Papers and Proceedings

The 15th

Federal Forecasters Conference 2006

September 28, 2006
at the Bureau of Labor Statistics

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Announcement

The 16th
Federal Forecasters Conference
FFC/2008

Will be held

April 24, 2008

In

Washington, DC

Federal Forecasters Conference – 2006

Papers and Proceedings

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Foreword

The 15th Federal Forecasters Conference (FFC/2006) was held September 28, 2006 in Washington, DC, and was a great success. FFC/2006 continued a long string of successful conferences that began in 1988. These conferences have brought wide recognition to the importance of forecasting as a major statistical activity within the federal government and among some of its partner organizations. Over the years, the federal forecasters conferences have succeeded most at providing a forum for practitioners and others interested in the field to organize, meet, and share information on forecasting data and methods, the quality and performance of forecasts, and major issues impacting federal forecasts.

The theme of FFC/2006 was "Aging: Implications for Forecasting." The keynote speaker was Lawrence Meyer, Director of Macroeconomic Advisors, and a former Governor of the Federal Reserve Board. As the population of the United States and other major countries continues to age, policymakers at every level face major challenges in providing needed services while maintaining economic prosperity. Aging affects the dynamics of our economy and society, including the composition of the labor force, the nature of jobs to be filled, and the demands for goods and services, including health care, pension benefits, and other public sector services. The implications of an aging society for forecasting in the public sector are equally profound, affecting both the input side and the output side of many projection models. FFC/2006 highlighted how forecasters account for this transformation.

The papers and presentations in this FFC/2006 proceedings volume cover a range of topics, including: Model Development and Calibration; Consumer Spending and Income; Forecasting Trends, Cycles, and Recessions; Trade Impacts on Employment and Prices; Defense-Related Employment; Finance and Health Topics Related to Aging; and Occupational Employment, Forecasts, and Analysis.

Acknowledgements

Many individuals contributed to the success of the 15th Federal Forecasters Conference (FFC/2006). First and foremost, without the support of the cosponsoring agencies and the dedication of the Federal Forecasters Consortium Governing Board, FFC/2006 would not have been possible.

Mitra Toossi of the Bureau of Labor Statistics (BLS) opened the morning program, introducing Jack Galvin, Associate Commissioner of BLS, who gave the welcoming remarks. Stephen MacDonald of the Economic Research Service (ERS), introduced the other members of the Governing Board, and closed the morning program. Kathleen Sorensen of the Department of Veterans Affairs (VA), previewed the conference's afternoon program. Brian Sloboda, of the Bureau of Transportation Statistics, presented certificates to the winners of the FFC/2006 forecasting contest. Teri Manzi, of the Internal Revenue Service, Frederick L. Joutz of the George Washington University, and Jeff Busse, of the U.S. Geological Survey, announced the FFC/2005 best conference paper awards. Frederick L. Joutz introduced the keynote speaker, Laurence Meyer. All the members of the Federal Forecasters Organizing Committee worked hard to provide support for the various aspects of the conference, making it the success it was.

Special thanks go to Brian Boulier, Robert Trost, and Frederick L. Joutz of The George Washington University for reviewing the papers presented at the 14th Federal Forecasters Conference and selecting the winners of the Best Conference Paper awards for FFC/2005.

Special thanks go to Lilia George, Erma McCray, and Vanessa Sandige, all of ERS, for directing the organization of materials into conference packets and staffing the registration desk. In addition, special thanks also go to Mary Jane Slagle from the Census Bureau for managing the FFC 2006 name tags. In addition, special thanks go to Wendy Davis, Kasmira Smarzo, Patricia Tate, and Rose Woods, of BLS, for assisting on the day of the conference.

Special thanks go to Marybeth Matthews and Denise Ott of the VA for producing the conference program, and Marybeth Matthews for producing this publication. Additionally, special thanks also go to the staff of the BLS Conference and Training Center, who once again helped to make the day go smoothly.

Finally, we thank all of the presenters, discussants, and attendees whose participation made FFC/2006 another successful conference.

2006 Federal Forecasters Conference

Forecasting Contest Winners

Winner

Betty Su
Bureau of Labor Statistics
U.S. Department of Labor

First Runner Up

Peggy Podolak
U.S. Department of Energy

Second Runner Up

Roger Moncarz
Bureau of Labor Statistics
U.S. Department of Labor

Honorable Mention

Terry Schau
Bureau of Labor Statistics
U.S. Department of Labor

2005 Federal Forecasters Conference

Best Conference Paper Awards

Winner

Tucker McElroy and William Bell
Forecasting Age Distribution Curves
U.S. Census Bureau

Katy Yeh
Forecasting the Weekly Volume of Individual Income Tax Return Filings
U.S. Department of the Treasury

Honorable Mention

Frederick W. Holloman
Toward a Legal Immigrant Data Series for Population Projections
U.S. Census Bureau

Stacey Harrison
Forecasting Customer Data to Prioritize Marketing Efforts at the Postal Service
U.S. Postal Service

Charter of the Federal Forecasters Consortium

The Federal Forecasters Consortium is a collaborative effort of agencies in the United States Government, as well as other interested parties in the academic and not-for-profit communities, who share an interest in the practice, planning, and use of forecasting activities by and within the Federal Government. In this context forecasting is taken to mean advance planning, decision-making, and the description of expected outcomes, all for unknown future situations. The art of forecasting encompasses many disciplines and utilizes many tools, all applied with the intent of predicting and evaluating alternative futures.

The Consortium provides an environment in which forecasters can network, present papers, take courses, attend seminars, and otherwise improve their ability to prepare meaningful and timely forecasts of occurrences in today's complex and changing world.

