upward revision to reflect average levels of desired completed family size higher than 1.9.

Making the Transition to the Long-term Average TFR

The TFR in the first half of the 1990s has been at a level of about 2.05. This level is up from its historic low of 1.74 in 1976, and reflects some making-up of births by women in the baby-boom cohorts, as well as a tendency toward increased fertility among women currently aged 20-24. Because of the evidence cited previously, the Panel recommends that SSA actuaries should assume a continued increase in the TFR during the next decade, before assuming a decline to the long-term average. This approach would be consistent with the recent observed attenuation in labor-force participation rates among younger women and the gradual improvement in young males' average earning potential that began in the mid 1980s. In keeping with these trends, the Panel recommends that, in the intermediate estimate, the SSA actuaries should allow the TFR to rise to a level of about 2.2 during the next decade, before declining to 1.95 ultimately. In the low-cost scenario, the Panel recommends that the TFR be allowed to rise to a level of 2.5 before declining to its long-term average of 2.2. In the high-cost scenario, the Panel recommends that the TFR simply be assumed to decline monotonically from its current level to its long-term level of 1.6. In summary:

<table>
<thead>
<tr>
<th></th>
<th>Current level</th>
<th>Level in 2000-2005</th>
<th>Ultimate Average Level (reached in 2018)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-cost</td>
<td>2.05</td>
<td>2.50</td>
<td>2.20</td>
</tr>
<tr>
<td>Intermediate</td>
<td>2.05</td>
<td>2.20</td>
<td>1.95</td>
</tr>
<tr>
<td>High-cost</td>
<td>2.05</td>
<td>1.80</td>
<td>1.60</td>
</tr>
</tbody>
</table>

The Panel assumes that the SSA actuaries will follow current practice in translating these TFRs to age-specific fertility rates; that is, all age-specific rates will simply be factored by the assumed change in the TFR after the initial transition period. During the
transition period (that is, for cohorts in the childbearing age groups between now and 2018), the SSA actuaries should project age-specific birth rates separately for each cohort on the assumption that currently older cohorts with a delayed pattern of childbearing will have somewhat lower completed fertility rates than the assumed long-term average TFR for each alternative, and vice versa for younger cohorts.

### Monitoring Short-Term Trends

Because considerable volatility in the TFR is expected in the short term, the Panel recommends that the SSA actuaries closely monitor patterns of age-specific fertility and completed family size in this period in order to achieve a better understanding of cyclic as opposed to long-term movements. In particular, completed family size should be monitored as the baby-boom cohorts complete their childbearing years in order to discern any long-term secular trend in this variable. Will the baby boomers achieve smaller completed families than the cohorts born in the first quarter of this century? This information, combined with continued monitoring of trends in desired completed family size, should be used to determine if the estimated intermediate long-term average is appropriate. The recommended intermediate TFR estimate of 1.95 assumes some continuing decline in completed family size, and may require another upward revision.

### C. MARRIAGE AND DIVORCE RATES

The Panel recommends that the intermediate estimate of marriage rates should be raised from the current age-adjusted central rate of 5,730 to 6,000 per 100,000 unmarried of each sex, and that the intermediate estimate of divorce rate should be lowered from the current age-adjusted central rate of 2,140 to 2,000 per 100,000 married couples.

With regard to the high-cost and low-cost estimates, the Panel believes that the range provided by the assumptions used in the current Trustees Report is adequate. Consideration should be given to the anomaly created by combining low marriage rates and high divorce rates, however, with high fertility rates in the low-cost estimate (Alternative I), and vice versa in the high-cost estimate (Alternative III). In addition, current high levels of labor force participation, even among married women, suggest that the assumed link between high marriage rates and high OASDI auxiliary benefits may be outdated.

Projections of the marital status of the population can affect OASDI cost estimates in several ways. Obviously, these projections of the total numbers of married individuals by sex have repercussions because various other characteristics of the population are assumed to vary by marital status, such as labor-force participation.
rates (primarily for women, but also for men at older ages). Then, a third aspect of OASDI projections is affected; namely, projections of auxiliary benefit eligibility (such as, numbers of non-contributing spouses -- primarily wives -- who are eligible for OASDI benefits on the basis of their spouse’s contributions). Assumptions regarding marriage and divorce do not affect the projections of births, because age-specific fertility rates are applied to all women regardless of marital status.\(^9\)

The Panel recommends that more effort be made to integrate and rationalize these various aspects of the OASDI projections. That is, it is likely that marital status acts simply as a proxy for other characteristics of the population, rather than actually causing variables such as labor-force participation rates. The SSA actuaries currently assume high marriage rates in the high-cost estimate (Alternative III) because it also assumes relatively low female labor-force participation rates (and hence high levels of eligibility for spousal benefits) for married women. Over the past two decades, however, the labor-force participation differential between married and unmarried women has declined dramatically, so that even this impact of marital status on OASDI revenues and costs has diminished.

Although female labor-force participation rates appear to have topped out recently, no strong evidence indicates that there will be a return to pre-1970s rates in the future. (Projections in Macunovich, 1994, estimate declines for the 20-24 age group from current levels of 82 percent to about 75 percent over the next decade.) The high levels of labor-force participation among female baby boomers may have been sufficient to exert an effect on social norms regarding married women’s labor force participation. Taken together with changed social norms regarding the acceptability of purchased childcare, this could imply that, even with improved economic circumstances and higher fertility, the baby-bust generation might opt to stay with the established pattern of dual-career families. Hence, higher marriage rates may lose their impact on OASDI spousal benefits.

Divorce rates impact OASDI auxiliary benefits because, through divorce, one individual may have multiple partners, all of whom may claim OASDI benefits as a result of marriage to the individual. This will be the case if the individual spends at least 10 years with each partner, the partners do not remarry, and the partners do not participate in the labor market (or do so only in low wage jobs). Given current patterns of female labor-force participation, even among married women with children, it does

\(^9\)In fact, in the SSA projections, the split between fertility assumptions, and marriage and divorce assumptions, is so great that Alternative I combines high fertility with low marriage rates and high divorce rates, while Alternative III combines low fertility rates with high marriage and low divorce rates.
not seem that divorce rates will pose a significant threat to future OASDI auxiliary benefits. That is, the majority of divorced partners will tend to have made sufficient OASDI contributions on their own, to qualify independently for benefits which will be larger than spouse benefits (and, less often, widow(er)'s benefits) based on their spouse's earnings record. This option is consistent with the SSA actuaries putting their high divorce assumption in the low cost scenario.

It seems likely, on the basis of the foregoing comments, that marriage and divorce rates should have little effect on OASDI cost projections. Given current projection methodologies, however, which tend to treat marriage and divorce as causal variables in projecting spousal benefits, it is not altogether clear what impact these rates actually have. The various technical reports do not report any sensitivity analyses for marriage and divorce rate assumptions. The Panel recommends that attention be devoted in the future to rationalizing these projections and conducting sensitivity analyses with logical pairings of marriage, divorce, labor force participation, and fertility assumptions.

**Suggested Revisions to Intermediate-Cost Assumptions**

With regard to current assumptions on marriage and divorce rates, the 1994 Trustees Report simply states that "the population was projected by marital status, as well as by age and sex. Marriage and divorce rates were based on recent data from the National Center for Health Statistics." (pp.143-144). A recent source of detailed assumptions on marriage and divorce rates, and methodologies used to apply them, is the SSA Actuarial Study No. 106 (February 1992). There, the age-adjusted central marriage rate (per 100,000 unmarried of each sex) and age-adjusted divorce rate (per 100,000 married couples) are assumed to take the following patterns:

<table>
<thead>
<tr>
<th></th>
<th>Marriage</th>
<th>Divorce</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previous Peak Level:</td>
<td>10,168 (1968)</td>
<td>2,278 (1981)</td>
</tr>
<tr>
<td>1990 Actual Level:</td>
<td>5,736</td>
<td>2,102</td>
</tr>
<tr>
<td>2015 Assumed Level:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alt. I (low-cost):</td>
<td>4,000</td>
<td>2,400</td>
</tr>
<tr>
<td>Alt. II (intermediate):</td>
<td>5,730</td>
<td>2,140</td>
</tr>
<tr>
<td>Alt. III (high-cost):</td>
<td>9,000</td>
<td>1,800</td>
</tr>
</tbody>
</table>

It can be seen that the marriage and divorce rates in the intermediate estimate (Alternative II) are basically held constant at their 1990 levels, throughout the forecast period, the reasoning being that both rates appeared "to have stabilized in recent years". In Alternative I (low-cost), the marriage rate is assumed to continue to decline,
and the divorce rate to increase, while in Alternative III (high-cost), the marriage rate is assumed to rise close to its previous peak, while the divorce rate falls. While the range of these alternatives seems acceptable, in light of historic experience, the Panel does not endorse combination of low marriage rates and high divorce rates with the assumed higher fertility rates in Alternative I.

The age-adjusted central divorce rate has been declining since 1981 (from 2,278 per 100,000 couples to 2,102 in 1990). This almost steady monotonic pattern in that period is consistent with the relative-cohort-size hypothesis -- namely, that as relative cohort size has declined (since 1979-80), the perceived reduction in economic hardship has led to declining divorce rates. It is also consistent with findings by Macunovich (1995), which indicate a rise in marriage rates and a decline in divorce rates since 1988 specifically in those age groups (20-22) most affected by improving male relative incomes in that period.

It would appear that the society has recently come through the low point in a marriage cycle (and the high point in a divorce cycle). As a result, the intermediate estimate of marriage rates should anticipate some increase over 1990 levels, while divorce rates should anticipate some decline from 1990 levels, to acknowledge that our recent experience has been part of a cycle, rather than part of a linear trend.

D. IMMIGRATION

The panel recommends no change in the current procedures used to make immigration assumptions. The procedures used by the SSA actuaries to update the assumptions seem appropriate. The level of the Alternative II projection seems to be appropriate.

The intermediate assumption of the SSA actuaries in the 1995 Trustees Report is for total net annual immigration of 900,000 persons in the years after 2000. This number includes 250,000 other-than-legal immigrants and 650,000 legal immigrants. The 900,000 represents an increase of 50,000 from the 1994 report and 300,000 from the 1990 report.

The recent change toward assuming higher levels of immigration reflects the inclusion of the implications of the 1990 Immigrant Act that raised the number of legal migrants as well as recent data from the Immigration and Naturalization Service.

The alternative assumptions result in a range of 750,000 to 1,150,000 net immigrants per year after 2000. This range replaces a range of 450,000 to 750,000 in the 1990 Trustees Report. For that time, the Technical Panel of four years ago recommended a 150,000 increase in the total net number of immigrants in the
Alternative I projection, so that the range would be 450,000 to 900,000.

Unlike other demographic assumptions, immigration flows can be largely (but not totally) determined by legislative changes making the future even more difficult to project. Members of the Panel noted that it is easily within the range of possibility that immigration could occur at a level very different from any of the assumptions of the SSA actuaries. For example, total immigration could be many times higher than even the highest estimate. The SSA actuaries, however, appear to regularly update their assumptions in accordance with legal changes and new estimates of the INS. They also regularly consult experts in the field. Both the current assumptions and the approach to making changes in these assumptions seem to be appropriate.
REFERENCES


VI. ECONOMIC ASSUMPTIONS

This section discusses Real Wage Growth, Real Interest Rates, Inflation, and Unemployment assumptions, with emphasis on the intermediate projection. Although the Panel suggests that modifications be considered in various specific assumptions, the overall effect of those suggestions (including the demographic assumptions discussed in the preceding section) would not significantly change the financial evaluation provided by the intermediate projection in the Trustees Report.

The Panel split in its recommendations about assumptions for ultimate annual Real Wage Growth (RWG) and Real Interest (RI) rates. Half the Panel recommends RWG of 0.8 percent and RI of 2.8 percent; the other half recommends continued use of the assumptions used in the current Trustees Report: RWG of 1.0 percent and RI of 2.3 percent.

The Panel does not recommend any change in the ultimate Inflation (4 percent) or Unemployment (6 percent) assumptions.

Regarding short-range assumptions, the Panel recommends that considerable weight be given to the forecasts in the budget submissions of the Administration. However, a procedure for use when the long-range assumption for a variable is significantly different from actual recent experience is suggested.

The Panel does not recommend any explicit adjustment in assumptions due to possible changes in measurement of the Consumer Price Indices; implicit allowance for improved measurement procedures is reflected in the conclusions about each variable. It is emphasized that modifications to benefit formulas (such as, CPI less 1 percent) have a result different from that of measurement changes; arbitrary adjustments would produce changes in the real benefits of the program.

Finally, suggestions for future research are indicated. These should be considered in conjunction with the subsequent section on Research and Other Matters.

The Panel focused its attention on two broad questions: (1) what assumptions are most reasonable for the 75-year forecasting period typically used by the SSA actuaries; and (2) how should potential changes in the calculation of inflation rates affect the status of the OASDI Trust Funds. The Panel used economic theory, empirical evidence, and estimates from leading forecasters in making its recommendations.
A. Economic Assumptions for the Next 75 Years

The Panel agreed that it was important to provide forecasts of four economic variables. In order of importance, these variables are: the rate of real wage increase; the real interest rate; the inflation rate; and the unemployment rate. As the sensitivity table below shows, the first two of these variables in particular have a great effect on the status of the trust funds.

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Baseline (1994)</th>
<th>Effect on 75-Year Actuarial Balance (as % of taxable payroll)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real wage growth (increase by 0.5%)</td>
<td>1.0%</td>
<td>+.54</td>
</tr>
<tr>
<td>Real interest rate (increase by 0.5%)</td>
<td>2.3%</td>
<td>+.31</td>
</tr>
<tr>
<td>Inflation rate (increase by 0.5%)</td>
<td>4.0%</td>
<td>+.11</td>
</tr>
<tr>
<td>Unemployment rate (increase by 0.5%)</td>
<td>6.0%</td>
<td>-.03</td>
</tr>
</tbody>
</table>

The Panel's discussions of economic conditions for the next 75 years was dominated by fundamental uncertainty about the direction the economy would take. Economists tend to use historical information as the guide to the future, but the macroeconomic history of the United States in the past 50 years does not suggest a single theme for forecasting. As a result, different Panel members viewed the historical record -- and thus their projections for the future -- in different ways. Panel members agreed on some issues, but not on others, even after several months of discussion.

i. Real Wage Growth

The Panel split in its recommendations about real wage growth. For the long-range assumption, half the Panel recommends real wage growth of 0.8 percent annually, and half the Panel recommends real wage growth of 1.0 percent annually.
The real wage growth is the differential between the percentage increase in average annual wages and the rate of CPI inflation. There are two methods for determining real wage growth. The first is termed the productivity method. It estimates the growth rate in real annual earnings per worker, using this equation:

\[
\left( \frac{\text{Earnings} \text{ Worker}}{\text{Hour}} \right) = \left( \frac{\text{Output}}{\text{Hour}} \right) \left( \frac{\text{Compensation}}{\text{Output}} \right) \left( \frac{\text{Earnings}}{\text{Compensation}} \right) \left( \frac{\text{Hours}}{\text{Worker}} \right) \left( \frac{\text{GDP}}{\text{CPI}} \right)
\]

growth. The next four terms are the "linkages" between productivity and earnings. They are the trends in: (1) the share of output paid out as compensation to labor; (2) the share of compensation that is paid out as earnings; (3) annual hours per worker; and (4) the rate of GDP inflation compared with CPI inflation.

For two of these linkages -- the share of output paid out as compensation and the relative inflation ratio -- economic theory suggests that there ought to be no change over time (although the Panel returns to the issue of changes in measured inflation later). Thus, the Panel focused its consideration on the remaining two linkages -- the share of compensation paid out as earnings and the change in hours/worker.

The second method for determining earnings per worker is to look at the growth of real wages directly. The Panel used both of these methods in its discussions. Because the fundamental determinant of earnings growth is productivity growth, however, the Panel spent most of its time analyzing productivity and its determinants, rather than real wages directly.

In forecasting productivity and its determinants, the Panel focused most heavily on the post-World War II period. The previous technical panel summarized the historical record using weighted averages of past productivity growth rates, with years farther back being weighted less heavily than more recent years. Because the weighting system chosen is arbitrary, and because estimated long-run productivity growth will vary depending on when in the business cycle the weighting is performed, the Panel found it most informative to measure average productivity growth rates and linkages for lengthy time intervals, and then to consider these periods separately.

---

10 The differential is defined as \([(1+\text{growth rate}) \times (1+\text{inflation rate})] - (1+\text{inflation rate})\). Therefore, the assumed numerical value of the differential implies a slightly smaller numerical value of the growth rate.
As the next table shows, productivity growth -- and thus real wage growth -- was remarkably different in the two periods. Productivity growth averaged 2.3 percent annually in 1953-73, but only 0.9 percent in 1973-93. Real earnings growth was 2.0 percent vs. -0.2 percent. The simple average of real earnings growth was 0.9 percent:

<table>
<thead>
<tr>
<th>Measure</th>
<th>1953-73</th>
<th>1973-93</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Productivity Growth</td>
<td>2.3%</td>
<td>0.9%</td>
<td>1.6%</td>
</tr>
<tr>
<td>Total Linkages</td>
<td>-1.0%</td>
<td>-0.6%</td>
<td>-0.8%</td>
</tr>
<tr>
<td>Earnings/Compensation</td>
<td>-0.4</td>
<td>-0.3</td>
<td>-0.3</td>
</tr>
<tr>
<td>Annual Hours/Worker</td>
<td>-0.6</td>
<td>-0.3</td>
<td>-0.4</td>
</tr>
<tr>
<td>Implied Real Wage Growth</td>
<td>1.4%</td>
<td>0.3%</td>
<td>0.9%</td>
</tr>
<tr>
<td>Actual Real Earning Growth</td>
<td>2.0%</td>
<td>-0.2%</td>
<td>0.9%</td>
</tr>
</tbody>
</table>

Why productivity growth differed so dramatically pre- and post-1973 is a subject of great economic debate. Some have blamed the reduction in savings rates, others have argued that it was a temporary response to the oil price shocks of the 1970s, and others have focused on the demographics of the baby boom. The lack of consensus in the economics literature carried over directly into the Panel's discussions.

The Panel spent much time reviewing the historical record and its implications for the future. Two views emerged. The first view, held by roughly half the Panel, was that the experience of the previous 20 years is the best forecast of the experience to be expected over the next 75 years. If savings and investment rates are a key determinant of productivity growth, the past several years of continued low savings and investment suggest that there will be no rapid return to higher rates of productivity growth. Indeed, savings rates in the early 1990s have continued their low levels from the 1980s.

---


Panelists who were more pessimistic also pointed to the fact that the job market for many less-skilled persons has performed very poorly in the past two decades, and many persons are finding themselves unequipped in today's economy. Finally, these members noted that despite rapid investment in computers in the past decade, there is little evidence that computer investment has enhanced productivity growth directly. The Panelists who held this view thought that a real wage growth rate of 0.8 percent annually was a reasonable assumption, implied (for example) by a productivity growth rate of 1.3 percent, a reduction in earnings/compensation of 0.3 percent, and a reduction in hours/worker of 0.2 percent.

The second view, held by the other half of the Panel, was a more optimistic one. It argued that the 1973-93 period was an aberration and that the economy would return to a higher growth path in the long run. Several pieces of evidence were advanced in support of this view. First, it may take some time for computers to translate into higher productivity, just as it took time for telephones and other electronic devices to result in higher productivity. Second, the baby boom may have depressed real wage growth through a number of factors (such as labor-market crowding), and the return to smaller cohorts may increase productivity growth. Third, the U.S. economy has generally adjusted to the new era of international competition, and it may be poised for long-run growth. Finally, savings rates may ultimately return to their early postwar levels, prompting more investment and thus more rapid productivity growth. This view is consistent with the fact that productivity growth rates since 1979 have been significantly higher than in the 1970s. Proponents of this view argued that the current assumption of 1.0 percent real wage growth was appropriate, derived from productivity growth of 1.4 percent, and reductions in earnings/compensation and hours/worker of 0.2 percent each.


14 Baily and Gordon, supra.


16 See the references cited in the Fertility section.

The Panel was split between these two views. Indeed, long-run estimates of real wage growth in large scale macroeconomic models (for example, DRI and WEFA) are within this range. After much discussion, the Panel agreed to present these two forecasts rather than a compromise forecast. Panel members’ conclusions implicitly recognize that CPI measurement errors affect real growth rate estimates.

ii. Interest Rates and Inflation

The Panel was split in its recommendation on real interest rates. Those members who favor a real-wage-rate assumption of 0.8 percent annually believed that a real-interest-rate assumption of 2.8 percent is the best forecast. Those who favor a real-wage-rate assumption of 1.0 percent annually believe that the current real-interest-rate assumption of 2.3 percent is the best forecast.

The Panel recommends maintaining the current inflation-rate assumption at 4 percent.

Changes in interest rates affect the OASDI estimates in two ways. First, with some prefunding of benefits, increases in interest rates raise the return on assets and thus favorably affect the solvency of the trust funds. For example, a 1 percentage point increase in interest rates would move the projected exhaustion date of the trust funds back by about 2 years. Second, interest rates affect the present value calculations for income and cost rates. As interest rates increase, deficits in the long term are weighted less highly, and the present value of the actuarial deficit is correspondingly reduced. This present-value calculation is the major cause of the sensitivity results noted previously.

The same factors that caused the Panel such difficulty in forecasting real wage growth also were reflected in uncertainty over real interest rates. In particular, such rates have varied dramatically in the past several decades. As the following table shows, prior to the 1980s, real interest rates averaged about 1 to 2 percent. In the 1980s, in contrast, real interest rates averaged about 5 percent:
Historical Evidence on Real Interest Rates

<table>
<thead>
<tr>
<th>Measure</th>
<th>1953-79</th>
<th>1980-93</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal Interest Rate</td>
<td>5.3%</td>
<td>9.7%</td>
<td>6.8%</td>
</tr>
<tr>
<td>Inflation</td>
<td>4.2</td>
<td>4.7</td>
<td>4.4</td>
</tr>
<tr>
<td>Real Interest Rate</td>
<td>1.1</td>
<td>5.0</td>
<td>2.4</td>
</tr>
</tbody>
</table>

The real interest rate is the nominal rate minus the inflation rate.

The Panel chose to estimate real interest rates and inflation rates separately, and then to forecast the nominal interest rate as the sum of these elements. This approach is consistent with economic evidence on the determination of nominal interest rates.

The real interest rate clearly responds to world demand for, and supply of, savings. The Panel was divided in its estimate of real interest rates, corresponding to its two estimates of real wage growth. Those who believe that savings rates were likely to remain low (and thus that real wage growth would be low) thought that real interest rates would be higher than the post-war average, at about 2.8 percent. Those who thought that savings rates would be higher, and thus that productivity growth would be more rapid, favored maintaining the current real-interest rate assumption of 2.3 percent.

Inflation rates are more difficult to forecast than real wage growth or real interest rates, because they depend as much on the actions of the Federal Reserve Board as on the behavior of the economy. The historical evidence suggests that an inflation rate of 4 to 4.5 percent is consistent with the postwar average. Further, Panelists noted that the 25-year forecasts of DRI and WEFA are for ultimate inflation rates of 3.8 percent and 3.4 percent. Therefore, the Panel believes that the current forecast of 4 percent is a reasonable estimate.

Several Panelists thought that the nominal interest rate implied by these assumptions (between 6.3 and 6.8 percent) was too low. Other Panelists believed that the recent past reflected the experience of two oil price shocks, and that such sporadic events are not likely to have significant impact on the average annual rate over a 75-year period.

Further study should be given to procedures for estimating real interest rates, because they are inferred from observed nominal rates and inflation measures, rather than separately derived.
iii. Unemployment Rates

The Panel recommends maintaining the current unemployment-rate assumption of 6.0 percent.

The long-term unemployment-rate assumption has relatively little effect on the cost of the program. The Panel believes that long-term unemployment rates are best forecast as the average "natural rate of unemployment." Current estimates place the natural rate at about 5.5 to 6 percent. The Panel thus recommends maintaining the current unemployment-rate assumption of 6 percent. (The section on Disability rates has some further comment about the impact of unemployment rates.)

iv. Short-Term Transition

The Panel was also asked to recommend a transition between current economic conditions and long-range assumptions. In general, the Panel thought that considerable weight should be given to the forecasts in the budget submission of the Administration. When the long-range assumption for a variable is significantly different from actual recent experience, however, the Panel recommends that a procedure similar to the following be considered:

1. Determine the cyclically adjusted short-term level as the average level of the variable being forecast over the most recent business cycle. For example, short-term real-wage growth would use the average from 1979 to 1989.

2. Transition from the short-term to the long-term would be over a period depending on the variable being forecast, usually about 10 years.

3. Superimposed on the short-term growth rate would be the cyclical condition of the economy. For example, if the economy is in a recession, short-term real-wage growth would be above the estimate determined from (1) and (2) by an amount equal to the average increment to real-wage growth at that stage of the business cycle. This increment is already a part of the models of the SSA actuaries.

———

18 This range is common in macroeconomic models of the U.S. economy.
B. Measurement Issues Associated with Consumer Price Indices

The Panel was also asked to evaluate the importance of biases in the Consumer Price Index for the OASDI Trust Funds. The Panel considered this issue in considerable detail. Price measurement concerns can be divided conceptually into three issues.

First, certain factors bias CPI inflation rates more than inflation rates from other indices, such as the GDP deflator. An example of such a bias is the fact that the CPI is reweighted only infrequently, and thus changes in the basket of goods consumed may result in CPI inflation rates being larger than GDP inflation rates. The sampling of goods from new stores is another reason the CPI inflation rates may be overstated. At least 60 percent (and maybe more) of the bias in the CPI is believed to result from this issue.

The Panel agreed that this source of bias had already been taken into account in forecasting real wage growth. In particular, one of the linkages noted previously is the relative inflation rate of the CPI compared with the GDP deflator. The Panel assumes (as previous Panels have done) that the substitution bias would be corrected, and that the two deflators would grow at the same rate in the future. Hence, the component of CPI inflation due to this first issue has implicitly been assumed to be measured more accurately in the future.

In fact, if these corrections are not made, the status of the OASDI Trust Funds will be less favorable. Suppose, as an example, that productivity growth (less the hours-and-earnings adjustment) is 1 percent annually and that GDP inflation is 4 percent annually. Nominal wages, and thus contributions into the system, will grow at the rate of nominal output (5 percent). If the CPI were measured correctly, inflation adjusted payout would also grow by 4 percent. When the CPI measure is overstated, however, payouts will grow more rapidly than 4 percent, and hence the trust funds will show increased deficits.

The second issue is the fact that, even with correction for substitution bias, some differences may remain between the growth of CPI inflation and the growth of GDP inflation. Because the basket of consumption goods is different from the basket of production goods, changes in the relative price of consumption goods as compared

---

19Two recent discussions of potential difficulties in price indices are: Congressional Budget Office, "Is the Growth of the CPI A Biased Measure of Changes in the Cost of Living?", October 1994; and David Lebow, John Roberts, and David Stockton, "Monetary Policy and 'The Price Level'", Federal Reserve Board Working Paper, August 1994.

20References in this section to "goods" generally means "goods and services."
with production goods would affect the CPI and GDP price indices differently. An example of this differential effect is the fact that relative capital-goods prices have fallen over time, and the GDP deflator weights capital goods more heavily than consumer goods. If this differential persisted, the rate of real wage growth (measured relative to the CPI) would be less rapid than the forecast noted previously.

The third issue is the fact that all inflation measures -- including the CPI and the GDP deflator -- may not accurately account for quality change. As the quality of goods and services changes, an ideal measure of inflation would take this into account. When quality improves, for example, effective inflation rates should be lower, and when quality decreases, effective inflation rates should be higher.

Most analysts believe that quality improvements in the goods-producing sector have been underweighted over time, but that quality improvement for some goods may have been overstated. On net, most analysts believe that the measures of GDP and CPI inflation that are currently reported overstate the true degree of inflation because the quality of goods and services produced has, on net, increased.

When the issues noted above are addressed in CPI revisions, most analysts believe that reported inflation rates will fall, and thus that measured real-wage rates will increase. These results would improve the financial status of the trust funds. Benefit amounts would be lower in nominal terms, but contributions would be unchanged (or, equivalently, contributions would increase in real terms for the same nominal benefits).

Absent a firm estimate of the amount of bias resulting from all these different factors, the Panel chose not to adjust explicitly its estimates of real rates to account for changes in the measurement of inflation. The Panel believes that, on net, all of these factors taken together would likely increase the real rates in the future, and agreed that these issues should be incorporated into each individual's weighting of the historical record in projecting the future. The Panel's recommendations for real-wage growth and real interest rates described previously reflect these inflation measurement considerations.

The Panel also noted that these adjustments to inflation measurement are different from modifications of benefit formulas, such as proposals to increase benefits by the CPI minus 1 percent. The adjustments for mismeasured inflation are an attempt to make benefits consistent in real terms over time -- so that purchasing power for those relying on OASDI would be unchanged from year to year. Benefit formulas based on arbitrary estimates of the overstatement or understatement of inflation would change the
real benefits that Social Security recipients receive.\textsuperscript{21}

C. Additional Recommendations

In addition to the recommendations above, the Panel agreed on the following recommendations (also see the section on Research and Other Matters):

1. The SSA actuaries should work with outside economists to develop a model of national savings that can be integrated with their model. Such a model would incorporate a feedback between national savings, real wage growth, and the status of the trust funds. The model would necessarily be preliminary at first, but might be used in the future to prepare conditional forecasts and to analyze the effects of various policy reforms on the trust funds.

2. The SSA actuaries should continue to monitor measurement issues in the CPI and GDP deflators, and as information about quality biases becomes known, these estimates should be incorporated into their assumptions as to future real-wage growth.

3. The SSA actuaries should work with outside economists to understand better the changes in the distribution of covered earnings over time, with the goal of incorporating these estimates into future projections. The effect on the trust funds of increased earnings dispersion may be substantial. For example, increased inequality of permanent income will have effects on future benefit levels different from those of mainly transitory income fluctuations for workers. In addition, changes in the distribution of permanent income may affect the desirability of some policy changes relative to others.

\textsuperscript{21}Subsequent to the Panel's deliberations, the 9/95 Interim Report of the Advisory Commission to Study the Consumer Price Index was released. Young and Cutler reviewed that document and concluded it did not introduce issues which would revise the Panel's conclusions.

As indicated in the Table on page 37, the CPI inflation rate has relatively small direct effect on the financial status of OASDI because the program's income and outgo are similarly affected by that rate.

A more significant issue is the relation between inflation and real wage growth. The Panel's wage growth analysis was based mainly on productivity and its linkages to wages; hence, the GDP deflator and its relation to the CPI are important, but those matters were not considered in the 9/95 Interim Report.
VII. DISABILITY RATES

The Panel recommends periodic updating of the age-sex matrices used to project disability incidence and termination by recovery rates. In addition, use of different matrices for major categories of disability should be considered. Analysis and projection of the factors, which reflect the overall levels of these rates, should give explicit recognition to the effect of unemployment and of claims administration practices.

The Panel's review of the Disability Insurance projections focused on the assumptions for disability incidence and disability termination by recovery (the latter being one of several possible reasons for termination). For each of these assumptions, SSA has developed an age-sex matrix of rates. To project rates to a specific future year, the appropriate matrix is multiplied by a factor assumed to apply to that year.

For incidence rates, the matrix is based on 1984-86 data. The intermediate projection in the 1995 (and 1994) Trustees Report used a factor of 1.35 for the long-range; hence the assumption is that for each age-sex cell in the matrix the ultimate incidence rate will be 35 percent higher than the 1984-86 rate for that cell.

Similarly, the termination by recovery matrix is based on 1977-80 data, and the intermediate projection in the 1995 Trustees Report used a factor of 0.500 for the long-range. In the 1994 Trustees Report, the corresponding factor was 0.650.

For each of these assumptions, the Panel considered the following three issues:

1. How valid is the pattern by age and sex represented by the base period matrix?
2. What factor(s) should be multiplied by the base period rates to simulate future activity?
3. What refinements to the projection technique should be considered?

Incidence

Regarding the base period matrix, there are indications that the distribution of new claims has shifted by age and cause of disability. One indication is the increased incidence of mental and nervous claims that is especially noticeable at the younger ages. Another indication is changing medical technology and disease incidence such as AIDS. Therefore, a more current matrix for projection purposes is more appropriate and should be regularly updated.
In regard to question two on magnitude of projection factors: Figures 2 and 3 done by the Office of the Actuary, SSA, are very helpful in visualizing the assumptions used for both short- and long-term projections. The Long-Range lines represent the data used as the basis for the long-range estimates. The long- and short-range estimates are based on different data. Hence the short-range lines in Figures 2 and 3 are special calculations of comparable factors based on the short-range projections. In actual projections, there is a grading between the end of the short-range assumptions and the ultimate long-range assumptions.

Claims administration practice also plays an important role. The overall incidence rates are expected to increase to a peak and then decline in the short term. This pattern is in recognition of the larger-than-desired backlog of claim applications and in anticipation of how bringing down the backlog will impact the measurement of disability rates. The ultimate assumptions used for long-term projections are slightly more optimistic than the final level for the short-term projections, but not much different from the recent past (i.e. 1991-93 for males and 1993 for females). Therefore, the Panel does not disagree with the judgment shown by the SSA actuaries in viewing the expected influence of administrative practices.

In regard to question three, work in the area of the economics of the disabled suggests that the number of applications in part reflects the state of the economy. One measure of labor-market opportunities is the unemployment rate. Therefore, the Panel recommends that, in preparing disability incidence projections, SSA explicitly recognize the effect of unemployment.

Additionally, work by Gina Livermore and others of LEWIN-VHI suggests that the projections would be improved if categories of diagnosis for disabilities were used. She uses four categories (Mental Disorders, Musculoskeletal, Infectious Diseases, and Internal Organs), but at a minimum using mental and physical groups would improve the projections. Her analysis finds that from 1988 to 1992, the application rate for all impairments has increased; but that the overall increase of 6.4 percent masks large differences, such as a 10.5 percent increase in applications based on mental disorders as compared to a 3.5 percent increase in the category of internal organs. Her work also suggests the importance of the unemployment rate in understanding the changing rate of applications.
Termination by Recovery

It may first be helpful to summarize the current situation:

1. A large backlog of initial claims has accumulated.

2. Many Continuing Disability Reviews (CDRs) have been postponed, contributing to a noticeable drop in claim terminations by recovery.

3. Concern has been raised about the quality of administration.

4. Incidence rates are up, particularly for younger ages and for mental and nervous claims.

5. In an effort to catch up, some full medical CDRs will not be done, but rather CDRs will be based on answers to self-reported data received from mailers. Although a sampling will be reviewed in more depth to monitor accuracy, there is some concern that the results may be less satisfactory than full medical CDRs.

Figures 4 and 5, done by SSA, are helpful in visualizing the assumptions used for both short- and long-term projections. As with incidence rates, the short-range lines are special calculations of comparable termination factors based on the short-range projections. The graphs have been enhanced by drawing lines for a rough illustration of the 1995 change in ultimate long-term assumptions.

The graphs show (a) the decline in recoveries since 1988, (b) the relatively low level currently, (c) the fact that the assumed improvement caused by catching up on CDRs has been averaged over the short term, and (d) the ultimate long-term projections (for the 1994 Report, and as decreased in the 1995 Report).