The primary objectives of the Consortium are as follows:

1. To provide a forum for forecasters to exchange information on data issues and data quality, on forecast methodologies, and on evaluation techniques.
2. To promote an ongoing dialogue about various forecasting topics among professionals from a variety of disciplines.
3. To build a core network of professionals whose collaboration furthers the use of forecasting as an important planning tool in the 21st century.
4. To expand the network of forecasters by seeking sponsorship from agencies in all parts of the Government and by actively seeking out and fostering working relationships among government, private, and academic communities of forecasters.
5. To provide both formal and informal opportunities to learn about general forecasting methodologies or about new techniques still in experimental stages.
6. To discuss data presentation and dissemination issues.

Membership

The role of member organizations is to provide support and advice to the Federal Forecasters Consortium Governing Board in promoting, planning, and conducting the periodic Federal Forecasters Conference, annual forecast methodology workshops, and such seminars and presentations as are deemed necessary and useful by the Board.

Any government agency may seek to become a member of the Consortium by satisfying the following criteria:

1. Provide support to the Federal Forecasters Consortium in the form of financial support, in-kind contributions, or person-hour support for the programs of the Consortium.
2. Name one or more representatives to the Consortium Governing Board who shall regularly attend and participate in the meetings of the Consortium.

Any not-for-profit or academic organization with an interest in the purposes and goals of the Consortium may become an associate member of the Consortium by satisfying the same criteria.

While there is no intent to exclude agency representatives from the Governing Board if their management is unwilling or unable to formally commit to support for the organization, we feel that it is equally important for the largest participating agencies to understand, acknowledge, and support in a more formal way the activities of the FFC. If it is not against current policies of these agencies, a Memorandum of Understanding is one appropriate way to show high-level agency support of the Consortium.

Governing Board

The Federal Forecasters Consortium Governing Board shall consist of one or more individuals from each of the member agencies and associate members. These individuals are named to the Board by their respective organization or agency. Those agencies designated as "sponsoring agencies" as of January 1, 2003, shall continue in that role so long as they continue to support the Consortium as they have prior to that date.

The chairperson, recording secretary, and other committee assignments are chosen from and by the Governing Board.

The role of the Governing Board is to meet at least four times a year to plan the conference, locate resources to conduct the conference, deliberate on issues affecting its operations, promote collaboration among forecasters, organize and present forecasting workshops, and support an ongoing seminar series focusing on topics of interest to forecasters.

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Keynote Speaker

Keynote Speaker

Dr. Laurence Meyer

Director of Macroeconomic Advisers, (LLC)

"Aging: Implications for Forecasting"

The morning session's distinguished key note speaker was Dr. Laurence Meyer. He is a former Governor of the Federal Reserve Board and is co-founder, vice chairman, and director of Macroeconomic Advisers, LLC. He has also established the Monetary Policy Insights Service which provides forecasts of Federal Policy actions. He is a distinguished author of several economic books including, "A Term at the Fed, an Insider's View" and "Macroeconomics: a Model Building Approach."

Dr. Meyer's feature presentation for the 15th Federal Forecasters Conference was *Global Aging and Financial Markets.*

Concurrent Sessions I

Model Development and Calibration

Session Chair: James Franklin, Bureau of Labor Statistics

Long-Range Forecasts of Mortality and Life Expectancy Using Bayesian Vector Autoregressions

Javier Meseguer, Social Security Administration

The Lee-Carter model is often regarded as the benchmark approach to mortality forecasting by many U.S. and foreign government agencies. This paper explores the use of Bayesian vector autoregressive (BVAR) processes as a viable alternative. Under the so-called random-walk prior, BVAR models provide an extremely flexible framework, allowing the forecaster to accommodate the main empirical regularities characterizing age-specific mortality. Substantial gains in forecast performance can be achieved by appropriately calibrating the model, in order to preserve the temporal contiguity features of the data. In addition, the generated Bayesian predictive densities incorporate uncertainty due to variation in both the sample and parameter outcomes.

A Dynamic Analysis of Permanently Extending EGTRRA and JGTRRA: An Application of a Coordinated Calibration of Macroeconomic and Microsimulation Models

Tracy L. Foertsch, Ph.D. and Ralph A. Rector, Ph.D., The Heritage Foundation

Changes in tax policy can influence incentives to work, save, and invest. Subsequent changes in employment and incomes can impact tax revenues. Dynamic analyses capturing such interactions between taxes and the economy require coordination between macroeconomic models and microsimulation tax models. An important part of that coordination is calibration to a common baseline.

We calibrate Global Insight's U.S. macroeconomic model and a microsimulation individual income tax model to CBO's baseline economic-and-budgetary projections. The calibrated models are then used to simulate the economic-and-budget effects of permanently extending the provisions of the 2001-and-2003 tax laws set to expire in 2010.

Predicting Growth Defection

David Cruz and Kimberly Dawson, U.S. Postal Service

Halil E Esen and Poyraz Ozkan, Peppers and Rogers Group, A Division of Carlson Marketing Group

How profitable would your business be if you could predict your customers' next move? Identify growth customers, maximize revenue opportunities, and attack revenue loss problems before they become irreversible through forecasting. The Growth Defection Predictive Model developed by the U.S. Postal Service uses customer demographics, past purchase behavior, and customer comparisons to forecast future customer behavior. Providing insight for sales and service resource allocation, the model uses the logistic regression technique to help the U.S. Postal Service maintain its ability to be a self-funding Government agency.

Long-Range Forecasts of Mortality and Life Expectancy Using Bayesian Vector Autoregressions

Javier Meseguer
Social Security Administration
Office of Policy - Division of Economic Research

This report provides a summary of ongoing research undertaken by the author. The analyses, opinions and findings contained in this report represent the views of the author and are not necessarily those of the Social Security Administration. Any errors or omissions are solely the author's responsibility.