Examining the first question, is the matrix for base period 1977-80 still appropriate? That was a period of extremely high termination rates. Many terminations during that time were criticized as being arbitrary and inappropriate. The backlash from the criticism produced changes. Adjustments to that situation alone would raise a question about the validity of data from that period. Since then there has been a much lower absolute level and a change in official attitude as to the disabilities at older ages. For older ages, the attitude that suitable work is almost impossible to find has produced little or no pressure from the SSA on the claimants to return to work or be terminated as no longer disabled. Today, there is also a much higher prevalence of mental and nervous claims among the disabled population. A reasonable assumption is that recovery patterns are different from other (physical based) claims. More AIDS claims are also present, and they do not lead to any termination by recovery. For all of these
reasons, it would be appropriate to develop a new matrix based on more recent data and to update that periodically.

With the recent decline in recovery rates and fewer terminations, the resulting matrix of recoveries is likely to have comparably fewer numbers in each cell. Therefore, the data may have to be smoothed out before use. Smoothing may be desirable, however, and the effort is a small price to pay to replace outdated data with more appropriate data.

The second question considers the factors used for projections. Figures 4 and 5 indicate that the current factors are still high when compared to the recent past or the projected short term. There are some arguments why the ultimate long-range termination rates might increase from the last level shown in the short-term projections. One might be optimistic and assume that some of the current claims practices from the private sector might be gradually used by the SSA. Among these would be truly continuous claim review, more personalized service, and more field investigations. Incentives might be developed for the private sector to be rewarded for proving that some claimants are not truly disabled. CDRs might be targeted on the basis of disability diagnosis. Such targeting could not only increase the recovery rates, but would also improve the projections. One could theorize for some time on possibilities. However, the problem with such aggressive assumptions is that the very fact they are used to decrease projected costs tends to lessen the urgency to change the political process necessary to implement such actions -- a type of Catch 22 whereby change will tend not to occur! Although the 1995 Report decreased the assumptions as to recovery rates from the 1994 Report, even the new projections will turn out to be too optimistic if the review process is inadequate.

The third question deals with potential enhancements of the projection techniques. Here the same issues discussed for incidence above are the obvious ones.

Labor market conditions could affect recovery rates, but SSA actuaries indicated that past studies did not show any real difference as the unemployment rate varied. Whether or not one believes there should be a difference, if the actual claims administration cannot take advantage of an improved economy, then the actuaries should not vary assumptions around the economy.

The SSA actuaries should check terminations rates by major diagnosis category. With the increased incidence of mental and nervous disorder claims and AIDS claims, as a minimum these categories deserve special attention.
Figure 1. Average annual improvement is old-age mortality for males and females, by single year of age, from the 1960s to the 1980s for an aggregation of 13 countries with highly reliable data.

Notes: The countries are Denmark, Finland, Iceland, Norway, Sweden, Austria, England and Wales, France, Germany (West), Italy, Japan, the Netherlands, and Switzerland.

Figure 2

SSA Disability Incidence Factors for Males
(base period 1984-86)

1.60
1.55
1.50
1.45
1.40
1.35
1.30
1.25
1.20
1.15
1.10
1.05
1.00


Calendar year

Projections based on the 1994 Trustees Report
alternative II assumptions.
Figure 3

SSA Disability Incidence Factors for Females (base period 1984-86)

SSA Disability Recovery Factors for Males
(base period 1977-80)

Figure 5

SSA Disability Recovery Factors for Females
(base period 1977-80)

VIII. ASSUMPTIONS REGARDING RETIREMENT AGE UNDER CURRENT LAW

The Panel recommends that the assumed pattern of retirement ages and the related benefits, and the sensitivity of the cost rates to such assumptions, be studied further, and that detailed results should be made available for review.

Each individual's retirement benefits are affected by the age at which the benefits commence, because of the benefit calculation formula as well as the earnings history. SSA makes various assumptions about commencement ages (often called retirement ages), but provides little detailed information about the basis for those assumptions or the resulting projections. The Panel concludes that inadequate attention has been given to analyzing the effect retirement age assumptions may have on the financial projections, especially since the "full benefit" retirement age is scheduled to increase from 65 to 67.

Although the Trustees Report provides some procedural description (e.g., on pages 130-1, 154-5 and 165-6 of the 1995 Report), it contains little information regarding the methods and assumptions used, and no analysis regarding their sensitivity effect. However, it is noted (on pages 90 and 131) that changes in those assumptions affected the trust fund ratio and actuarial balance projections.

Discussions with the SSA actuaries provided some details about those assumptions and related aspects of the methods used to estimate future benefit payments and cost rates, as they were applied to the 1994 Report. Additional explanation regarding that report, and the changes made for application to the 1995 Report, was requested but the analysis was not completed in time for the Panel's report.

The major questions are summarized here, and are discussed in further detail later:

1. What are the assumed numbers of retirees for future years, especially as affected by the full-benefit retirement age increase from 65 to 67?

2. How consistent are the retirement assumptions with the projected labor-force participation rates?

3. What are the corresponding projections of Primary Insurance Amount (PIA) levels for retirees in the various age-sex categories?

4. How sensitive are the financial estimates to these assumptions?
Assumed Numbers of Retirees

Assumptions as to the retirement rates are by sex, for each age from 62 through 70; at age 70, essentially all eligibles are assumed to be retired, because the retirement earnings test no longer applies thereafter. Thus, higher age retirees can be projected using only mortality assumptions. There also are some marital-status assumptions.

Actuarial Studies No. 100 (2/88) and No. 104 (10/91) provide considerable data and procedural information. The latter only covers the period through the year 2000, however, and it is not clear whether the former is still applicable.

As one justification for the lack of detail provided about this topic, the SSA actuaries pointed out that, in future years, variation in benefit commencement age will produce approximately actuarially equivalent monthly benefits, so (they assert) the present value of benefits should be little affected by the retirement-age pattern. Several questions about that reasoning arise:

1. Because the present values (that is, the summarized cost rate) do not include benefit payments beyond the 75-year projection period, the actuarial equivalence argument does not fit the actual procedure used.

2. The year-by-year cost rates could be affected, even if benefits are exactly actuarially equivalent. Consider an extreme example: all retirees commence benefits at age 62 as compared with all at age 70 -- clearly there would be substantially different annual costs during the initial eight years, and the differences would decrease but not disappear during the remaining lifetime of the retirees.

3. The actuarial-equivalence concept presumes a fixed earnings history. However, (as noted later) different retirement-age patterns could affect the program’s overall payroll-tax income, as well as PIA levels.

Labor-Force Participation Rates

The Panel was advised that labor-force participation rates are not directly linked to the assumed retirement-age patterns, although both of those are based on comparable economic and demographic effects. Thus, it is clear that alternative projections cause retirement-age assumptions to move in the opposite direction from labor-force participation rates at ages 62 to 70 (such as, higher retirement rates and lower labor-force participation rates). However, there is not verification that the size of these movements are comparable (presumably they would not be equal because some retirees continue to have covered earnings).
The most direct impact of labor-force-participation variation is on the program’s income rate (due to payroll tax receipts); a secondary impact is on PIA entitlements. If there is any inconsistency, however, it is not clear how that would affect the overall income and cost projections.

Projected PIA Levels

Because the PIA is not proportional to covered earnings, future benefit levels are not projected in the aggregate using assumed average levels. Instead, PIA levels are projected using a distribution of individual lifetime earnings records (involving changing proportions of data from past and future years).

The projection involves several interrelated complex procedures, which were orally explained several times by the SSA actuaries, supplemented by sample computer results. There is not a comprehensive written description for the long-range projection procedure; however, it seems quite similar to the short-range procedure described in Actuarial Study No. 104.

Historical trends are extrapolated, with modifications to reflect program changes. However, the assumed effect of the scheduled changes in the full-benefit retirement age is unclear. How do the assumed changes in retirement age patterns affect the projected earnings records? These assumptions, and their implications, have not been evaluated by SSA.

Sensitivity

For each of the above items, the final question is "What would be the effect on the overall financial projections?"

If the assumptions and procedures were changed in some reasonable way, how would the projected annual costs (which depend on benefit levels adjusted for commencement age, rather than just the PIA), annual income (especially payroll-tax receipts), and actuarial balance results be affected?

Although other assumptions have been tested for sensitivity effect, those related to retirement age have not been tested by SSA.
IX. PRESENTATION OF LONG-TERM STATUS OF THE TRUST FUNDS

Evaluation of the long-range status should put less emphasis on the "75-year actuarial balance" and the "test of long-range close actuarial balance."

The Panel does not recommend any change in the 75-year projection period, or in the concept of the 100 percent Trust Fund Ratio as an adequate contingency reserve.

The 75-year actuarial balance is an overall measure of changes in financial status, but should be less emphasized as a basis for evaluating the status of the program or for designing reform proposals (especially if a substantial trust fund is to be accumulated).

The Panel suggests some revision in the presentation of annual balance projections (a different concept than the actuarial balance) and the treatment of trust fund interest.

Prior to enactment of legislation reforming the program, primary emphasis should be on the projected date that the Trust Fund Ratio would fall below 100 percent (Appendix E discusses a related technical aspect of the short-range financial adequacy test.)

When definitive legislative revisions are adopted, subsequent long-range evaluation should compare up-dated projections with the intended results of the legislation; based on the most frequently discussed proposals, such evaluation should consider whether the 75-year actuarial balance tends to decrease as the projection period moves forward; also, whether the pattern of annual balances or Trust Fund Ratio trend line departs significantly from legislative intent, or if the latter shows an apparent lack of stability beyond the 75-year valuation period. The Panel notes there is an important distinction between the financial adequacy tests appropriate for the Trustees Reports in contrast to considerations for satisfactory legislative action.

Suggestions are also provided regarding indicators of future affordability of the program.

The Panel was specifically requested to "examine alternatives to 75-year forecasts to reflect better the long-range financial soundness of the program and to make the estimates less dependent on particular timeframes." The Panel saw no compelling reason to recommend changes in the 75-year projection period, or the concept of a standard of a 100 percent Trust Fund Ratio (referred to as TFR) as an adequate target level for a contingency reserve. (See Appendix E regarding the Test of Short-Range Financial Adequacy.) The Panel has concerns related to: (1) the manner in which the 75-year Actuarial Balance is interpreted; (2) the treatment of projected net annual

54
payouts from the Trust Fund; (3) evaluation of long-term adequacy; and (4) the indicators of future affordability of the program.

75-Year Actuarial Balance

The SSA actuaries perform numerous measures of the status of the system and its projected adequacy to make payments to beneficiaries. Despite their availability in the annual Trustees Reports, and the caveats about the need for a full understanding of the financial characteristics, it is natural to use a single number to summarize the results.

Thus, primary attention is usually given, in many policy discussions and decisions, to the 75-year Actuarial Balance -- the extent to which current assets, plus taxes, interest, and other income to the trust fund are sufficient to pay benefits under current law for 75 years, and to end up with a 100 percent TFR. Unfortunately, that measure is often viewed as stating more than it does. Some people interpret the number to imply that, under reasonable assumptions, achieving actuarial balance over 75 years would make the system sound for that entire period and perhaps beyond, as long as assumptions about wage growth, birth rates, and so forth are matched by the actual experience. Even the 1995 Trustees Report states, "The size of the actuarial balance for any period represents a measure of the program's financial adequacy for that period."

Although literally true, that interpretation glosses over flows into and out of the trust funds during individual years and other portions of the 75-year period and ignores the changes in the TFR. Furthermore, even though the projection is formally done for only 75 years, the obvious ongoing trends are not indicated by considering only the Actuarial Balance.

When significant demographic changes occur, such as the upcoming drop in worker-to-retiree ratios, one does not require changes in assumptions to push this 75-year actuarial measure into imbalance. In particular, when the beginning of the 75-year period is in surplus, and the other end is in deficit, simply moving the calculation period out one year adversely affects the actuarial balance over the new 75-year period. This latter point also is noted in the 1995 Report (p. 23): it indicates an increase of 0.07 percent of taxable payroll in the actuarial deficit since the prior report, due to the time shift (and refers to a specific later portion of the report, where the reader would have to identify the "Valuation Period" entry for this effect), but it is not explicit that this source of deficit increase is expected to continue in each annual report for the indefinite future. (Prior to the mid-1960s, the valuation period was infinity; this largely avoided the problem of the foregoing time shift but had other disadvantages.)
Because legislative change inevitably involves significant lead time (for enactment and then to be put into effect), another consequence of the moving-valuation-period effect is that the Actuarial Balance shown in any Report is likely to understate the financial correction that will have to be implemented.

Therefore, the Panel concluded that the Actuarial Balance is an overall measure to indicate changes in the status of the program, but it should be less emphasized as the basis for evaluating the status of the program or for designing reform proposals. For the latter purposes, it is necessary to emphasize the following additional considerations.

**Annual Balances and the Trust Funds**

The Annual Balances (a concept different from the Actuarial Balance discussed above) essentially show the income minus the outgo of the system during a full year, excluding interest from the assets of the trust funds. A positive annual balance clearly implies trust fund increase for that year, but the change in the TFR will depend also on the growth rate of outgo.

On the other hand, a negative Annual Balance does not necessarily imply decrease in either the trust funds or the TFR for that year. For example, current projections indicate that maintaining the TFR at a fairly stable level toward the end of the 75-year projection period (and presumably beyond that for an extended period) would be consistent with negative Annual Balances during those years, because interest earnings of the trust funds should exceed the amount needed for annual increases in the trust funds.

Furthermore, analysis by the SSA actuaries of proposals considered by the Advisory Council indicates that the size of such "stabilizing" negative Annual Balances increases if the TFR is to be stabilized at a higher level, or if the interest earnings rate of the trust funds is larger. More generally, because of the expected demographic pattern, it is quite likely that, when program reform is enacted, it will be intended for the TFR to increase, and then decrease before stabilizing. That pattern almost certainly would imply that some negative annual balances are planned to occur.

The Panel recognized that the Annual Balance measure is a significant indicator of the interaction between the OASDI program and the rest of the economy. With the trust fund investments confined to government bonds, as under current law, a positive (or negative) Annual Balance means that funds are available for (or withdrawn from) other than current federal activity. Some members of the Panel are quite concerned

---

22 There is intrayear use of such interest as well as principal repayments, but that is not significant for this analysis.
about these implications of negative Annual Balances, while others believe that those balances will be absorbed in the usual course of federal budget activity.

Despite these different views, and a unanimous conclusion that the interaction between OASDI and the remainder of the economy (private and public) needs considerable additional study, the Panel agreed that a financially sound OASDI program can have negative Annual Balances. Therefore, the Panel concluded that the long-range analysis of the Trustees Reports should indicate the extent to which redemptions from the investments of the trust funds and the investment income thereof are intended to finance some of the benefit outgo of the program. The source of such payments should be provided -- for example, interest vs. principal redemption, with additional categorization if different types of investments are used.

Currently, the Trustees Reports use fairly subtle distinctions to indicate how trust fund interest is treated. For instance, "income" includes interest, whereas "income rate" excludes interest; "summarized income rate" and "summarized cost rate" are on a present value basis and, therefore, reflect interest. The Panel realizes that readers need to see receipts or income without interest, and also with interest. The Panel recommendation is that terms be adopted that more quickly alert the reader as to whether interest is included or not, such as "Payroll Tax and General Revenue Transfers, Excluding (Including) Interest" or "Income, Excluding (Including) Interest." The Panel is not wedded to the precise terms adopted, only that they be clearer immediately to the reader as to the assumptions being made about interest.

**Evaluation of Long-Term Adequacy**

The Trustees Reports place considerable emphasis on the Test of Long-Range Close Actuarial Balance (referred to here as the Test). Although this Test provides a vast amount of detail, reflecting the results of computations for each of 66 valuation periods, the information content is not clear.

Under current circumstances, for example, in the 1995 Trustees Report, the shortest period that produces unsatisfactory results using the Test is not substantially different than the estimated time until the trust fund would be exhausted:

<table>
<thead>
<tr>
<th>Trust Fund</th>
<th>Using the Test</th>
<th>Trust Fund Exhausted</th>
</tr>
</thead>
<tbody>
<tr>
<td>OASI</td>
<td>2030</td>
<td>2031</td>
</tr>
<tr>
<td>DI</td>
<td>2009</td>
<td>2016</td>
</tr>
<tr>
<td>OASDI</td>
<td>2028</td>
<td>2030</td>
</tr>
</tbody>
</table>

The Panel considers the estimated date of exhaustion of the trust fund (or perhaps the first year of decrease below 100 percent TFR) to be more relevant, especially because
the Test involves more arbitrary comparisons. Of course, as more fully discussed in the section on Uncertainty of Projections, the dates noted cannot be considered as definitive.

On the other hand, if program reform is designed (as indicated by many of the proposals under consideration, including those by the Advisory Council) to accumulate a TFR well in excess of 100 percent for extended time periods, a Test that involves a projected 100 percent TFR at the end of each interim time period would not give useful indication of whether the actual change that occurs in the program status and projections is satisfactory.

Therefore, prior to the time that program reform is enacted, the Panel recommends that the primary focus of program adequacy be the date that the Trust Fund Ratio for OASDI is projected to fall below 100 percent (currently estimated at 2025 for the intermediate-cost estimates). After specific reform provisions are enacted, a new long-range test should be developed to provide early warning if updated projections indicate that:

- The 75-year Actuarial Balance shows a tendency to deteriorate as the projection period moves forward.
- The pattern of Annual Balances departs significantly from that intended in the legislation.
- The TFR trend line departs significantly from that intended in the legislation during the projection period, or if the apparent subsequent trend thereafter (which should be considered even though the formal projection period is not extended) indicates lack of relative stability.

The Panel also emphasizes the distinction between various financial adequacy tests appropriate for the Trustees Reports versus considerations for satisfactory legislative action. Legislated revisions should involve projections that indicate desired target levels (however defined) are likely to be met. On the other hand, the Trustees Reports reflect the actual experience that occurs subsequent to such legislation; because of statistical variation, that can be expected occasionally to show less satisfactory results than were projected. Thus, it is appropriate for the Trustees Reports to use less stringent tests (than the legislative ones), provided they give warning if the legislative targets are not likely to be achieved within a reasonable period of time.

---

23 This refers to the linear comparison (from 0 percent to 5 percent, over 66 years) and to using Actuarial Balance as percentage of cost rate as the key variable.
Indicators of Future Affordability of the Program

In calculating effects of changes in the OASDI program, the SSA actuaries already distinguish among productivity changes, compensation/GDP, earnings/compensation, hours/week, GDP deflator/CPI, and real wages. Nonetheless, the Panel believes that some of the implications of these differences should be displayed in a manner that might better reveal the changes in the program over time. For example, the cost rate is shown as a percentage of taxable payroll -- a quite useful calculation. Nonetheless, the Panel recommends showing costs/GDP (now shown in Table III.C1 of the 1995 Trustees Report) when costs/taxable payroll are demonstrated, and cost/compensation when cost/wages are shown (as in a modified Table III.C2).
X. RESEARCH AND OTHER MATTERS

The Panel recommends a substantial expansion of SSA's research capabilities, using additional inhouse resources as well as outside consultants and contractual research. The prior (1990-91) Panel suggested an extensive list of research topics, many of which are still relevant; therefore, just a few topics are highlighted in this report, but the important question of methodology is also discussed. The gradual erosion of support for the Office of the Actuary and the Office of Research and Statistics, in particular, pose fundamental problems to the system as a whole. These Offices operate with only a very small fraction of the resources that would be made available in private insurance companies and actuarial consulting firms to study matters of importance to clientele. Adequate funding and organizational support for these Offices are vital to the long-term status and effectiveness of the Social Security Administration.

To ensure periodic review and that the most appropriate assumptions and techniques are used for projections of the operations of the trust funds and other policy purposes, the Panel recommends that:

1. Technical panels be appointed periodically (at least once every 5 years) to conduct comprehensive reviews of the assumptions and methods;

2. An ongoing advisory committee of experts be established to provide, on an as-needed basis, advice on specific matters; and

3. The SSA develop procedures to enable the staff easily to contract for extramural research and expert analysis to supplement ongoing staff activities.

The Panel believes that the ability of policy makers and the public to deal with important Social Security issues can be influenced significantly by the information made available to them. For example, proposed reforms being considered by the Advisory Council and others confirm the importance of research about their distributional effects.

Work and Demographic Histories

Analysis of many important questions facing the Social Security system would be improved by individual work and demographic histories. For example, changes in the distribution of earnings and income among individuals will have different effects on the trust funds depending upon whether they reflect permanent changes in resources or just transitory
fluctuations. Similarly, the lifetime history of marriage, divorce, fertility, and employment for various individuals will affect the distribution of benefits and contributions, as well as their totals, in a way that cannot be captured with just averaged data. A clear priority for Social Security research is therefore to assemble individual work and demographic histories, and use these to forecast OASDI contributions and benefits. The SSA actuaries have begun some of this “microsimulation” work, but with inadequate time and resources.

Note that these histories may be used to estimate the actuarial impact of many types of changes in benefit formulas, spouse’s benefits, and other types of changes. For example, estimates of long-term costs and revenues to the trust funds do not take advantage of the information available from earnings histories (especially for persons not yet retired) for couples and for earnings records matched to survey data. The projected costs of the system are affected by spouse’s and widow(er)’s benefits, which in turn depend upon lifetime earning histories of married couples. Work is needed both to project lifetime earnings by persons in different cohorts by marital status, and to incorporate this information into the projection model. It is possible that a thorough evaluation of current projections making use of this kind of information would reveal some necessary changes in the projections and in the estimates of costs of policy proposals to change the benefit provisions as to calculating benefits for survivors.

In addition to making possible better projections for current and proposed law, these data allow estimation of the various distributional aspects of the tax and benefit structure, both today and for future cohorts of retirees. To perform such analysis, one needs to review the lifetime records of OASDI taxpayers and beneficiaries according to a variety of socioeconomic characteristics, including lifetime earnings, sex, race, and mortality (such as, length of benefit receipt), and family income.

As an important corollary, the Panel suggests that priority attention be given to combining existing administrative data with survey data that contain supplementary information. Such efforts can yield quite valuable information at modest costs because most of the cost of data collection has already been paid -- in the previous filing, copying, and recording of the administrative information itself. Currently, these records and their combination with other sources are not well-documented, nor can they be accessed easily to answer important questions about the impact of the OASDI program on the population.
As a final example of the usefulness of this work, real wages are currently assumed to grow at a specified rate regardless of an individual's location in the earnings distribution. Recent research in labor economics, however, examines whether the rate of growth of earnings will be lower for persons with low skills and education than for persons currently near the top of the earnings distribution. These types of important economic phenomena currently are not built into the projections nor into assessment of the future benefit structure and the potential distributional impact of the program as a whole.

**Mortality Data**

Compared with Western European countries, the United States has perhaps the poorest quality data on mortality from vital statistics, especially with respect to age reporting. Social Security records of the deaths of beneficiaries, however, offer a wealth of underutilized mortality data. These data could be used to address questions about mortality level and trends, and socioeconomic and occupational differentials in mortality. Tabulations and analyses of these data would, in turn, help improve mortality and population projections at older ages.

More generally, the Panel also recommends further research into the ultimate rates of mortality decline at all ages and methods of projecting such rates. This research would include the detailed examination of recent changes in the U.S., changes in other low-mortality countries, and opinions of a range of experts about the potential for future change.

**Cohort Patterns**

The Panel recommends that the SSA actuaries should devote more research attention to cohort patterns, especially in labor-force participation, fertility, and marriage and divorce projections, to supplement time-series observations. In particular, the financial impact of alternative female labor force participation assumptions should be more fully analyzed. In addition, more attention should be devoted to examining the effects of age composition of the population on the historic patterns of various factors, to accommodate possible long-cycle effects in projections.

**Lifetime Values**

The Panel also suggests that it is useful to consider the value of OASDI benefits and contributions not simply from an annual perspective, but from a lifetime perspective. Therefore, the Panel recommends that the SSA actuaries should regularly calculate
expected lifetime value of OASDI benefits both at age 65 and the full-benefit retirement age. Changes in this value should also be calculated whenever reform proposals are being considered. Lifetime values would be calculated for various low-, average-, and high-earnings workers and, when feasible, different socioeconomic groups. An extension of this basic approach would consider lifetime value of taxes (employee only, and employee-employer combined), but at least an initial focus on benefits would measure their adequacy and how lifetime, rather than annual, benefits would be changing over time. Admittedly there are complications to communicating such estimates, especially when the system is out-of-balance, and it is unrealistic to assume that all current provisions will continue unchanged. Even if these calculations are not put into the Trustees Reports, they should be available and calculated at least yearly along with a description of changes in assumptions and laws.

Displaying All Support Systems for the Elderly and Disabled

The Panel is also concerned that programs for the elderly and the disabled are not often considered in an integrated manner, mainly because their combined impact is hardly ever displayed in an integrated fashion. The Panel believes this can distort decision making. The Panel recommends that the SSA work with the Office of Management and Budget so that regular reports are issued for the combined budgetary impacts of all programs for the elderly, and with other government research agencies in examining the combined impact of these programs on the well-being of this population. A similar approach would apply to programs for the disabled.

For the Trustees Reports themselves, the Panel recommends, at a minimum, that the combined data for OASDI, Hospital Insurance (HI), and Supplementary Medical Insurance (SMI) [and, perhaps, Supplemental Security Income (SSI) for the elderly] also be displayed together -- for instance, by showing total benefits, total payroll tax collections, and total premiums for these programs in a single chart -- perhaps as a percentage of GDP over time. Tables III.B4 and III.C1 of the 1995 Trustees Report could easily be modified to include SMI for these purposes.\(^{24}\)

Necessary Research -- General Concerns

The Panel did not examine organizational questions, such as, where the suggested research might be performed -- such as the Office of Research and Statistics.

\(^{24}\)In fact, the Summary of the 1995 Trustees Report (page 9) shows such combined data for selected years.
or the Office of the Actuary; there was some concern that the Office of the Actuary should continue to give priority attention to cost estimates, without trying to estimate the lifetime distributional impacts.

It is common for Social Security technical panels to call for additional research, when feasible. The Panel is not merely continuing that practice; rather there is concern that the ability of policy makers to make future reform choices in a considered manner and to meet various standards of equity, efficiency, and cost-effectiveness is seriously compromised by the lack of research on issues that have important bearing on those choices.

Access to Data by Private Researchers

The majority of the Panel believes that, in many cases, costs could be kept to a minimum, while the value of research could be increased substantially, if research with Social Security data could be more easily conducted by private researchers. There are at least two steps in this process.

First, there may be legal requirements, particularly for access to tax data, to be dealt with; new legislation may be useful. Confidentiality must be protected. The Panel believes that this is possible through a variety of mechanisms. Among others, outside researchers might be required to take the same pledges as government workers.

Second, the data must be adequately documented, whether for use by internal or external researchers. Many data are collected and essentially thrown away when not saved in a useful format for future research and analysis. Greater use of academics on temporary assignment or of internships could also bring more personnel into the system, but, again, only if the files are already documented and ready for use. Computer technology also will permit researchers, such as graduate students to undertake projects at their academic location. SSA specialized staff would have to be expanded to facilitate outside researchers' use of these data.

In any case, the relative paucity of research on vital Social Security and retirement issues is related to the inability to better integrate private researchers into Social Security research and to inadequate access to important data.

Future Panels

As noted earlier in this report, the Panel was authorized by the Quadrennial Advisory Council on Social Security, which was established under the Social Security Act. With the establishment of the Social Security Administration as an independent
agency by the Social Security Independence and Program Improvements Act of 1994 (P.L. 103-296), quadrennial Advisory Councils were replaced by a permanent Advisory Board. Thus, periodic review of assumptions and methods are not routinized under the new structure.

The inherent complexity of the OASDI program demands that the internal procedures be subject to periodic independent review. Furthermore, the usual desire to maintain consistency with prior techniques, often by making marginal changes in major computer models, and the relatively small size of the technical staff, make it very difficult for that staff to keep up with, evaluate, and implement new developments in related fields.

The value of such overall reviews by a panel -- such as the current one -- of experts from related fields, but generally not familiar with the details of OASDI procedures, is not limited to the formal recommendations that result. On several occasions during the current Panel's activity, SSA staff members commented that the need to explain carefully many "routine procedures," and to consider questions and comments from the Panel, caused the staff to reconsider those matters and to identify items for future study. For example, questions about labor force participation rates and preliminary cohort-based analysis by a member of the Panel revealed that such analysis was in use to some extent, but should be more fully considered.

At the same time, the advantages of periodically assembling such a new group of experts means that considerable effort is needed to become familiar with the wide range of OASDI provisions and procedures, so this Panel and prior technical panels have required a lengthy period to produce any formal recommendations. The SSA actuaries need more than that, because a major part of their activity is to respond to requests for estimates related to legislative proposals. Such requests usually involve short deadlines, and often become an interactive exercise with modifications proposed as the actuarial estimates become available.

Here again, the desire to maintain consistency with the annual projection procedures, and to use estimating techniques compatible with the main computer model, can result in too limited an examination of the issues and inadequate documentation of the estimating procedures. Of course, not every proposal needs a full-blown estimating procedure; many times "quickie" techniques, with minimal documentation, are appropriate. But when there are proposals for substantial changes, they should be more carefully and broadly considered, especially if they are perennially suggested.
The Panel believes, and several members of the SSA staff indicated agreement, that it would be helpful to have an ongoing group of experts who would maintain familiarity with OASDI and the related procedures for making estimates and would be available for ad hoc advice on specific matters. Unlike the previously described periodically established panels, this ongoing group -- with gradually changing membership -- could meet every six months or so (as well as receive interim materials from SSA), stay in touch with procedural developments, and be available for ad hoc consultation on an individual or group basis for advice regarding the proposals that SSA is asked to evaluate. The Office of the Actuary of the Health Care Financing Administration accomplishes this objective, using a contract with an actuarial consulting firm.

While some expenses are to be expected in connection with such an ongoing arrangement, it also seems reasonable that, to the extent that law permits, some pro bono activity should be available; presumably that could be arranged through the professional societies of actuaries, demographers, and economists, as well as through organizations such as the National Academy of Social Insurance.

Nevertheless, advice from outside experts and research support cannot be a substitute for the development of internal staff capabilities and maintenance of procedural documentation and other aspects of institutional memory. The Panel concluded that SSA has too few technical staff and related resources and recommends a significant increase in those.
APPENDIX A

Demographic Results from SSASIM, a Long-Run Stochastic Simulation Model of Social Security* 

Martin R. Holmer†
HR&A
May 16, 1995

*This research has been conducted as part of the activities of the 1994-95 Social Security Advisory Council's Technical Panel on Assumptions and Methods. Valuable assistance on model design and data have been provided by Steve Goss, Deputy Chief Actuary, Social Security Administration, and by Rick Foster, Chief Actuary, Health Care Financing Administration.

†Principal, HR&A Inc., 1156 15th Street, NW, Suite 1202, Washington, DC 20005 (voice: 202-986-0050, fax: 202-986-0052. email: holmer@digex.net).
Contents

1 Model Overview .................................................. A-4
   1.1 Model Rationale ........................................... A-5
   1.2 Model Architecture ....................................... A-6
       1.2.1 Assumptions Module .................................. A-7
       1.2.2 Population Module .................................... A-8
       1.2.3 Other Modules ....................................... A-9

2 Non-Stochastic Model Validation Runs ................................ A-12
   2.1 Intermediate-Cost Alternative .......................... A-12
   2.2 Low-Cost Alternative ..................................... A-16
   2.3 High-Cost Alternative .................................... A-20

3 Low-Uncertainty Stochastic Runs ................................ A-24
   3.1 Trustees Report’s Perfect Correlation ................ A-25
   3.2 Zero Correlation ......................................... A-27
   3.3 Only Negative Fertility-Immigration Correlation ..... A-29

4 Higher-Uncertainty Stochastic Runs ................................ A-34
   4.1 Trustees Report’s Perfect Correlation ................ A-35
   4.2 Zero Correlation ......................................... A-38
   4.3 Only Negative Fertility-Immigration Correlation ..... A-40

List of Figures

1 Client/Server Architecture of SSASIM .......................... A-6


5 Population Projections from SSASIM Run I and 1994 Trustees Report Low-Cost Alternative I ................ A-17


### List of Tables

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Total Dependency Ratio Projections from SSASIM Run 1 and 1994 Trustees Report Low-Cost Alternative I</td>
<td>A-19</td>
</tr>
<tr>
<td>8</td>
<td>Population Projections from SSASIM Run 3 and 1994 Trustees Report High-Cost Alternative III</td>
<td>A-21</td>
</tr>
<tr>
<td>10</td>
<td>Total Dependency Ratio Projections from SSASIM Run 3 and 1994 Trustees Report High-Cost Alternative III</td>
<td>A-23</td>
</tr>
<tr>
<td>11</td>
<td>Aged Dependency Ratio Distribution from SSASIM Run 21</td>
<td>A-26</td>
</tr>
<tr>
<td>12</td>
<td>Aged Dependency Ratio Distribution from SSASIM Run 20</td>
<td>A-28</td>
</tr>
<tr>
<td>13</td>
<td>Aged Dependency Ratio Distribution from SSASIM Run 22</td>
<td>A-30</td>
</tr>
<tr>
<td>14</td>
<td>2070 Population Distribution from SSASIM Run 22</td>
<td>A-31</td>
</tr>
<tr>
<td>15</td>
<td>2070 Aged Dependency Ratio Distribution from SSASIM Run 22</td>
<td>A-32</td>
</tr>
<tr>
<td>16</td>
<td>2070 Total Dependency Ratio Distribution from SSASIM Run 22</td>
<td>A-33</td>
</tr>
<tr>
<td>17</td>
<td>Aged Dependency Ratio Distribution from SSASIM Run 25</td>
<td>A-37</td>
</tr>
<tr>
<td>18</td>
<td>Aged Dependency Ratio Distribution from SSASIM Run 23</td>
<td>A-39</td>
</tr>
<tr>
<td>19</td>
<td>Aged Dependency Ratio Distribution from SSASIM Run 24</td>
<td>A-41</td>
</tr>
<tr>
<td>20</td>
<td>2070 Population Distribution from SSASIM Run 24</td>
<td>A-42</td>
</tr>
<tr>
<td>21</td>
<td>2070 Aged Dependency Ratio Distribution from SSASIM Run 24</td>
<td>A-43</td>
</tr>
<tr>
<td>22</td>
<td>2070 Total Dependency Ratio Distribution from SSASIM Run 24</td>
<td>A-44</td>
</tr>
</tbody>
</table>

**List of Tables**

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Input Distribution for SSASIM Run 2</td>
<td>A-12</td>
</tr>
<tr>
<td>2</td>
<td>Input Distribution for SSASIM Run 1</td>
<td>A-16</td>
</tr>
<tr>
<td>3</td>
<td>Input Distribution for SSASIM Run 3</td>
<td>A-20</td>
</tr>
<tr>
<td>4</td>
<td>Input and 2070 Output Distributions for SSASIM Run 21</td>
<td>A-25</td>
</tr>
<tr>
<td>5</td>
<td>Input and 2070 Output Distributions for SSASIM Run 20</td>
<td>A-27</td>
</tr>
<tr>
<td>6</td>
<td>Input and 2070 Output Distributions for SSASIM Run 22</td>
<td>A-29</td>
</tr>
<tr>
<td>7</td>
<td>Input and 2070 Output Distributions for SSASIM Run 25</td>
<td>A-35</td>
</tr>
<tr>
<td>8</td>
<td>Input and 2070 Output Distributions for SSASIM Run 23</td>
<td>A-38</td>
</tr>
<tr>
<td>9</td>
<td>Input and 2070 Output Distributions for SSASIM Run 24</td>
<td>A-40</td>
</tr>
</tbody>
</table>

*HR&A Working Paper dated May 16, 1995*
1 **MODEL OVERVIEW**

1 Model Overview

This section of the paper presents an overview of the current version of SSASIM, a long-run stochastic simulation model of Social Security. It begins with a discussion of why stochastic methods are needed for both current-law projections and policy-reform estimates. And it concludes with a description of the high-level logic of the model's assumptions and population modules.