Introduction

Using time-series statistical techniques to produce population forecasts has become standards practice among demographers and other social scientists. Unlike the traditional deterministic "scenarios" methodology, stochastic models are capable of generating projections that are consistent with a probabilistic representation of uncertainty. In this context, the approach to mortality forecasting pioneered by Ronald Lee, Lawrence Carter and many others following on their footsteps has received much attention in recent years. This report explores the use of Bayesian vector autoregressive (BVAR) models as an alternative to the Lee-Carter method.

The Bayesian framework offers a number of significant advantages over the traditional sampling theory approach. First, Bayesian inference derives from an exact finite-sample probability distribution, regardless of sample size. Hence, there is no need to rely on asymptotic theory approximations that can be poor in small samples.

Second, by providing a formal mechanism for the inclusion of available prior information, it is possible to introduce model restrictions that better accommodate the main empirical regularities characterizing all-cause mortality. This, in turn, can translate into improved forecast performance.

Finally, since the Bayesian paradigm treats a model's parameters as random variables, the generated predictive distributions account for variation due to both the sample and parameter outcomes. This ability to coherently incorporate parameter uncertainty can be particularly relevant in the context of demographic applications, where for example, very long forecast horizons are required to evaluate the solvency of a pension plan.

Time-Series Specifications for Mortality Forecasting

The so called Lee-Carter model,[8] postulates the logarithm of a set of age-specific mortality rates as the linear function of a time-varying index of the general level of mortality

$$\log(y_{i,t}) = \alpha_i + \beta_i k_t + \varepsilon_{i,t}, \qquad (1)$$

for $i = 1,\ldots,m$, and $t = 1,\ldots,T$, where the term $y_{i,t}$ denotes mortality at age i and time t. The age-specific set of parameters α_i describes the average shape of the logarithmic mortality rates, while the slope coefficients β_i determine both the direction and magnitude by which mortality at every age varies with the index k_t.

Subject to appropriate identifying constraints, least square estimates of the parameters in the Lee-Carter model can be obtained by applying singular value decomposition to the matrix of centered logarithmic death rates. Then, the estimates of the mortality index are treated as a univariate time-series that is projected into the future. In most applications, a random-walk with drift is found to provide a good empirical fit for k_t. Finally, the resulting forecasts of the mortality index are "plugged" back into equation (1), in order to recover a probability distribution of the future death rates for each age category.

Several time-series econometric specifications have been suggested as alternatives to the Lee-Carter method.[4] One such possibility is to model the first difference of logarithmic mortality as a p^{th}-order autoregressive process AR(p)

$$\Delta\log(y_{i,t}) = c_i + \sum_{s=1}^{p} \phi_{s,i} \Delta\log(y_{i,t-s}) + e_{i,t}. \qquad (2)$$

In this case, future changes in the individual mortality rates are determined by their own past values plus a random disturbance term $e_{i,t}$. The m age-specific series are estimated within a system of seemingly unrelated regression equations (SURE), in order to accommodate the significant degree of contemporaneous correlation characterizing all-cause mortality data. A variant of this framework is for instance used by the Congressional Budget Office's stochastic model of long-term trust fund finances.[3]

A further extension of the model in equation (2) is a quasi-vector or QVAR(p) autoregression.[4] The latter includes an index of the general level of logarithmic mortality as part of each univariate autoregression, where the index itself is a function of all the age-specific death rates. Of course, an even more general specification involves a full vector autoregressive (VAR) process, in which the lagged values of all m mortality series appear in the right side of each equation

$$\Delta \log(y_{i,t}) = c_i + \sum_{i=1}^{m}\sum_{s=1}^{p} \phi_{s,i} \Delta \log(y_{i,t-s}) + e_{i,t}. \quad (3)$$

However, estimation of an unrestricted VAR model is not feasible in this context, without a priori imposing severe restrictions on the autoregressive coefficients.

One potential problem with unrestricted VAR processes is the fact that the number of parameters increases geometrically with the set of variables being modeled. Hence, as m increases, the number of autoregressive coefficients involved is eventually guaranteed to outstrip the number of available observations. For instance, a VAR(p) model with p = 1 lag and m = 21 mortality age groups comprises 462 autoregressive coefficients. This problem is referred to in the literature as overfitting (when too many parameters are estimated relative to the number of data points). The result is usually imprecise parameter estimates that often translate into poor out-of-sample forecast performance.

Bayesian vector autoregressive (BVAR) models can successfully overcome the overfitting problem. This is accomplished through the concept of shrinkage, by imposing a priori stochastic restrictions on the autoregressive coefficients, so that their value is determined by a handful of so-called hyperparameters. The following sections describe a Bayesian prior that provides the researcher with a great deal of control over the relative influence that the lags of every series have on each equation.

Empirical Regularities in All-Cause Age-Specific Mortality

Mortality for U.S. males and females combined and 21 age categories (age 0, ages 1-4, ages 5-9,…, ages 90-94, and ages 95+), is used to fit the BVAR models estimated in this report. The data set was constructed from the period life tables published by

Figure 1: Surface of the logarithmic age profile of mortality (1928-2001).

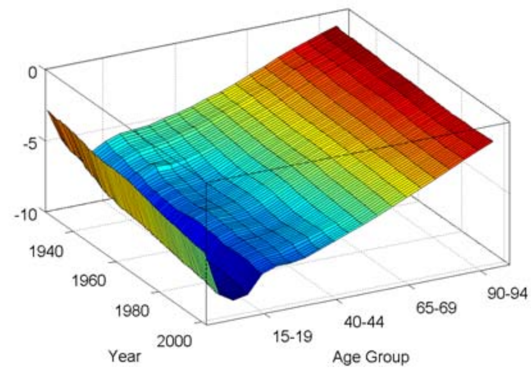


Figure 2: Contours of the logarithmic age profile of mortality (1928-2001).

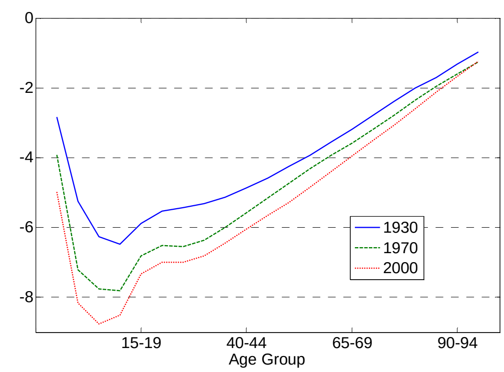
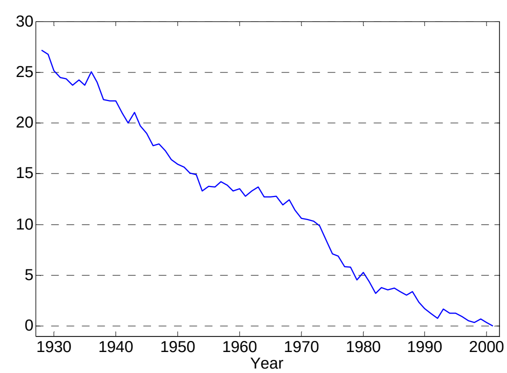


Figure 3: Lee-Carter index of logarithmic mortality (1928-2001).



the Social Security Administration's Office of the Chief Actuary.[1] The sample is restricted to the time frame (1928-2001), so as to exclude the excessive volatility displayed by the series in earlier years (particularly during the 1918 Spanish influenza pandemic). Figures 1, 2 and 3 illustrate a number of features that are common to all-cause age-specific mortality data.

One evident characteristic in the data is the regularity in the shape of logarithmic mortality over the ages, resembling an "elongated v." For any given period, mortality declines smoothly from birth until about ages 10-14 and then, it increases almost linearly for the remaining ages until death. Moreover, for the portion of the sample roughly involving the second half of the 20th century, the death rates experience a sharp increase associated with motor-vehicle fatalities in the 15-19 age group, often referred to as "the accident hump." This can be seen in the surface and contours of the age profile of logarithmic mortality in Figures 1 and 2, respectively.

A second feature of the age profile in all-cause mortality is a downward trend. That is, while mortality across the age groups maintains a fairly regular shape, it also shifts downward over time. This is illustrated in Figure 3, which displays the estimated Lee-Carter mortality index. Evidently, the general level of logarithmic mortality follows a downward trend that is approximately linear over the time period entertained. This empirical regularity is confirmed by the high degree of cross-correlation in the levels of logarithmic mortality, as the death rates move closely together.

Table 1 presents the 21×21 sample correlation matrix for the first difference of logarithmic mortality. Notice how in general, the degree of correlation among the age groups tends to decrease with the order of temporal adjacency. For instance, the sample correlation between age 0 and ages 1-4 is 0.61 (second entry in the first column of Table 1). On the other hand, the correlation in $\Delta\log(y_{i,t})$ between age 0 and ages 95+ is only 0.19 (last entry in the first column of Table 1). This simply implies that age groups that are temporally closer to one another have greater ability at predicting each others movements than those that are far apart. BVAR models can be calibrated to exploit this feature, by having each lag carry a weight that is proportional to the correlation structure in the data.

Bayesian Vector Autoregressions and the Minnesota Prior

Let $L(\theta \mid Y)$ denote a probability model (typically in the form of a likelihood function), where Y represents the observable data and θ is a set of unknown parameters to be estimated. From a Bayesian perspective, a complete model also requires the specification of a prior density on the parameters $\pi(\theta)$. Bayesian inference then proceeds by conditioning on the observables through Bayes's theorem, in order to derive the so-called posterior density

$$\pi(\theta \mid Y) = \frac{\pi(\theta)\, L(\theta \mid Y)}{f(Y)} \propto \pi(\theta)\, L(\theta \mid Y) \qquad (4)$$

The prior density represents any knowledge the researcher has about θ prior to observing the data and provides the means to accommodate any available non-sample information. This information might be guided by statistical theory considerations, empirical evidence from previous analysis or simply, the subjective judgment of the researcher. On the other hand, Bayes's theorem can be thought of as the mechanism through which the sample information contained in the likelihood function modifies the knowledge about θ embodied in the prior. Once the posterior density is derived, it can be used to produce optimal point estimates of the parameters and to construct credible intervals and regions of the parameter space corresponding to some posterior probability.

One problem with vector autoregressions is overfitting, due to the large number of parameters involved. A VAR(p) model with m equations comprises a total of pm^2+m coefficients, in addition to the $m(m+1)/2$ distinct elements in the residual covariance matrix. Overfitting is successfully overcome by the random-walk or Minnesota prior, which derives its name from the research undertaken at the University of Minnesota and the Federal Reserve Bank of Minneapolis. [5] Originally developed as an alternative to the predictions generated by large-scale structural macroeconomic models, BVAR systems under the Minnesota prior have accumulated an impressive forecast record, becoming one of the most widely applied Bayesian time series forecasting approaches to date.[6]

Given an arbitrarily long lag p, the Minnesota prior imposes inexact (stochastic) prior constraints on the model's parameters, based on two premises:

1. The movement over time of the variables being modeled is assumed to be well approximated by a random-walk around an unknown deterministic component.

2. Recent values are likely to contain more useful information about a variable's future direction than more distant ones.

The first prior restriction is well suited to the purposes of this paper, given that most applications of the Lee-Carter method find that a random-walk with drift fits well the general level of mortality. The second constraint is implemented in practice by increasing the prior probability that the coefficients in the model are closer to zero as a function of lag length.