The rest of the paper is organized into three sections. The second section presents results from a model validation exercise, in which input assumptions from the 1994 Trustees Report are used to specify three non-stochastic SSASIM runs. The demographic results from these three runs are compared to demographic results for the three alternatives reported in the Trustees Report.

The third section of the paper specifies several stochastic runs, each one of which makes the same assumptions about the means and variances of the long-run, ultimate values of the three stochastic input variables related to population (fertility, immigration, and mortality decline). To facilitate comparison with results from the Trustees Report, the three means have been set to the ultimate value used in the Trustees Report's intermediate-cost alternative. The variances of these three variables have been specified by interpreting the low-cost/high-cost alternative range as representing four standard deviations. This is equivalent to interpreting the Trustees Report range as covering about 95% of the uncertainty related to each of the three demographic input variables. All the model runs reported in this third section use these mean and variance assumptions, but they differ in their assumptions about the correlation among the three demographic input variables.

The fourth, and final, section of the paper repeats this exercise except that the variances of the demographic input variables are assumed to be larger. The variances of these three variables have been specified by interpreting the low-cost/high-cost alternative range as representing two standard deviations. This is equivalent to interpreting the Trustees Report range as covering about 67% of the uncertainty related to each of the three demographic input variables. The same group of correlation assumptions are used to get a sense of the sensitivity of model results to alternative assumptions about the correlation among input variables.
1.1 Model Rationale

Long-run Social Security current-law projections and policy-reform estimates are made in the face of substantial uncertainty about future demographic and economic developments. The use of stochastic simulation methods allows policy makers and analysts to make explicit assumptions about this uncertainty and then to generate the implied distributions for different Social Security program performance measures.

In the context of current-law projections, stochastic simulation methods provide a probabilistic foundation that supports estimation of the likelihood that program performance measures will be above or below certain levels in the future. This methodology makes explicit the genuine uncertainty facing the program and forces policy makers and analysts to specify their beliefs concerning the central tendency, variability, and correlation of the uncertain demographic and economic assumption variables. The output of a stochastic projection is a complete statistical distribution for each program performance measure rather than a point estimate of unknown representativeness.

In the context of policy-reform estimation, stochastic simulation methods provide an even greater advantage over deterministic simulation methods. It is well known by experienced policy analysts that a particular policy reform will generate different programmatic effects depending on which uncertain demographic and economic scenario is realized. Given this genuine uncertainty about the future effect of a reform, it is usually inappropriate to summarize the effect with a single number such as the mean of the distribution generated using stochastic simulation methods or the point estimate of the effect generated using single-scenario, deterministic simulation methods. This is particularly true when comparing the effects of two different policy reforms. Consider a situation in which one reform’s mean effect is considered better than another reform’s mean effect, but the second reform’s effect is much more reliable than the first’s. Comparison of the complete effect distributions for the two reforms could easily lead a risk-averse policy maker to prefer the second reform over the first. Deterministic simulation methods do not permit quantitative analysis of the risk properties of different kinds of reform, a shortcoming that is significant now and is likely to grow in importance.

Development of a new stochastic simulation model of Social Security also provides an opportunity to introduce methodological improvements in the characterization of demographic and economic dynamics as well as how the economic...
1 MODEL OVERVIEW

Effects of the program are represented in the model. In addition, development of a new model provides an opportunity to utilize modern software development techniques that permit creation of a more complex simulation while at the same time reducing the cost of model development and use.

1.2 Model Architecture

SSASIM has been implemented on a high-end personal computer with a client/server architecture as represented in Figure 1.

SSASIM consists of three computer programs: a database interface, a stochastic simulator, and an output analyzer. The model's input data have been organized as a relational database that can be easily accessed by policy analysts using a customized version of FoxPro, which provides a mouse-driven graphical interface.

The stochastic simulator is custom written using the object-oriented programming capabilities of the C++ language. It reads model input parameters and historical demographic and economic data from the relational database, performs the simulation, and writes the simulation output to text files.

These output files are formatted in a manner that allows them to be easily imported into any spreadsheet or statistical analysis program that the policy analyst wants to use as an output analyzer. This flexibility ensures that subsequent analysis of
1 MODEL OVERVIEW

the simulation output and preparation of presentation graphics is conducted with software that is well suited to the task and is familiar to the policy analyst.

The rest of this model architecture discussion describes the high-level logic of each of the major modules that comprise the stochastic simulator.

1.2.1 Assumptions Module

The model's non-policy assumptions can be divided into stochastic assumptions and non-stochastic assumptions. Input parameters associated with nonstochastic assumptions are described below in the discussion of the module in which they are used. The model has three input variables that are assumed to be stochastic: total fertility rate, net immigration flow, and mortality decline rate. The multivariate stochastic process used to generate the time paths of these variables is described here.

The model's assumptions module utilizes a very simple kind of multivariate stochastic process that produces cross-sectional correlation between the different variables, but not time-series cycles in the values of an individual variable. The time path of an individual variable is assumed to start at its last observed historical value, move to its randomly generated ultimate value over a transition period following a linear trend, and stay at that ultimate value in all years following the transition period. The ultimate values of the stochastic variables are generated for each model scenario by drawing from a multivariate normal distribution, whose mean vector and variance-covariance matrix are specified to represent the model user's expectations about the uncertainty in the ultimate values of the stochastic input variables.

It would be possible to incorporate in the assumptions module a more complex multivariate stochastic process that generates time-series cycles in addition to cross-section correlation between the trend in these variables. Foster [1] has estimated and simulated more complex univariate stochastic processes for each of four variables that are critical to the short-range projection contained in the Trustees Report. These more complex processes are able to generate for each individual variable more realistic time-series paths that exhibit cycles. Future work should give serious consideration to specifying a more complex stochastic process that combines the multivariate trend analysis used here with cyclical deviations around the long-run trend.

Despite its time-series simplicity, the multivariate stochastic process used here to model long-run trends has several advantages. First it is relatively easy to implement in
1 MODEL OVERVIEW

the model, making this modeling effort feasible in a short period of time. Second, it places relatively modest specification demands on the model user. Besides the mean and standard deviation of each variable's ultimate value, only the ultimate-value correlation coefficient for each pair of variables needs to be specified. And third, it is relatively close in spirit to the time-series path assumed in the three Trustees Report alternatives, facilitating comparison of results from those three alternative with results from this model's runs.

It may also be true that the results generated by this simple model are essentially the same as those generated by a more complex model with cyclical deviations around the long-run trends. Further work will be needed to determine the extent to which this is true.

1.2.2 Population Module

The population module generates demographic changes in the model. The population is represented by age-gender cells with age running from zero (for newborns who have not yet had their first birthday) to a maximum of one hundred-forty. The population stock at the end of the year is aged to the end of the subsequent year in three steps. First, population decrements (deaths and emigration) are experienced in each age, gender cell. Second, everyone experiences a birthday causing movement of people to their next age cell. And third, population increments (births in zero-age cells and immigration in each age-gender cell) are experienced.

Fertility. The stochastic input variable that determines the number of births is the total fertility rate. For each stochastic scenario the assumptions module generates a time path for the total fertility rate. The value of this rate in each year along that path is used to generate births among women of different ages using a constant age vector of normalized birth rates that add to one. The number of births experienced by women of a given age is the product of the non-stochastic normalized birth rate for that age and the total fertility rate for that year.

Immigration. The stochastic input variable that determines the volume of immigration is total net immigration (measured in millions per year). For each stochastic scenario the assumptions module generates a time path for the total net immigration variable with positive values representing net inflows and negative values representing net outflows. The value of this variable in each year along that path is used to generate
net immigration flows in each age-gender cell using a constant age-gender matrix of normalized net immigration flows that add to one (million). The volume of net immigration experienced by a given age-gender cell is the product of the non-stochastic normalized net immigration flow for that age-gender cell and the total net immigration value for that year.

Mortality. The stochastic input variable that determines the number of deaths is the overall mortality decline rate. For each stochastic scenario the assumptions module generates a time path for the overall mortality decline rate. The value of this rate in each year along that path is used to generate a age-gender matrix of mortality rates in the following manner. The previous year's mortality rate matrix is adjusted cell by cell using, a constant age gender matrix of relative mortality decline rates that indicate whether a cell's rate of mortality decline is above or below the overall rate. If every cell were assumed to experienced the overall rate, every element of this relative mortality rate matrix would be exactly one. Actually, middle-aged people experience rates of mortality decline that are higher than the overall rate, while the elderly rates are below the overall rate. An age-gender cell's rate of mortality decline is the product of the non-stochastic relative mortality decline rate for that cell and the overall mortality decline rate for that year. After adjusting the age-gender matrix of mortality rates from the previous year, the current matrix and the number of people in each age-gender cell are used to determine the number of deaths for that year.

All the non-stochastic input parameters used in the model have been supplied by the Social Security Administration's Office of the Actuary. The methodology employed in the model's population module is quite similar to that used by the Office of the Actuary except in the case of mortality rate adjustments. The Office of the Actuary uses cause-specific mortality rate declines, while the simpler methodology here is similar to recent work by academic demographers.

1.2.3 Other Modules

The model has been designed with the idea that, in addition to the modules describe above, it will eventually include a labor market module, a business establishment module, a product market module, a capital market module, and a Social Security Administration program (tax and benefit) module.
1 MODEL OVERVIEW

These other modules have not yet been implemented.
2 Non-Stochastic Model Validation Runs

This section presents the results of single-scenario runs that use input values equivalent to those used for the three alternatives in the 1994 Trustees Report. The purpose of these runs is to confirm that the model can generate demographic projections that are similar to those reported in the Trustees Report.

The results presented in this section show a close agreement between the 75-year time paths of the total population, the aged dependency ratio, and the total dependency ratio produced by the model and the paths reported in the Trustees Report for the low-cost, intermediate-cost, and high-cost alternatives. Most of the differences in paths is attributable to the structural differences in the two models in the mortality decline area. The Office of the Actuary models mortality and its decline using a cause-of-death approach, while SSASIM simply assumes that the each age-gender mortality rate declines at a rate that is a fixed proportion of the randomly-venerated mortality decline rate.
2 NON-STOCHASTIC MODEL VALIDATION RUNS

2.1 Intermediate-Cost Alternative

This subsection compares output from non-stochastic SSASIM run 2 with the results from the intermediate-cost alternative II from the 1994 Trustees Report.

<table>
<thead>
<tr>
<th></th>
<th>Fertility</th>
<th>Immigration</th>
<th>Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Value</td>
<td>1.90</td>
<td>0.850</td>
<td>0.60</td>
</tr>
<tr>
<td>Std Deviation</td>
<td>0.00</td>
<td>0.000</td>
<td>0.00</td>
</tr>
<tr>
<td>Correlation:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertility</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immigration</td>
<td>0.0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Mortality Decline</td>
<td>0.0</td>
<td>0.0</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 1: Input Distribution for SSASIM Run 2

The 1994 Trustees Report (pages 142-143) states that the initial value for (age-gender-weighted) mortality decline rate is 1.4% for the intermediate-cost alternative, that the mortality decline rate moves in a linear fashion to its ultimate, long-run value in twenty-five years, and that the 75-year average of the rate is 0.6%. Other material provided by the Office of the Actuary shows that the (age-gender-weighted) mortality decline rate was about 0.37% over the 1982-89 period. SSASIM Run 2 assumes an initial value of the mortality decline rate of 0.37% and an ultimate value of 0.6%. These values imply a 75-year average rate of about 0.56%, which is close to the 0.6% average mentioned in the Trustees Report. The discrepancy in initial values, however, creates some difference in the time pattern of assumed mortality decline rates.

Despite that mortality decline rate difference and other simplifications, the model's projections of total population, aged dependency ratio, and total dependency ratio (shown on the following three pages) are very close to the intermediate-cost projections shown in the 1994 Trustees Report.
Figure 2: Population Projections from SSASIM Run 2 (plain line) and 1994
Trailer Report Intermediate Cost Alternative II (marked line)
2 NON-STOCHASTIC MODEL VALIDATION RUNS

Figure 3: Aged Dependency Ratio Projections from SSASIM Run 2 (plain line) and 1994 Trustees Report Intermediate-Cost Alternative II (marked line)

A-14
Figure 4: Total Dependency Ratio Projections from SSASIM Run 2 (plain line) and 1994 Trustees Report Intermediate-Cost Alternative II (marked line)
2 NON-STOCHASTIC MODEL VALIDATION RUNS

2.2 Low-Cost Alternative

This subsection compares output from non-stochastic SSASIM run 1 with the results from the low-cost alternative I from the 1994 Trustees Report.

<table>
<thead>
<tr>
<th></th>
<th>Fertility</th>
<th>Immigration</th>
<th>Mortality Decline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Value</td>
<td>2.20</td>
<td>1.100</td>
<td>0.00</td>
</tr>
<tr>
<td>Std Deviation</td>
<td>0.00</td>
<td>0.000</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Correlation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertility</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immigration</td>
<td>0.0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Mortality Decline</td>
<td>0.0</td>
<td>0.0</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 2: Input Distribution for SSASIM Run 1

The 1994 Trustees Report (pages 142-143) states that the initial value for (age-gender-weighted) mortality decline rate is 0.7% for the low-cost alternative, that the mortality decline rate moves in a linear fashion to its ultimate, long-run value in twenty-five years, and that the 75-year average of the rate is 0.3%. Other material provided by the Office of the Actuary shows that the (age-gender-weighted) mortality decline rate was about 0.3% over the 1982-89 period. SSASIM Run 1 assumes an initial value of the mortality decline rate of 0.37% and an ultimate value of 0.0%. These values imply a 75-year average rate of about 0.06%, which is below the 0.3% average mentioned in the Trustees Report.

The demographic results from this run specification (shown on the next three pages) do not differ much from those resulting from a run (not shown here) that used exactly the same input assumptions for the mortality decline rate as used in the Trustees Report. The percent (not percentage-point) differences in the 2070 values of total population, aged dependency ratio, and total dependency ratio are 1.8, 6.2, and 2.1, indicating that Run I reported here is very similar to the model run that is produced from using, the Trustees Report assumptions about mortality decline.

Despite these differences in the mortality decline rate and other simplifications, the model's demographic projections are close to the low-cost projections shown in the 1994 Trustees Report.
Figure 5: Population Projections from SSASIM Run 1 (plain line) and 1994 Trustees Report Low-Cost Alternative I (marked line)
2 NON-STOCHASTIC MODEL VALIDATION RUNS

Figure 6: Aged Dependency Ratio Projections from SSASLM Run 1 (plain line) and 1994 Trustees Report Low-Cost Alternative I (marked line)

A-18
Figure 7: Total Dependency Ratio Projections from SSASIM Run 1 (plain line) and 1994 Trustees Report Low-Cost Alternative I (marked line)
2.3 High-Cost Alternative

This subsection compares output from non-stochastic SSASIM run 3 with the results from the high-cost alternative III from the 1994 Trustees Report.

<table>
<thead>
<tr>
<th></th>
<th>Fertility</th>
<th>Immigration</th>
<th>Mortality Decline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Value</td>
<td>1.60</td>
<td>0.700</td>
<td>1.20</td>
</tr>
<tr>
<td>Std Deviation</td>
<td>0.00</td>
<td>0.000</td>
<td>0.00</td>
</tr>
<tr>
<td>Correlation:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertility</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immigration</td>
<td>0.0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Mortality Decline</td>
<td>0.0</td>
<td>0.0</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 3: Input Distribution for SSASIM Run 3

The 1994 Trustees Report (pages 142-143) states that the initial value for (age-gender-weighted) mortality decline rate is 2.1% for the high-cost alternative, that the mortality decline rate moves in a linear fashion to its ultimate, long-run value in twenty-five years and that the 75-year average of the rate is 1.0%. Other material provided by the Office of the Actuary shows that the (age-gender-weighted) mortality decline rate was about 0.37% over the 1982-89 period. SSASIM Run 3 assumes an initial value of the mortality decline rate of 0.37% and an ultimate value of 1.2%. These values imply a 75-year average rate of about 1.06%, which is close to the 1.0% average mentioned in the Trustees Report. The discrepancy in initial values, however, creates some difference in the time pattern of assumed mortality decline rates.

Despite that mortality decline rate difference and other simplifications, the model's demographic projections (shown on the following three pages) are close to the high-cost projections shown in the 1994 Trustees Report.
2 NON-STOCHASTIC MODEL VALIDATION RUNS

Figure 3: Population Projections from SSASIM Run 3 (plain line) and 1994 Trustees Report High-Cost Alternative III (marked line)

HREA Working Paper dated May 16, 1985

A-21
Figure 9: Aged Dependency Ratio Projections from SSASIM Run 3 (plain line) and 1994 Trustees Report High-Cost Alternative III (marked line).
2 NON-STOCHASTIC MODEL VALIDATION RUNS

Figure 10: Total Dependency Ratio Projections from SSASIM Run 3 (plain line) and 1994 Trustees Report High-Cost Alternative III (marked line).