Formally, let a_{ijp} represent the parameter associated with variable j in equation i at lag p, and let σ_{ijp} denote its corresponding prior standard deviation. The Minnesota prior specifies the individual priors of a_{ijp} as independent normal distributions with mean equal to one for the first lag of the dependent variable in each equation, and zero for all other coefficients and all other lags

$$a_{ijp} \sim \begin{cases} N(1,\sigma_{ijp}^2), & \text{for } i=j, \text{ and } p=1. \\ N(0,\sigma_{ijp}^2), & \text{otherwise.} \end{cases} \quad (5)$$

This, of course, centers the prior density for the i^{th} equation around the random-walk specification

$$y_{i,t} = c_i + y_{i,t-1} + e_{i,t}. \quad (6)$$

The standard deviations of the autoregressive coefficients in the Minnesota prior are defined in terms of four hyperparameters (denoted by λ_1, λ_2, λ_3 and λ_4), as follows

$$\sigma_{ijp} = \begin{cases} \dfrac{\lambda_1}{p^{\lambda_3}}, & \text{for } i=j. \\ \dfrac{\lambda_1\lambda_2(i,j)}{p^{\lambda_3}}\left(\dfrac{s_i}{s_j}\right), & \text{for } i \neq j. \\ \lambda_4 s_i, & \text{for } c_i. \end{cases} \quad (7)$$

Notice that for a given equation, three cases can be distinguished: (1) the prior standard deviations on the lags of the dependent variable; (2) those associated with the autoregressive coefficients of the remaining variables; and (3) the standard deviations of the intercept parameters c_i.

Hyperparameter λ_1 represents the prior standard deviation on the first lag of variable i in equation i. For a given equation, decreasing its value has the effect of shrinking the prior density on the coefficient of the first lag of the dependent variable toward one, and the prior densities on all other parameters toward zero. For this reason, λ_1 is often referred to as the "overall tightness" of the Minnesota prior, as it determines how tightly the random-walk specification is imposed a priori.

The second hyperparameter (λ_2) affects the prior standard deviation of variable j in equation i, relative to λ_1. Setting $0< \lambda_2 <1$ shrinks the prior densities of all variables other than the dependent variable toward zero. This implies that for a given equation, variation in the dependent variable is explained to a greater extent by its own lags than by any other variable. By contrast, setting $\lambda_2 = 1$ treats the lags of the dependent and all other variables equally.

Two limiting cases are of particular interest. When $\lambda_2 \rightarrow 0$ each equation follows the functional specification in equation (2), which is a univariate autoregression. In addition, as λ_1 also approaches zero, each equation follows a random-walk with drift instead.

It is important to emphasize that the notation $\lambda_2(i,j)$ indicates the possibility of specifying alternative degrees of shrinkage (values of λ_2) for different variables. In other words, for a given equation, it is possible to allow the lag of each series to assume a different prior weight with which to impact the current value of the dependent variable. Such degree of flexibility can in fact be relied upon to exploit the temporal contiguity relationships in the correlation structure of the data in Table 1. This is accomplished by assigning a smaller value to $\lambda_2(i,j)$ the lower the correlation is between the i^{th} and j^{th} mortality series.

The term p^{λ_3} in the Minnesota prior standard deviations has the effect of shrinking all the coefficients toward their prior means as a function of lag length p. In this case, the hyperparameter λ_3 represents the rate of lag-decay, where a value $\lambda_3 = 1$ implies a harmonic rate of decay. An increase in λ_3 shrinks higher-order lags toward zero more quickly, giving greater importance to more recent lags than to more distant ones.

Finally, hyperparameter λ_4 determines the prior standard deviations associated with the intercept parameters c_i, as well as any exogenous variables introduced in the VAR system. Decreasing λ_4 tightens the prior densities on these parameters around their mean. Typically, in most applications, the Minnesota prior is made noninformative on the intercept coefficients by selecting an arbitrarily large value for λ_4. In addition, the term (s_i/s_j) serves as a scale factor that accounts for variation due to differences in the measurement units of the variables. An "empirical Bayes" approach is followed in practice, estimating s_i from the data as the standard error in a p-lag autoregression of variable i.

Estimation and Inference in BVAR Models

Estimation of BVAR systems can be carried out under different prior distributional assumptions. The models implemented in this report correspond to the normal-diffuse variety[7,6] The latter combines a diffuse prior on the residual covariance matrix and a multivariate normal density on the autoregressive coefficients, with first and second moments respectively defined in equations (5) and (7). This framework offers additional flexibility over other approaches (such as the asymmetric prior treatment of different equations), but comes at the expense of lacking posterior analytical tractability. Fortunately, Markov chain Monte Carlo (MCMC) techniques are well suited for estimation purposes.[2]

All the estimates presented are based on samples of 30,000 posterior parameter draws, which were obtained via Gibbs sampling, after discarding an initial number of 2,000 "burn-in" iterations. The Gibbs sampler is an MCMC algorithm that exploits the tractability of the posterior conditional densities in the specified BVAR systems. Specifically, the posterior conditional density of the regression coefficients is known to be multivariate normal, while the inverse of the residual covariance matrix has a wishart conditional posterior distribution.

Notice that when working with differenced data as it is the case in this study, the prior mean for the first lag of the dependent variable in equation (5) should be set to zero. This implies a first lag coefficient of unity in the levels of logarithmic mortality (which is a random-walk specification). Furthermore, in order to avoid the possibility of explosive behavior when generating mortality projections over very long forecast horizons, the estimated BVAR processes are constrained to the stationary region of the parameter space.

Two alternative Bayesian vector autoregressive specifications are entertained for posterior inference, denoted as BVAR(1)-I and BVAR(1)-II, respectively. Both models involve an overall tightness of $\lambda_1 = 0.3$ and a prior on the intercept coefficients that is made noninformative by setting $\lambda_4 = 10^5$. The first model effectively replicates the functional form in equation (2), that consists of a system of first-order univariate autoregressions with a common residual covariance matrix. This is achieved by selecting $\lambda_2(i,j) = 0.001$, for $i \neq j$. On the other hand, the second model accommodates the temporal contiguity regularities observed in the correlation structure of the data. In particular, letting $\Omega_{i,j}$ denote the corresponding element of the sample correlation matrix in Table 1, the prior lag weights are set to $\lambda_2(i,j) = 0.8 \times \Omega_{i,j}$, for $i \neq j$. In addition, both models involve a harmonic rate of lag decay ($\lambda_3 = 1$), which happens to make no difference, since the selected lag length is $p = 1$.

Posterior Predictive Validation and Model Choice

Thoughtful statistical analysis should address the two related issues of model assessment and model choice. The former investigates how well a model fits the data. The latter deals with selecting the "best" model, given a collection of competing specifications $\{M_1, M_2, \ldots, M_k\}$. From a Bayesian perspective, it is actually possible to determine the posterior probability associated with each model. Therefore, the Bayesian solution to the model selection problem is to choose the model with highest posterior probability.

Formally, the posterior probability associated with model M_j is given by

$$\mathrm{pr}(\mathrm{M}_j \mid Y) = \frac{\mathrm{pr}(\mathrm{M}_j)\, f(Y \mid \mathrm{M}_j)}{\sum_{j=1}^{k} \mathrm{pr}(\mathrm{M}_j)\, f(Y \mid \mathrm{M}_j)}, \qquad (8)$$

Where $\mathrm{pr}(M_j)$ represents the prior probability assigned to model M_j, and $f(Y \mid M_j)$ is the marginal likelihood previously appearing in denominator of equation (4). The latter serves as the normalizing constant that makes the posterior density proper, by forcing it to integrate to one

$$f(Y \mid \mathrm{M}_j) = \int \pi(\theta \mid \mathrm{M}_j)\, L(\theta \mid \mathrm{M}_j)\, d\theta. \qquad (9)$$

Of course, when equal probabilities are assigned to each model then, the specification with the highest posterior probability is also the one with the largest marginal likelihood value.

The accurate estimation of marginal likelihoods is often one of the most challenging computational problems in Bayesian applications. The approach followed in this report exploits a very insightful connection between the marginal likelihood of a model and its predictive density. Let $Y_T^0 = \{y_1^0, y_2^0, \ldots, y_T^0\}$ represent a sample of T observations (where the fact that it is observed is explicitly emphasized with a superscript), and let $Y_F = \{y_{T+1}, y_{T+2}, \ldots, y_F\}$ denote a future (unobserved) sample. The model's predictive density for Y_F is given by

$$P(Y_F \mid Y_T^{\,0}) = \int P(Y_F \mid Y_T^{\,0}, \theta)\, \pi(\theta \mid Y_T^{\,0})\, d\theta. \qquad (10)$$

Once the future sample is observed, the quantity $P(Y_F^0 \mid Y_T^0)$ is known as the predictive likelihood and can be shown to represent the multiplicative factor used to update the marginal likelihood, as new data becomes available.[6] This implies that a model's marginal likelihood can be decomposed in terms of the product of its predictive likelihood factors

$$f(Y_T^0 \mid \mathrm{M}_j) = \prod_{t=1}^{T} P(y_t^0 \mid y_{t-1}^0, y_{t-2}^0, \ldots, y_0^0, \mathrm{M}_j). \qquad (11)$$

Using this approach, the logarithm of the marginal likelihood estimates for the BVAR(1)-I and BVAR(1)-II models are respectively 4,276.5 and 4,478.7. Consequently, the estimates suggest a significant improvement in predictive performance for the second model, as a result of accommodating the temporal contiguity regularities present in the correlation structure of the data (Table 1).

The predictive decomposition in equation (11) emphasizes the link between model selection and the out-of-sample prediction record of the specified models. It formally embodies the maxim that "a model is as good as its predictions." Moreover, by following the predictive route, it is possible to specifically target criteria for model choice that are consistent with the intended use of the models. For instance, the variables directly fit to the BVAR systems in this application are the first differences of logarithmic mortality. However, what matters ultimately is the models' performance in forecasting the mortality rates themselves (their levels), as well as nonlinear functions of the death rates, such as life expectancy at various ages.

Posterior predictive validation represents the Bayesian equivalent of classical goodness-of-fit diagnosis. Let $g(y_t)$ denote any function of the age-specific mortalities. Clearly, given a sample of posterior draws, for every available observation $g(y_t^0)$ there is an associated predictive density $P(y_t \mid y^0_{t\text{-}1},\ldots,y^0_{t\text{-}p},\mathrm{M}_j)$ from which synthetic draws of $g(y_t)$ can be generated. This provides a way to identify any discrepancies between the observed data and the posited model, as well as the means to specify meaningful model selection criteria. In addition, from a computational perspective, the analysis can be carried out in a straightforward fashion as a simple by-product of the posterior simulation.

For all 21 age-specific mortalities, life expectancy at birth and life expectancy at ages 19, 35, 65 and 80, Table 2 presents some useful results for the purposes of model validation and model choice. The first two columns in Table 2 display the sum of squared residuals for the two models, defined as

$$\mathrm{SSR} = \sum_{t=1}^{T}\left(g(y_t^0) - E[g(y_t)]\right)^2. \qquad (12)$$

For ease of presentation, the third column in Table 2 shows the ratio of SSR between the two models. In addition, the last two columns in Table 2 report the percentage of observations in the sample that lie within the 90% credible intervals generated by the models.