3 LOW-UNCERTAINTY STOCHASTIC RUNS

3 Low-Uncertainty Stochastic Runs

This section presents SSASIM results from three multiple-scenario runs that use different, but closely related, input distributions. All three runs assume mean values equal to the ultimate values in the intermediate-cost alternative II from the 1994 Trustees Report. All three runs assume standard deviations that are consistent with the assumption that the Trustees Report lowcost/high-cost range is equal to four standard deviations (i.e., that this range represents a 95% confidence interval). The assumed correlation between the input variables differ across the runs and are described below. All three runs generate output for 1,000 stochastic scenarios beginning in 1993 and ending in 2070.

It should be stressed that the variances assumed here are based on one of many possible probabilistic interpretations of the three alternatives in the Trustees Report. No empirical work has been undertaken to assess the plausibility of these variances or of the assumed means, and therefore, the degree of realism in these assumptions is not known.

Since this interpretation assumes that the low-cost/high-cost range represents almost all (95 percent) of the uncertainty in the ultimate values of the three demographic input variables, these are relatively low-uncertainty assumptions. The fourth section of the paper offers a different subjective interpretation of the same three alternatives that produces higher-uncertainty assumptions.

The low-uncertainty assumptions have been combined with different correlation assumptions that are described along with the low-uncertainty results in the rest of this section.
3.1 Trustees Report's Perfect Correlation

This subsection presents the input and output from SSASIM run 21, which assumes the perfect correlation implicit in the Trustees Report's definition of the low-cost and high-cost alternatives. The assumed correlation coefficients reflect the Trustees Report assumption that all three demographic input variables simultaneously move to their low-cost ultimate values in the low-cost alternative and that all three simultaneously move to their high-cost ultimate values in the high-cost alternative. These kinds of variations, in which everything, woe in a low-cost (high-cost) direction at the same time, can occur only if the variables are perfectly correlated. The Office of the Actuary does not present these two alternatives as necessarily realistic, but more as "stress tests" with unknown occurrence probabilities.

<table>
<thead>
<tr>
<th></th>
<th>Fertility</th>
<th>Immigration</th>
<th>Mortality Decline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Value</td>
<td>1.90</td>
<td>0.850</td>
<td>0.60</td>
</tr>
<tr>
<td>Std Deviation</td>
<td>0.15</td>
<td>0.100</td>
<td>0.30</td>
</tr>
<tr>
<td>Correlation:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertility</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immigration</td>
<td>1.0</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Mortality Decline</td>
<td>-1.0</td>
<td>-1.0</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Population</th>
<th>Aged Dep Ratio</th>
<th>Total Dep Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Value</td>
<td>368.0</td>
<td>40.8</td>
<td>83.3</td>
</tr>
<tr>
<td>Std Deviation</td>
<td>38.0</td>
<td>6.3</td>
<td>2.3</td>
</tr>
<tr>
<td>Correlation:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aged Dep Ratio</td>
<td>-0.98</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Total Dep Ratio</td>
<td>-0.89</td>
<td>0.96</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 4: Input and 2070 Output Distributions for SSASIM Run 21

Notice how the negative correlation between mortality decline, on the one hand, and fertility and net immigration, on the other hand, produce a strong negative correlation between the total population and the dependency ratios.
3 LOW-UNCERTAINTY STOCHASTIC RUNS

Figure 11: Aged Dependency Ratio Distribution from SSASIM Run 21


A-26
3 LOW-UNCERTAINTY STOCHASTIC RUNS

3.2 Zero Correlation

This subsection presents the input and output from SSASIM run 20, which assumes no correlation between the ultimate values of the three demographic input variables. This zero-correlation assumption is completely arbitrary. No empirical work has been undertaken to determine the realism of this assumption. This assumption is presented so that the sensitivity of demographic results to the assumed degree of correlation among the input variables can be determined.

<table>
<thead>
<tr>
<th></th>
<th>Fertility</th>
<th>Immigration</th>
<th>Mortality Decline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Value</td>
<td>1.90</td>
<td>0.850</td>
<td>0.60</td>
</tr>
<tr>
<td>Std Deviation</td>
<td>0.15</td>
<td>0.100</td>
<td>0.30</td>
</tr>
<tr>
<td>Correlation:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertility</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immigration</td>
<td>0.0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Mortality Decline</td>
<td>0.0</td>
<td>0.0</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Population</th>
<th>Aged Dep Ratio</th>
<th>Total Dep Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Value</td>
<td>368.2</td>
<td>40.5</td>
<td>83.0</td>
</tr>
<tr>
<td>Std Deviation</td>
<td>38.2</td>
<td>4.3</td>
<td>2.4</td>
</tr>
<tr>
<td>Correlation:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aged Dep Ratio</td>
<td>-0.69</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Total Dep Ratio</td>
<td>0.36</td>
<td>0.39</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 5: Output and 2070 Output Distributions for SSAIM Run 20

In comparison to the perfect-correlation results reported in Table 4 on page 25, these zero-correlation results show much less strong correlation among the three demographic output variables. Only the variance of the aged dependency ratio is noticeably lower than in the perfect-correlation case.
3 LOW-UNCERTAINTY STOCHASTIC RUNS

Figure 12: Aged Dependency Ratio Distribution from SSASIM Run 20

*HR&A Working Paper dated May 16, 1995*

A-28
3.3 Only Negative Fertility-Immigration Correlation

This subsection presents the input and output from SSASIM run 22, which assumes no correlation between the ultimate values of the three demographic input variables except for a -0.5 correlation coefficient between the ultimate values of the total fertility rate and net immigration. No empirical work has been undertaken to determine the realism of this assumption. The assumption is presented so that the sensitivity of demographic results to the assumed decree of correlation among the input variables can be determined.

<table>
<thead>
<tr>
<th></th>
<th>Fertility</th>
<th>Immigration</th>
<th>Mortality Decline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Value</td>
<td>1.90</td>
<td>0.850</td>
<td>0.60</td>
</tr>
<tr>
<td>Std Deviation</td>
<td>0.15</td>
<td>0.100</td>
<td>0.30</td>
</tr>
<tr>
<td>Correlation:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertility</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immigration</td>
<td>-0.5</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Mortality Decline</td>
<td>0.0</td>
<td>0.0</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Population</th>
<th>Aged Dep Ratio</th>
<th>Total Dep Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Value</td>
<td>368.1</td>
<td>40.4</td>
<td>82.9</td>
</tr>
<tr>
<td>Std Deviation</td>
<td>33.8</td>
<td>4.2</td>
<td>2.4</td>
</tr>
<tr>
<td>Correlation:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aged Dep Ratio</td>
<td>-0.65</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Total Dep Ratio</td>
<td>0.45</td>
<td>0.34</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 6: Input and 2070 Output Distributions for SSASIM Run 22

These results are quite similar to the zero-correlation results reported in Table 5 on page 27, indicating that the change in the fertility-immigration correlation coefficient from 0.0 to -0.5 has little effect.

Notice that the variance across scenarios in the total dependency ratio is substantially less than that of the aged dependency ratio, even though a scale difference between the two charts tends to obscure that result.
3 LOW-UNCERTAINTY STOCHASTIC RUNS

Figure 14: 2070 Population Distribution from SSASIM Run 22


A-30
Figure 13: Aged Dependency Ratio Distribution from SSASIM Run 22

A-31
3 LOW-UNCERTAINTY STOCHASTIC RUNS

Figure 15: 2070 Aged Dependency Ratio Distribution from SSASIM Run 22


A-32

A-32
3 LOW-UNCERTAINTY STOCHASTIC RUNS

Figure 16: 2070 Total Dependency Ratio Distribution from SSASIM Run 22


A-33
4 HIGHER-UNCERTAINTY STOCHASTIC RUNS

4 Higher-Uncertainty Stochastic Runs

This section presents SSASIM results from three multiple-scenario runs that use different, but closely related, input distributions. All three runs assume mean values equal to the ultimate values in the intermediate-cost alternative II from the 1994 Trustees Report. All three runs assume standard deviations that are consistent with the assumption that the Trustees Report lowcost/high-cost range is equal to two standard deviations (i.e., that this range represents a 67% confidence interval). The assumed correlation between the input variables differ across the runs and are described below. All three runs generate output for 1,000 stochastic scenarios beginning in 1993 and ending in 2070.

It should be stressed that the variances assumed here are based on one of many possible probabilistic interpretations of the three alternatives in the Trustees Report. No empirical work has been undertaken to assess the plausibility of these variances or of the assumed means, and therefore, the degree of realism in these assumptions is not known.

Since this interpretation assumes that the low-cost/high-cost range represents only about two-thirds of the uncertainty in the ultimate values of the three demographic input variables, these are higher-uncertainty assumptions relative to those assumed in the previous section of the paper.

The higher-uncertainty assumptions have been combined with different correlation assumptions that are described along with the higher-uncertainty results in the rest of this section.
4 HIGHER-UNCERTAINTY STOCHASTIC RUNS

4.1 Trustees Report’s Perfect Correlation

This subsection presents the input and output from SSASIM run 25, which assumes the perfect correlation implicit in the Trustees Report’s definition of the low-cost and high-cost alternatives. The assumed correlation coefficients reflect the Trustees Report assumption that all three demographic input variables simultaneously move to their low-cost ultimate values in the low-cost alternative and that all three simultaneously move to their high-cost ultimate values in the high-cost alternative. These kinds of variations, in which everything, goes in a low-cost or in a high-cost direction at the same time, can occur only if the variables are perfectly correlated. The Office of the Actuary does not present these two alternatives as necessarily realistic, but rather as “stress tests” with unknown occurrence probabilities.

<table>
<thead>
<tr>
<th></th>
<th>Fertility</th>
<th>Immigration</th>
<th>Mortality Decline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Value</td>
<td>1.90</td>
<td>0.850</td>
<td>0.60</td>
</tr>
<tr>
<td>Std Deviation</td>
<td>0.30</td>
<td>0.200</td>
<td>0.60</td>
</tr>
<tr>
<td>Correlation:</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Fertility</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immigration</td>
<td>1.0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Mortality Decline</td>
<td>-1.0</td>
<td>-1.0</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 7: Input and 2070 Output Distributions for SSASIM Run 25

The standard deviations of the input variables assumed in this section are twice the size of those assumed in the previous section of the paper. While the estimated means of the three demographic output variables are basically the same as those reported in Table 4 on page 25, the standard deviation of the 2070 total population is about twice of that in the previous section, the standard deviation of the aged dependency ratio is
4 HIGHER-UNCERTAINTY STOCHASTIC RUNS

about two and one-quarter times larger, and the standard deviation of the total
dependency ratio in 2070 is about three times larger. This relatively large increase in the
variability of the total dependency ratio seems to be an artifact of the perfect-correlation
assumption, as will be seen below.
Figure 17: Aged Dependency Ratio Distribution from SSASIM Run 25
4 HIGHER-UNCERTAINTY STOCHASTIC RUNS

4.2 Zero Correlation

This subsection presents the input and output from SSASIM run 23, which assumes no correlation between the ultimate values of the three demographic input variables. This zero-correlation assumption is completely arbitrary. No empirical work has been undertaken to determine the realism of this assumption. This assumption is presented so that the sensitivity of demographic results to the assumed degree of correlation among the input variables can be determined.

<table>
<thead>
<tr>
<th></th>
<th>Fertility</th>
<th>Immigration</th>
<th>Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Value</td>
<td>1.90</td>
<td>0.850</td>
<td>0.60</td>
</tr>
<tr>
<td>Std Deviation</td>
<td>0.30</td>
<td>0.200</td>
<td>0.60</td>
</tr>
<tr>
<td><strong>Correlation:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertility</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Immigration</td>
<td>0.0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Mortality Decline</td>
<td>0.0</td>
<td>0.0</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 8: Input and 2070 Output Distributors for SSASIM Run 23

Under the zero-correlation assumption, the standard deviations of the three output variables are all about twice those reported in Table 5 on page 15.
Figure 18: Aged Dependency Ratio Distribution from SSASIM Run 23
4 HIGHER-UNCERTAINTY STOCHASTIC RUNS

4.3 Only Negative Fertility-Immigration Correlation

This subsection presents the input and output from SSASIM run 24, which assumes no correlation between the ultimate values of the three demographic input variables except for a -0.5 correlation coefficient between the ultimate values of the total fertility rate and net immigration. No empirical work has been undertaken to determine the realism of this assumption. The assumption is presented so that the sensitivity of demographic results to the assumed decree of correlation among the input variables can be determined.

<table>
<thead>
<tr>
<th></th>
<th>Fertility</th>
<th>Immigration</th>
<th>Mortality Decline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Value</td>
<td>1.90</td>
<td>0.850</td>
<td>0.60</td>
</tr>
<tr>
<td>Std Deviation</td>
<td>0.30</td>
<td>0.200</td>
<td>0.60</td>
</tr>
<tr>
<td>Correlation:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertility</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immigration</td>
<td>-0.5</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Mortality Decline</td>
<td>0.0</td>
<td>0.0</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Population</th>
<th>Aged Dep Ratio</th>
<th>Total Dep Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Value</td>
<td>371.4</td>
<td>41.2</td>
<td>83.8</td>
</tr>
<tr>
<td>Std Deviation</td>
<td>68.4</td>
<td>8.7</td>
<td>5.2</td>
</tr>
<tr>
<td>Correlation:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aged Dep Ratio</td>
<td>-0.63</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Total Dep Ratio</td>
<td>0.40</td>
<td>0.42</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 9: Input and 2070 Output Distributions for SSASIM Run 24

The results here are quite similar to those of the previous run and the standard deviations of the three output variables are all about twice those reported in Table 6 on page 29.

Notice that the variance across scenarios in the total dependency ratio is substantially less than that of the aged dependency ratio, even though a scale difference between the two charts tends to obscure that result.
Figure 19: Aged Dependency Ratio Distribution from SSASIM Run 24
Figure 20: 2070 Population Distribution from SSASIM Run 24
Figure 21: 2070 Aged Dependency Ratio Distribution from SSASIM Run 24
4 HIGHER-UNCERTAINTY STOCHASTIC RUNS

Figure 22: 2070 Total Dependency Ratio Distribution from SSASIM Run 24
REFERENCES

References

APPENDIX B

Stochastic Simulation of the Financial Status
of the Social Security Trust Funds in the Next 75 years

May, 1995

Michael Sze

Technical Panel on Assumptions and Methods
1994-95 Social Security Advisory Council

The author gratefully acknowledges assistance provided by the staff of the Social Security Administration and the Advisory Council, and helpful comments from Barnet N. Berin, Robert L. Brown, Richard S. Foster, Stephen C. Goss, Robert J. Myers, Marc M. Twinney, Jr., Howard Young, and the members of the Technical Panel on Assumptions and Methods 1994-95 Social Security Advisory Council.
Contents

1. Introduction
2. Method and Assumptions
3. Baseline Projection
4. Sensitivity Test
5. Conclusion
6. Appendices
   A. Actuarial Assumptions
Introduction

Today's world is filled with uncertainty. Unclear about the factors contributing to crises, we react erratically to our unfounded apprehensions. Only through a careful scientific analysis of all the critical factors underlying our problems are we able to dispel the cloud of misconception and formulate constructive solutions.

In recent debates on Social Security, we often hear such sensational remarks as:

"The Social Security Trust Funds will be exhausted in 2030."

These remarks are usually based on projection results under the Alternative II scenario in the 1995 Trustee Report of the Federal Old-Age and Survivors Insurance and the Federal Disability Insurance Trust Funds. Inasmuch as the Alternative II scenario is only an educated guess of future events, the chance of all events unfolding exactly as predicted is negligible. Consequently, whether the Trust Fund will be so depleted in 2030, for example, is highly questionable.

A more realistic approach is to study the chance of exhaustion of the Trust Funds by any given year. A stochastic simulation which analyzes the effect on Social Security funding from numerous combinations of future economic and demographic trends is best suited for such a task. The purpose of this paper is to explain the stochastic simulation process and to illustrate how it can be used to study the financial status of the Social Security Trust Funds in the next 75 years. This process will result in a more reasonable prediction of the possible range of the future funded status of the Trust Funds.
Background

The financial status of the Social Security program is evaluated by means of a 75-year projection of the income and expenditures of the system. Based on such a projection, the net income (the excess of tax and investment income over benefit payments and other expenses) is estimated for each year in the projection period. The estimated trust fund balance at the end of each year is equal to that at the beginning of the year plus the net income for the year. The actuarial balance for each interim projection period is the excess of the present value on January 1, 1995, of tax income during the period plus the initial trust fund assets over the present value of expenditures during the period plus the reserve at the end of the period (the last present value is called the summarized cost rate). The three items listed above (the net income, the trust fund balance, and the actuarial balance) are often used as measures of the funded status of the Social Security System. The System is considered well funded if there is a positive net income every year. The trust fund is inadequately funded if the trust fund balance exhibits decreasing trends. The system would be broke if the trust fund balance is zero or negative. The actuarial balance is an aggregate measure of the funding adequacy during an interim projection year. A positive actuarial balance signifies that in the aggregate there is more income than outgo during the interim projection period. A negative actuarial balance indicates more outgo than income. The projection forms an integral part of the annual trustees' report of the Federal Old-Age and Survivors Insurance and the Federal Disability Insurance Trust Funds every year.

Critical to the projection process are the projection methodology and the assumptions used. The projection methodology specifies the method used to estimate future income and expenditures. The assumptions define the projected economic and demographic environment in each future year. Much effort has been spent by the actuaries of the Social Security Administration in the choice of assumptions. Based on these assumptions the Social Security population is projected forward on an expected basis. Then the expected incomes and expenditures are computed. Such a projection is useful to provide information on the funded status of the Social Security System if the future economy unfolds in the anticipated manner.