Evidently, with the exception of mortality at ages 50-54, the BVAR(1)-II specification achieves a point forecast error reduction for all other projected quantities ranging anywhere between 2% to 22%. This finding is fully consistent with the previously reported marginal likelihood estimates favoring the BVAR(1)-II model. It supports the notion that the lags of other series different from the dependent variable carry useful predictive information. Furthermore, both models produce forecast intervals with an actual probability content that is close to the nominal 90% coverage. Hence, the BVAR systems seem to provide a reasonably good fit to the observed data.

Long-Range Forecasts

Long-rage projections (2002-2075) corresponding to the predictive densities of the BVAR(1)-II model were generated, based on a sample of 30,000 posterior draws. For selected forecast periods, Table 3 presents the 5th, 50th and 95th quantiles of life expectancy at various ages, as well as the width of the resulting interval predictions. Similar results corresponding to the Lee-Carter model are also included for comparison. For the purposes of illustration, Figures 4 through 6 display historical and projected values of life expectancy at birth and ages 35 and 65, while Figures 7 through 9 show equivalent forecasts for mortality at ages 30-34, 60-64 and 75-79.

In general, the point forecasts generated by the BVAR specification are fairly close to those of the Lee-Carter method, with the latter model typically yielding slightly greater increases in mortality improvement over time. For instance, the Lee-Carter projected median life expectancy at birth in the years 2015 and 2075 exceeds the BVAR approach by roughly three and a half weeks and seven months, respectively.

Figure 4: Life Expectancy at birth.

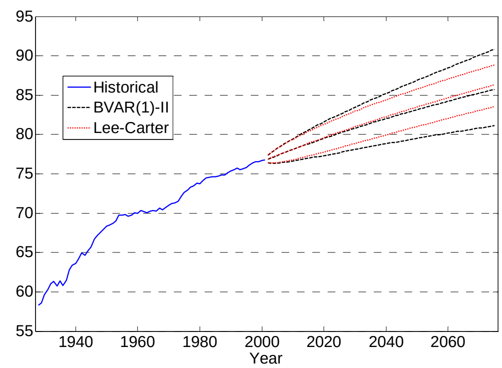


Figure 5: Life Expectancy at age 35.

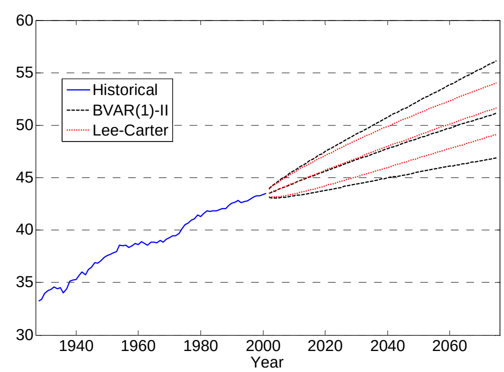
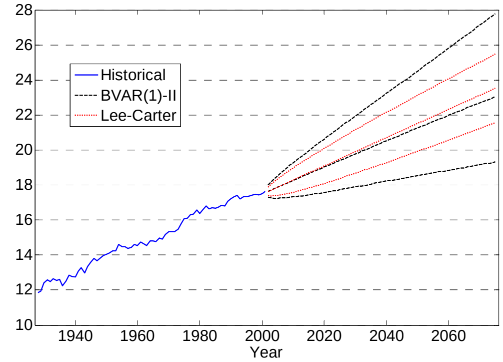


Figure 6: Life Expectancy at age 65.



The credible intervals of the BVAR model, on the other hand, are wider than the corresponding confidence intervals in the Lee-Carter method. This tends to be the case in particular for the older age groups. In other words, the difference among the intervals widens not only as a function of the forecast horizon, but as age increases. For example, the Bayesian interval projections in 2075 for life expectancy at birth, at age 65 and at age 80 are respectively 1.8, 2.2 and 3 times wider than those of the Lee-Carter model.

Figure 7: Mortality at ages 30-34.

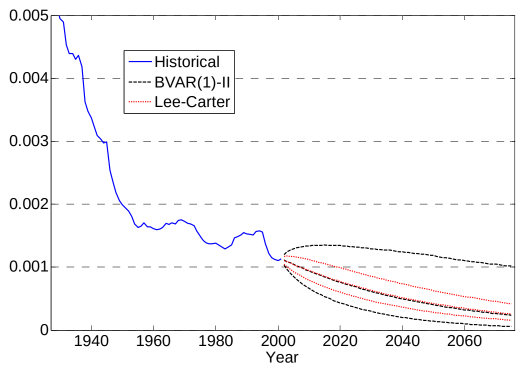


Figure 8: Mortality at ages 60-64.

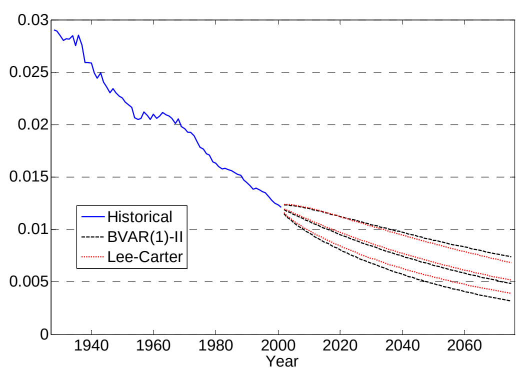
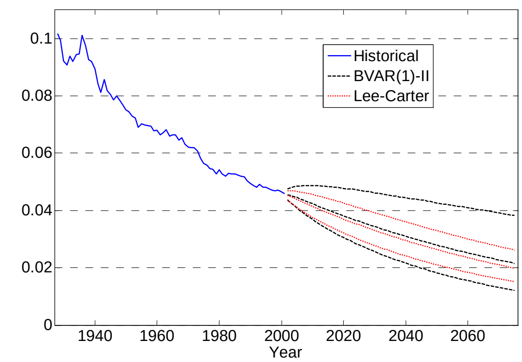


Figure 9: Mortality at ages 75-79.