A major limitation of the process lies in the fact that such a deterministic projection does not provide enough insight into the probability (or chance) of variable outcomes. For example, it fails to forecast the chance of depletion of the trust fund in
any given year. In order to provide some indication of the range of possible outcomes, the current Social Security projections are performed under three alternative scenarios:

- Alternative I - Low Cost
- Alternative II - Intermediate Cost
- Alternative III - High Cost

Alternative II is regarded as the "best estimate" scenario of the projection. However, the range shown by the alternatives under the current methodology still fails to describe the chance of any particular future outcome in this range.

1991 Technical Panel

Every 4 years the Advisory Council on Social Security engages a panel of technical experts to review the assumptions and methodology used in the Social Security projection. The 1991 Technical Panel recommended that additional resources be allocated to an in-depth analysis of the projection methodology. The recommended specific analysis of the projection methodology includes, but is not limited to, the following issues:

- Sensitivity of the results to alternative methodologies. Specific issues to be addressed include:

  - Determination of appropriate differences between the short-range and long-range methodologies, with special emphasis on the merging of the short-range and long-range projections (regular rotation of some of the Office of the Actuary staff members between the short-range and long-range offices could be beneficial in this regard);

  - Determination of appropriate modifications to the process for simulating earnings histories;

  - Use of stochastic simulations to test the sensitivity of the projections to the projection methodology and to allow factors that could differ for the separate low- and high-cost projections;

  - Use of various approaches for integrating assumptions in the projection methodology (e. g., time series, cycles, trends); and
Determination of the appropriate balance between complexity and simplicity.

- Development of a systematic approach to allow comparison of projection results with subsequent actual experience; and
- Routinization and documentation sufficient to allow relatively easy determination of the reasonableness of the methodology and the results, and relatively easy identification of the areas that would most benefit from continued research.

**1994-95 Technical Panel**

The 1994-95 Technical Panel on Assumptions and Methods follows up on the Recommendations of the 1991 Technical Panel. With recent advancements in simulation technology and computer facilities, stochastic simulations are in more common use and projection results are better understood and appreciated. Such simulations encompass a wide range of economic scenarios, and are thus best suited for forecasting the chance of occurrence of any specified event. The Technical Panel puts forward a number of stochastic simulation models to project Social Security income and expenditures. The purpose of these prototypes is not to produce accurate forecast results. Rather, they are used to demonstrate how such models may provide more relevant information in the complex social and economic structure. This paper describes the working of one such model.

The stochastic simulation model described in this paper is a prototype built in the spirit of exploration and demonstration mentioned. This model does not perform a seriatim (or person by person) projection. It is intended to supplement rather than replace the current Social Security projection system. Indeed, it begins with the income/expenditure trends under the Alternative II economic scenario of the 1995 projections by the Social Security Administration. The model then assesses the impact of the varying economic climate on the income and expenditure trends. Through a statistical analysis of the results from multiple simulations, the expected trends and the probable ranges of the key measures of the funded status of the Social Security System are evaluated.

There are two main sections to this study:

- Baseline Projection; and
• Sensitivity Test of some major assumptions.

Note that because of the rudimentary nature of the prototype model, the reader cannot expect much accuracy in the projection results. It is interesting to note that the 50th percentile results are very close to those under Alternative II assumptions of the 1995 Trustees Report. A comparison of the projection results under an alternative scenario included in the Sensitivity Section against those under the Baseline scenario also indicates the effect of input assumptions. These all demonstrate how sensitive is the modelling process to the choice of the input assumptions.
Method and Assumptions

Methodology

This prototype model does not perform individual population projections. Instead, for each projection year, the model simultaneously simulates the values of the seven key variables listed in the assumptions subsection below. All variables simulated are assumed to be normally distributed and have standard deviations and correlation coefficients described below. In this model, the variables simulated each year are assumed to be independent of other years. The values of the tax income, expenditures, and taxable payroll are adjusted to reflect the deviation of the simulated assumptions from those under Alternative II. The interest income, the net income, the trust fund balance, and the trust fund ratio (the ratio of the trust fund balance at the beginning of each year to the outgo for the year) are determined for the year. Based on the income, expenditure, and investment return trends thus obtained, the actuarial balance for each interim projection period is calculated. This completes one track of simulation.

Altogether, a thousand tracks of simulation are performed and the key projection results are stored in a database. A statistical analysis is then performed on the data to derive the expected trends and the probabilistic distribution of each key element related to the financial status of the Social Security System.

Assumptions

The crucial step of a stochastic simulation process is the generation of a set of variables that satisfy some input assumptions. The Monte Carlo Technique is used in this process. A description of the Monte Carlo Technique can be found in many statistics textbooks.
The key inputs to a multivariate stochastic simulation are the assumptions of the variables to be simulated. The following seven variables are simulated:

- Inflation rate;
- Real wage increase;
- Real interest rate;
- Employment rate;
- Labor force increase;
- Mortality improvement; and the
- Fertility rate.

Input assumptions include the expected value of the above variables for each projection year, and the standard deviation for each variable, as well as the correlation coefficient for each pair of variables.

The expected values of the variables in the Baseline Projection are those under the Alternative II scenario of the Social Security Administration projection of 1995, as listed on pages 58 and 62 of the 1995 Annual Report of the Board of Trustees of the Federal Old-Age and Survivors Insurance and Disability Insurance (OASDI) Trust Funds. These are included in Appendix A-1. The assumptions in the Sensitivity Test reflect the variable to be tested. The expected values for the variable to be tested vary from those of the Baseline Projection. All the other assumptions are kept the same as those in the Baseline Projection. The tested assumptions are included in Appendix A-2.

The standard deviations and correlation coefficients are assumed to be constant for all projection years. These are assumed to be the same as those calculated from the historical data from 1975 to 1994 as shown on pages 58 and 62 of the 1995 Trustees Report. The standard deviation and the correlation coefficients calculated from the historical data are included in Appendix A-3.
**Baseline Projection**

These projections are performed assuming that the expected economic assumptions are the same as those under the Alternative II scenario in the 1995 Trustees Report. The study examines the degree of uncertainty introduced by the difference in the values of the economic and demographic variables from the expected. In this prototype model, only seven key economic and demographic variables are studied. These are inflation, real wage increase, real interest rate, unemployment rate, labor force increase, mortality improvement, and fertility rate.

The objective of this projection is twofold:

- To test how close the expected trend produced by this model of the key measures of the funded status of the Social Security System compare with those under the Alternative II economic scenario; and
- To determine the probability of attaining each level of funding security in each year of the projection period.

**Projection Results**

Based on simulated results on the economic and demographic variables, the model computes the projected tax and investment income, and expenditures. The graphs on the following pages show the expected trend as well as the probability distribution of the following for each projection year:

- Trust fund investment return;
- Tax income vs expenditures as a percent of taxable payroll;
- Net income as a percent of taxable payroll;
- Trust fund ratio;
- Actuarial balance, and
- Probability of a negative funded status.
Observations and Comments

1. The average long-term trust fund nominal return is expected to be about 6.3 percent.

2. There is 25 percent chance that the long-term trust fund return will exceed 8.0 percent.

3. There is a 75 percent certainty that the long-term trust fund return will not be below 4.8 percent.

4. It may be interesting to note the 1995 Trustees Report assumes a much narrower range of the long-time trust fund return (6.0 percent under Alternative I and 6.5 percent under Alternative III).
Observations and Comments:

1. Social Security tax income equals the taxable payroll times the combined employer and employee tax rate plus the revenue from part of the income taxation of OASDI benefits. Social Security expenditures include benefit payments and administrative expenses.

2. The average Social Security tax income exceeds average expenditures by 1 percent of taxable payroll in 1995.

3. The tax income trend is relatively stable.

4. The payment trend escalates significantly under all scenarios.

5. Consequently, it is expected that the average expenditures will exceed the average tax income before 2012.

6. There is 25 percent chance that the cross-over will happen in the next 10 years.
7. There is 75 percent certainty that the benefit payments will exceed tax income before the end of the next 21 years.

8. In the 1995 Trustee Report, the cross-over point under Alternative II is 2011, which is very close to the 50th percentile results under this model. The cross-over points under Alternatives I and III are 1999 and 2021 respectively.

9. It should, however, be noted that the cross-over points shown in 6 and 7 are gross estimates obtained by analysing the benefit payment stream separate from the tax income stream. A more concrete way to determine when the outgo exceeds income is to consider the excess of tax and investment income over all expenditures. This is the subject of the discussion on the next page.
Observations and Comments

1. Social Security Trust Funds net income each year is equal to the excess (or deficit) of the tax income plus investment income over total expenditures including benefit payments and administrative expenses.

2. Expressed as a percentage of taxable income, the average value of net income increases in the initial years before 2008. Thereafter, it decreases quickly to zero before 2020.

3. There is only a 25 percent chance that the net income will remain positive until 2023.

4. There is only a 25 percent chance that the net income will be zero by as early as 2016.

Observations and Comments

1. The Social Security trust fund ratio each year is the ratio of the trust fund balance at the beginning of each year to the total expenditures for the year.

2. The trust fund ratio is expected to increase steadily to reach a maximum in the next 12 years. At that time, the trust fund will probably be between two to three and three quarters times the social security expenditures for the year. Thereafter, the ratio decreases rapidly to zero.

3. There is a 25 percent chance that the trust fund ratio will reach zero before 2026.

4. There is only a 25 percent chance that the trust fund ratio will remain positive until 2034.

5. The 1995 Trustee Report projects an exhaustion of the trust fund by 2017 under Alternative III, and will not turn negative under Alternative I.
Observations and Comments

1. This graph shows the chance for negative results for each of the two key measures of the funded status of the Social Security Trust Funds: net income as a percent of taxable payroll, and the trust fund balance.

2. Besides summarizing the chance of turning negative for these measures of the funded status, the graph also shows the progression of funded deterioration.

3. At each probability level, we observe that net income first turns negative, followed by the trust fund balance.

4. At the central probability levels, in general, the trust fund balance depletion lags net income, depletion by 10 to 12 years.
Observations and Comments

1. The actuarial balance for an interim period is the difference between the summarized income rate and the summarized cost rate over that period. The summarized income rate is the ratio of (a) the sum of the trust fund balance and the present values as of January 1, 1995, of all tax incomes during the period, to (b) the sum of present values of taxable payrolls for the period. The summarized cost rate is equal to the ratio of (a) the sum of the present value as of January 1, 1995, of the outgo during the period and a reserve of one year's outgo at the end of the period, to (b) the sum of the present values of taxable payrolls for the period.

2. The actuarial balance shows a steadily decreasing trend at all probability levels for all interim projection periods.

3. There is only 25 percent chance that the actuarial balance will turn negative for interim periods ending before 2020. Similarly there is only a 25 percent chance that the actuarial balance will be positive after 2030.
4. When one considers the entire 75-year projection period, the actuarial balance will probably be between -2.0 percent to -2.6 percent. This compares with the range of 0.54 percent to -5.67 percent depicted under Alternatives I and III of the 1995 Trustees Report.
Sensitivity Test

In order to study the impact of the major assumptions on the projection results, several sets of projections are performed, each focusing on one economic or demographic variable. In such studies, the ultimate rate of the variable under study is changed to an alternative rate. The other variables are unchanged from those in the Baseline Projection. The results of the projection with the alternative scenario are compared with those of the Baseline Projection.

The following alternatives have been studied:

- Changing the real wage increase assumption from 1.0 percent to 1.5 percent;
- Changing the real interest rate assumption from 2.3 percent to 3.0 percent;
- Changing the inflation rate assumption from 4.0 percent to 3.0 percent;
- Changing the unemployment rate assumption from 6.0 percent to 5.5 percent;
- Changing the fertility rate assumption from 1.9 percent to 2.2 percent;
- Changing the mortality improvement rate assumption from current rates to 1.0 percent; and
- Changing the labor force increase rate assumption from current rates to 0 percent.

In each case, we examine the effect of the assumption change on the:

- Probability of zero net income;
- Probability of a zero trust fund ratio; and the
- Actuarial balance.

Our study shows that projection results are very sensitive to changes in the assumptions in the real wage increases, the real interest rates, and the labor force increases.

The comparison graphs showing the sensitivity of the funded status of the Social
Security Trust Fund to these assumption changes are included in the next three pages. A brief discussion of the other variables is included in last page of this section.
Observations and Comments

1. The funded status is heavily affected by real wage increases.

2. A half percent real wage interest increase has the effect of delaying funding status depletion under each of the two measures (net income rate, trust fund balance) by 4 or 6 years at the mid-range probability levels.
3. The following table summarizes the effect of real wage increase on the actuarial balance:

<table>
<thead>
<tr>
<th>Interim Projection Period</th>
<th>Baseline Projection: 1.0% Real Wage</th>
<th>1.5% Real Wage Projection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25th Percentile</td>
<td>50th Percentile</td>
</tr>
<tr>
<td>25-year: 1995-2019</td>
<td>0.9%</td>
<td>0.6%</td>
</tr>
<tr>
<td>50-year: 1995-2044</td>
<td>-1.0%</td>
<td>-1.4%</td>
</tr>
<tr>
<td>75-year: 1995-2069</td>
<td>-2.0%</td>
<td>-2.4%</td>
</tr>
</tbody>
</table>

4. The above results compare to those of the 1995 Trustees' Report:

<table>
<thead>
<tr>
<th>1995 Trustees' Report Real Wage Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interim Projection Period</td>
</tr>
<tr>
<td>25-year: 1995-2019</td>
</tr>
<tr>
<td>50-year: 1995-2044</td>
</tr>
<tr>
<td>75-year: 1995-2069</td>
</tr>
</tbody>
</table>

5. At all probability levels, a half percent increase in the real wages increases will increase the actuarial balance by 0.3 percent for a 25-year period, and by 0.4 percent and 0.5 percent for a 50-year and a 75-period respectively. The same results are observed in the 1995 Trustees' Report.

6. Any real wage increase has an immediate impact on the taxable payroll and tax income. The impact on expenditures is much delayed. Thus, as a percent of taxable payroll, the escalation of the annual expenditures is
slower when there is higher real wage increase. This translates into increases in the actuarial balance.
Observations and Comments

1. It should be noted that the interest rate is important only because there is partial funding in the current Social Security System. If the system were funded on a truly pay-as-you-go basis, the interest rate would have no impact on the funded status.

2. The funded status is substantially affected by real interest rate increases. The proportional impact, however, is not as big as real wage increases.

3. A 0.7 percent increase in real interest rate will delay funded status deterioration by 1 to 2 years at the mid-range probability levels.
4. The following table summarizes the effect of real wage increase assumption on the actuarial basis:

<table>
<thead>
<tr>
<th>Interim Projection Period</th>
<th>25th Percentile</th>
<th>50th Percentile</th>
<th>75th Percentile</th>
<th>25th Percentile</th>
<th>50th Percentile</th>
<th>75th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-year: 1995-2019</td>
<td>0.9%</td>
<td>0.6%</td>
<td>0.2%</td>
<td>1.0%</td>
<td>0.6%</td>
<td>0.3%</td>
</tr>
<tr>
<td>50-year: 1995-2044</td>
<td>-1.0%</td>
<td>-1.4%</td>
<td>-1.7%</td>
<td>-0.8%</td>
<td>-1.0%</td>
<td>-1.4%</td>
</tr>
<tr>
<td>75-year: 1995-2069</td>
<td>-2.0%</td>
<td>-2.4%</td>
<td>-2.6%</td>
<td>-1.6%</td>
<td>-1.9%</td>
<td>-2.2%</td>
</tr>
</tbody>
</table>

5. The above results compare to those of the 1995 trustees' report:

| 1995 Trustees' Report Ultimate Real Interest Rate |
|----------------------------------------|-----------------|-----------------|-----------------|
| Interim Projection Period              | 1.5%            | 2.3%            | 3.0%            |
| 25-year: 1995-2019                     | 0.40%           | 0.54%           | 0.65%           |
| 50-year: 1995-2044                     | -1.68%          | -1.33%          | -1.03%          |
| 75-year: 1995-2069                     | -2.68%          | -2.17%          | -1.75%          |

6. A 0.7 percent increase in real interest rate increases the actuarial balance by about 0.1 percent, 0.3 percent, and 0.4 percent for a projection period of 25 years, 50 years, and 75 years respectively. The 1995 Trustees' Report shows comparable results.

7. Although a real interest rate increase does not affect tax income nor annual expenditures, yet higher interest discount makes future deficits less important in the calculations of the actuarial balance. Hence, the increase in the actuarial balance under higher real interest assumption.
Observations and Comments

1. The impact of slowing down the labor force increase is substantial.
2. The depletion of the funded status is accelerated by about 4 years.
3. The following table provides a summary of the effect of labor force increase on the actuarial balance:

<table>
<thead>
<tr>
<th>Interim Projection Period</th>
<th>Baseline Projection: 1.2% Increase in 1995, Decreasing Gradually to 0.1% in 2069</th>
<th>No Labor Force Increase Projection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25th Percentile</td>
<td>50th Percentile</td>
</tr>
<tr>
<td>25-year: 1995-2019</td>
<td>0.9%</td>
<td>0.6%</td>
</tr>
<tr>
<td>50-year: 1995-2044</td>
<td>-1.0%</td>
<td>-1.4%</td>
</tr>
<tr>
<td>75-year: 1995-2069</td>
<td>-2.0%</td>
<td>-2.4%</td>
</tr>
</tbody>
</table>

4. Without labor force increase, the actuarial balance will decrease by about 0.4 percent for each projection period. This is mainly the impact of decrease in income not immediately offset by expenditures.
Sensitivity of the Funded Status to Other Assumptions

The impact of other assumptions on the funded status of the other factors is minimal according to the simulation under this model.

Inflation

Lower inflation produces comparable decreases in income and expenditures, resulting in minimal net impact on the funded status.

Unemployment

Lowering the ultimate unemployment rate from 6.0 percent to 5.5 percent% does not create much impact on income and outgo. Thus, the impact on the funded status is very small.

Fertility

Increasing the fertility assumption from 1.9 to 2.2 has delayed impact on income and expenditures. Thus, the impact on the depletion of net income and the trust fund balance is minimal. It does have more impact on the actuarial balance, increasing it by about 0.4 percent at all probability levels in a 75-year computation period.

Mortality

This model shows little impact of mortality on the funded status. This may partly be attributed to the rather short term nature of the depletion of the trust fund. More importantly, it is probably due to the crudeness of the model. This model does not differentiate the mortality improvements at different ages. Intuitively, the mortality improvement may be skewed towards the older ages, producing substantially greater impact on expenditures than income. This effect is not captured by the current model.
Conclusion

1. Readers should be cautioned of the crudeness of the current model. Much accuracy of the projection results cannot be expected.

2. However, the study clearly demonstrates the variability of the projection results. By shifting the focus from one single track of projection results under Alternative II to the range of possible outcome between the 25th and 75th percentiles, the reader is given a more realistic perspective of possible happenings.

3. The 25th and 75th percentile results may also fulfill the need of the readers to get a better sense of the range of possible outcomes. They provide an alternative to the projection under Alternative I and Alternative III.

4. In order that the model may be more useful for actual projections of the Social Security Trust Funds, several extensions are necessary.
   a. This model simulates economic and demographic variables that have no serial correlation from year to year. Historic data indicate substantial serial correlation in several of these variables. Simulation of serially correlated variables is necessary.
   b. Mortality improvement is different at different ages. Not capturing this difference may obscure critical effect. Differentiation of such improvement rates is crucial.
   c. Although it is not realistic to expect a stochastic simulation model to perform detailed seriatim computation for each projection year of each projection track, some methodology must be formulated to derive more accurate estimates of the impact of the deviation of simulated economic and demographic assumptions from those anticipated.
   d. The model has not analyzed the impact of disability rate and disability recovery rate changes. A detailed model should include such analysis in its methodology.
APPENDIX C -- MORTALITY

Mortality Assumptions of the SSA Actuaries
(1994 Trustees Report)

Under the intermediate projection, the age-sex adjusted death rate decreases by 35 percent between 1993 and 2068. Life expectancy at birth in 2070 is projected to rise to 77.9 years for men and 84.0 years for women. Life expectancy at age 65 is expected to rise to 22.3 years for women and 18.5 years for men. All of the projections are for future decreases in mortality and increases in life expectancy, both at birth and at age 65. Differences among the three alternatives reflect differences in the assumed speed of mortality decline. Alternative I (low cost) shows almost no increase in life expectancy for women over the next 75 years. Alternative III (high cost) shows a 9- to 10-year increase in life expectancy at birth for both men and women.

SSA Methods of Making Mortality Projections

Mortality projections made by the SSA actuaries are based on determining the most likely course of age-sex-cause specific death rates over the projection period. Rates for future years are determined by repeatedly applying annual percentage reductions to the mortality rates projected for the prior year. For the first 25 years of the projection, the annual rates of reduction are linked to the rate of decline observed in the 20-year period preceding the date beginning the projection. The rates of decline begin at the level observed in the recent period and are then gradually transformed into what the SSA actuaries term the “ultimate annual reductions.” Such reductions are determined by looking at past rates, consulting with experts, and thinking about the future.

Recent Rates of Decline: The estimates of the SSA actuaries as to mortality change in the near future depend heavily on trends over the past two decades by age, sex, and cause. The rates of change over this period (1968-1988) used as the basis for beginning the projection of mortality in the immediate future are shown in Table 6. During this period, mortality at all ages declined at about 1.5 percent per annum, with generally higher rates of decline at younger ages and somewhat lower rates of decline at older ages. Rates from most causes also declined. The highest rates of
decline, exceeding 4 percent annually, were in the vascular diseases and the diseases of early infancy. Rapid decrease was also observed for death rates from heart disease, violence, digestive diseases, diabetes, and cirrhosis. On the other hand, there were increases in some causes of death -- most notably cancer -- but also in respiratory diseases among the older population and the residual diseases category.

Ultimate Rates of Decline: These past rates of decline are then gradually changed into the "Ultimate Annual Percentage Reductions in Death Rates by Age, Sex, and Cause," which are shown in Table 7 (for Alternative II). The ultimate rates are then applied for the years after 2016. (AIDS deaths are projected separately.) For the causes of death that declined, the ultimate average rates of decline appear to be about half (or somewhat less than half) of the observed value over the last 20 years. For those that were actually increasing, the ultimate rate is projected to be one of decline. It is not clear what process has been used to determine the recent ultimate rates. There is some indication in SSA publications that they are changed regularly, but the process by which they are determined is not regularly described. The SSA actuaries clarified that the method of using experts in specific diseases to evaluate future trends has not been employed for at least 20 years. This means that, in the next 25 years, age-cause-specific rates of decline are expected to decrease gradually to about half the level experienced over the past 20 years, and then this lower ultimate level would be applied until the end of the projection period.

Alternatives I and III: The alternative assumptions are begun by assuming that age-cause-specific death rates begin to decline at rates one half (for Alternative I) those of the last 20 years and 1.5 times as fast (for Alternative III) as in that period. These rates of decline are gradually transformed into alternative ultimate rates of decline, and then the ultimate rates of decline are applied for the period after 2017. The alternative ultimate rates of decline are shown in Table 8. The ratio of the Alternative I and III rates to the Alternative II rates of decline varies by cause, but the Alternative I rates involve slower change in mortality and the Alternative III rates involve more rapid change. Alternative I involves mortality decreasing at a rate about one-fourth the average rate
observed during the 1900-1990 period, while for Alternative III, the projected rate of reduction is about the same as that observed in 1900-1990 (Actuarial Study No. 106, p. 11).

**How Do the Three Alternatives Translate into Life Expectancy?** The Alternative II assumptions would result in increases between 1990 and 2070 in life expectancy at birth of 6 years for men and 5 years for women (Table 9). At age 65, the increases would be 3.5 and 3.3, respectively. The Alternative III projection involves decreases in mortality faster, so that by 2070, life expectancy would be 6.5 years longer at age 65. Because the speed of mortality decline is faster in Alternative III, the levels of life expectancy in this projection for 2030 are very similar to those for 2070 in Alternative II. Alternative I involves very little increase in life expectancy. By 2030 only 1 year would be added to life expectancy at birth for females; and at age 65, almost no change is projected until after 2030.

**Further Detail Regarding the Views of Vaupel, Wilmoth, and Olshansky**

James Vaupel bases his opinion on evaluation of the importance of current international trends in old-age mortality. The recent rate of decline in old-age mortality has been faster in other low-mortality countries than in the United States (although the level of mortality rates at the very oldest ages is lower in the United States and Canada). Vaupel feels that the post-World War II rates of decline are the most relevant, and he thinks that old-age mortality rates will continue to decline at about 1 percent a year. Vaupel noted that an optimistic projection should project continued decline at 2 percent a year for older ages. His best estimates of life expectancy at birth in 2070 would be 82 years for men and 92 years for women.

Wilmoth holds the middle position. He thinks that the past 45 years, rather than trends for the entire century, ought to be used as the basis for projection, because he sees a significant change in the trend for old-age mortality at mid-century. He is somewhat more cautious than Vaupel as to projecting very large declines at the most advanced ages (over 95).

Olshansky believes that the assumptions used by the SSA actuaries are very reasonable up to 2030, perhaps even slightly optimistic. He thinks that using the rate of
change since 1900 (termed to be about 0.5 percent a year) is more appropriate than the rate since 1945. He feels that the rapid rates of mortality decline since 1945 are anomalous for the species. He also expressed the view about how difficult it will be to reach the low death rates at older ages implied by more rapid declines in mortality.

Olshansky has regularly been paired in debates on the future of life expectancy with Ken Manton, another noted demographer who specializes in mortality at the oldest ages. Manton sees the possibility of life expectancy at birth reaching 100 in the time range of the SSA projection. The pairing of these two researchers in debates arises from the fact that they are seen to represent both ends of the continuum in the argument on what the future of life expectancy will be.
APPENDIX D -- FERTILITY RATE ILLUSTRATION

Because the Total Fertility Rate is a synthetic measure, it can fluctuate tremendously even if completed family size in the population remains unchanged -- and it fluctuates much more widely than measures of completed actual fertility. This fluctuation occurs because of changes in the timing of births in the population, and consequent overlaps of childbearing among older and younger women, as illustrated schematically in Table 10.

That table depicts the distribution of a cohort's total childbearing over six age groups, from age 15-19 to age 40 and over. Time is on the horizontal axis in the table, and the lifetime experience of a given cohort can be read on the diagonal. A quick check of the diagonals in the table indicates that each cohort's fertility adds to 100, and assumes that there is no change in completed family size among the cohorts.

There is a change over time in the lifetime pattern of childbearing, however, with the cohorts aged 15-19 in years 5 and 45 tending to have most of their children at earlier ages, and the cohort aged 15-19 in year 25 tending toward later child-bearing. One could think of years 10 and 15 in the table as similar to the 1950s in the United States, when women who had delayed childbearing began late families at the same time that younger women decided to start their families early. The period fertility in years 10 and 15 -- the vertical total in the table, which is equivalent to the TFR -- is composed of both
high early and late fertility rates and rises sharply to 135. Then, in years 30 and 35 -- as in the late 1960s and early 1970s -- older women who had moved their childbearing forward had very few babies, at the same time that younger women were delaying childbearing because of careers and economic hardship. The period fertility in years 30 and 35, composed of low late and early fertility rates, drops sharply to only 65.

The period fertility in years 10 and 15 (and in the 1950s) exceeds the actual completed fertility of every cohort of women who were of childbearing age at that time, just as the period fertility in years 25 through 40 (and in the 1970s and 1980s) is lower than the actual completed fertility of every cohort of childbearing age at that time. In this sense, the TFR (which is equivalent to the period fertility) is a very bad measure to use when attempting to describe long-term average levels of childbearing. It is used simply because it is a summary measure that is (superficially, at least) easy to conceptualize.
APPENDIX E -- TEST OF SHORT-RANGE FINANCIAL ADEQUACY

The Panel noted a technical inconsistency in this test. Projections indicate, however, that the inconsistency is not likely to affect the OASDI Trust Funds in the near future (especially when considering the status of the combined OASDI Trust Funds). Still, this test is also used for the Hospital Insurance Trust Fund (which the Panel was not asked to review), and has relevance there under current projections.

As in the case of long-range status evaluation, the Panel believes that this test should be reconsidered after program reform is enacted. Therefore, the Panel decided only to call attention to the inconsistency described below, and recommends that it be resolved as part of that future reconsideration.

The short-range (10-year) adequacy test is bifurcated, based on whether or not the Trust Fund Ratio (TFR) is at least 100 percent at the beginning of the projection period. In either case, to satisfy the test, the estimated assets of the trust fund at the beginning of each month, during the 10 years, must be sufficient to pay benefits and administrative expenses for that month.

If the initial TFR is less than 100 percent, the test requires that the projected ratio must be at least 100 percent by the beginning of the sixth year, and remain above 100 percent for the remainder of the 10-year period.

If the initial TFR is at least 100 percent, however, the test is more stringent -- the projected ratio must remain above 100 percent for the entire 10-year period.

The inconsistency of the test bifurcation can be illustrated as follows:

In a hypothetical Trustees Report, for year Z, the short-range test would not be satisfied if the Trust Fund Ratio is

(a) 100 percent or more for the beginning of year Z,
(b) Less than 100 percent for the beginning of the subsequent four years,
(c) 100 percent or more at the end of the fifth year and thereafter.

---

25"The conditions required to meet this test...apply to each trust fund separately, as well as to the combined funds, and are evaluated based on the intermediate (alternative II) set of assumptions." (1995 Trustees Report, pp. 216-17)

26The requirement that the projected TFR should be at least 100 percent at the end of the 10-year period is consistent with the current long-range test requirement that the Actuarial Balance for the first 10-year period should be at least zero. That is, the requirement that the Actuarial Balance should be equal to zero for any period is equivalent to requiring a 100 percent TFR at the end of that period.
If no program change is made, however, and if experience is in line with the estimates, in the next year's Trustees Report (for Year Z+1), the short-range test would be satisfied. That is, nothing unexpected would have happened, but the "not satisfied" conclusion would change to "satisfied" without any remedial action.

The Panel again emphasizes the distinction between various financial adequacy tests appropriate for the Trustees Reports versus considerations for satisfactory legislative action.

Legislated revisions should involve projections which indicate desired target levels (however defined) are likely to be met. On the other hand, the Trustees Reports reflect the actual experience that occurs subsequent to such legislation. Because of statistical variation, updated projections can be expected occasionally to show less satisfactory results than were previously projected. Thus, it is appropriate for the Trustees Reports to use less stringent tests (than the legislative ones), provided they give warning if the legislative targets are not likely to be achieved within a reasonable period of time.

For example, a TFR lower than 100 percent would not be a desirable target at any time. Nevertheless, one function of the trust fund is to serve as a contingency reserve, so projection of a temporary period of lower TFRs due to unexpected events is acceptable.
I believe that the role of the Panel (and the Advisory Council as well) is to review and audit the assumptions and methodology underlying the actuarial cost estimates for the OASDI program and to determine if they are reasonable, and its role is not to develop what it believes are the "best" assumptions (if such are really determinable). The Panel may well present alternative assumptions and methodology which it believes to be reasonable, and the Chief Actuary of the Social Security Administration should, with profit, consider them. In the event that any element is determined not to be reasonable, then the Panel should recommend a reasonable alternative.

In the end, the reasonableness of the assumptions and the methodology is primarily the responsibility of the Chief Actuary, because Sec. 201(c) of the Social Security Act provides that the OASDI Trustees Report "shall include an actuarial opinion by the Chief Actuary of the Social Security Administration certifying that the techniques and methodologies used are generally accepted within the actuarial profession and that the assumptions and the cost estimates used are reasonable".

Along these lines, the Board of Trustees in its review of the assumptions and methodology which the Chief Actuary is using may suggest changes therein. The Chief Actuary can accept such changes if he/she believes them to be reasonable; otherwise, he/she can incorporate such changes, make the necessary computations, and note his/her objection in the Actuarial Opinion, or else he/she can resign and make suitable publicity of the reasons therefor to the public (in the history of the OASDI program, the latter two circumstances have never occurred, and the former has occurred only rarely).

An excellent Congressional statement of the very important role that the Office of the Actuary has played in the past, and which it should play in the future, "in assessing the financial condition of the Social Security trust funds and in developing estimates of the financial effects of potential legislative and administrative changes" is contained in the Conference Report on the Social Security Administrative Reform Act of 1994, House Report No. 103-670, August 4, 1994 (pages 96-97). The report concludes that the conferees "expect that in the independent SSA the office will be permitted to function with a high degree of independence and professionalism".
There are various basic principles which should apply to the development of the assumptions used in the actuarial cost estimates for the Social Security program.

First, emphasis should be placed more on experienced judgment than on "blind" mathematical analysis of past experience, which often is subject, in the end, to arbitrary, artificial adjustments to produce the desired "bottom line". True, the past history must be considered, but in the end, the factors of judgment and reasoning should control.

As an example, some decades ago, population projections were made by fitting elaborate mathematical curves to past data, as though some law of nature was involved, to obtain future populations. Now, the quite straightforward approach of projecting age-sex cohorts by mortality and fertility rates is universally used.

As another example, projection of mortality rates is sometimes done by examining the secular trend of reductions in age-specific rates and assuming the continuation of this trend indefinitely into the future. This may, or may not, produce reasonable results, but it is all in the judgment of the assumption-maker in the end. A great deal depends on the period in the past which is used as the base.

For example, for many years, the gap between female and male mortality widened as time went by, but in the last 15 years, the reverse has occurred. Should the mathematical analysis cover the last (say) 100 years or only the last 15 years? In the end, it is judgment that must prevail, rather than mathematical analysis.

I believe that it is unreasonable to assume that mortality rates will decrease by a constant relative rate over all years in the valuation period, as against assuming a decreasing relative rate of improvement. This is a matter of judgment and reasoning, and the "constant rate" basis just does not seem reasonable.

Another example is in the area of fertility rates. The trend of such rates has varied greatly in the past 75 years. Thus, when an average trend to be projected in the future is developed, so much depends on the past period selected for the mathematical analysis. Once again, primary reliance should be placed on judgment.
Second, there arises the question of consistency in the derivation of the low-cost and high-cost assumptions around the intermediate ones. The practice over the last 50 years has been, for each element for which assumptions are made, to group all low-cost assumptions together -- and similarly for the high-cost ones -- regardless of whether or not they appear to be consistent with each other. For example, in the low-cost estimate, high fertility and high immigration are assumed. Some persons would say that this is not consistent. I agree that this is not the most likely situation, but I believe that it is quite possible.

I strongly believe that the present practice of making low-cost assumptions for each element separately for the low-cost estimate -- and vice versa for the high-cost estimate -- should be continued. This produces a reasonable range in the aggregate.

Third, any large changes made -- especially those which have long-range effects -- should not be done suddenly. Rather, they should be phased in over a period of years, so that there is a reasonable certainty that they should be made in their entirety.

The majority of the Panel is adversely critical of the procedure involved in having three alternative cost projections -- low-cost, intermediate-cost, and high-cost. I do not agree, but rather I believe that the present basis is fine and should not be changed.

The majority of the Panel members believes that the low-cost and high-cost projections are not adequate indicators of the ranges of results that should be given consideration in evaluating the status of the program. I do not agree, because I see the purpose of these two projections as showing the reasonable possible range of costs under various assumptions that the user can clearly and easily understand.

If stochastic analysis alone were to be used, I believe that this would be undesirable, because its use of probability functions will give a false appearance of scientific methodology and accuracy, because, when probabilities and standard
deviations are assigned to the various elements, this is generally necessarily done in an arbitrary manner.