At this point, it is important to emphasize the methodological distinctions between the two models. Regarding the sources of uncertainty, the Bayesian interval forecasts incorporate variation due to both the sample and parameter outcomes. The Lee-Carter approach does not account for parameter uncertainty. From an empirical stance, the latter model has sometimes been criticized for producing implausibly narrow intervals.[9] Ongoing research by the author of this report has also found a tendency for the Lee-Carter method to generate mortality projections that are "too narrow" for the oldest age groups. Indeed, it is this type of criticism that has led to a number of extensions of the Lee-Carter model, in order to accommodate greater uncertainty in some of the parameter estimates.[8,9] Generally, however, there are both practical and conceptual problems to the notion of parameter uncertainty within the classical inference perspective. This is due to the fact that the sampling distribution of a classical estimator has support on the sample space, not on the parameter outcomes. Hence, the BVAR approach presented in this report seems promising in addressing some of the shortcomings of the Lee-Carter method.

References

1. Bell, F. C. and M. L. Miller (2005). "Life Tables for the United States Social Security Area 1900-2100." *Social Security Administration*, Actuarial Study No. 120, Pub. No. 11-11536. Available at http://www.ssa.gov/OACT/NOTES/s2000s.html.

2. Brooks, S. P. (1998). "Markov Chain Monte Carlo Method and Its Application." *The Statistician* 47(1), 69-100.

3. Congressional Budget Office (CBO) (2001). "Uncertainty in Social Security's Long-Term Finances: A Stochastic Analysis." Available at http://www.cbo.gov/ftpdocs/32xx/doc3235

4. Denton, F. T., C. H. Feaver and B. G. Spencer (2005). "Time Series Analysis and Stochastic Forecasting: An Econometric Study of Mortality and Life Expectancy." *Journal of Population Economics* 18, 203-227.

5. Doan, T., R. Litterman and C. Sims (1984). "Forecasting and Conditional Projection Using Realistic Prior Distributions." *Econometric Reviews* 3, 1-144.

6. Geweke, J. and C. Whiteman (2006). "Bayesian Forecasting." In *The Handbook of Economic Forecasting*. G. E. Clive, W. J. Granger and A. Timmerman, eds. North-Holland: Amsterdam. (Forthcoming).

7. Kadiyala, K. R. and S. Karlsson (1997). "Numerical Methods for Estimation and Inference in Bayesian VAR-Models." *Journal of Applied Econometrics* 12(2), 99-132.

8. Lee, R. D. and L. R. Carter (1992). "Modeling and Forecasting U.S. Mortality." *Journal of the American Statistical Association* 87, 659-671.

9. Lee, R. D. (2000). "The Lee-Carter Method for Forecasting Mortality, with Various Extensions and Applications." *North American Actuarial Journal* 4(1), 80-91.

Table 1: Sample correlation of first difference in logarithmic mortality.

Age	0	1-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95+
0	1.00																				
1-4	0.61	1.00																			
5-9	0.47	0.71	1.00																		
10-14	0.36	0.56	0.73	1.00																	
15-19	0.27	0.57	0.64	0.78	1.00																
20-24	0.29	0.47	0.55	0.67	0.80	1.00															
25-29	0.27	0.49	0.55	0.62	0.78	0.84	1.00														
30-34	0.28	0.47	0.50	0.66	0.74	0.73	0.86	1.00													
35-39	0.25	0.45	0.55	0.63	0.69	0.65	0.83	0.88	1.00												
40-44	0.34	0.46	0.43	0.58	0.67	0.62	0.71	0.78	0.83	1.00											
45-49	0.39	0.41	0.47	0.53	0.57	0.47	0.58	0.61	0.70	0.79	1.00										
50-54	0.40	0.46	0.45	0.38	0.48	0.42	0.51	0.51	0.62	0.73	0.75	1.00									
55-59	0.29	0.24	0.43	0.45	0.48	0.43	0.43	0.44	0.48	0.62	0.74	0.71	1.00								
60-64	0.36	0.27	0.30	0.34	0.34	0.25	0.30	0.36	0.41	0.53	0.67	0.76	0.76	1.00							
65-69	0.32	0.27	0.31	0.34	0.38	0.31	0.34	0.30	0.38	0.56	0.59	0.70	0.73	0.75	1.00						
70-74	0.25	0.19	0.24	0.26	0.27	0.22	0.20	0.21	0.28	0.44	0.50	0.60	0.71	0.79	0.80	1.00					
75-79	0.29	0.27	0.35	0.39	0.34	0.29	0.31	0.27	0.42	0.49	0.56	0.67	0.72	0.73	0.84	0.82	1.00				
80-84	0.28	0.25	0.26	0.30	0.32	0.28	0.25	0.23	0.32	0.49	0.50	0.62	0.69	0.71	0.80	0.87	0.87	1.00			
85-89	0.20	0.10	0.21	0.27	0.23	0.16	0.14	0.15	0.31	0.40	0.46	0.54	0.60	0.65	0.76	0.80	0.86	0.88	1.00		
90-94	0.20	0.10	0.21	0.28	0.24	0.18	0.15	0.15	0.31	0.41	0.46	0.51	0.60	0.62	0.73	0.76	0.85	0.87	0.97	1.00	
95+	0.19	0.12	0.23	0.30	0.25	0.22	0.19	0.17	0.31	0.42	0.46	0.49	0.60	0.58	0.70	0.69	0.82	0.83	0.90	0.97	1.00

Table 2: Posterior predictive validation and model choice.

$g(y_t^0)$	*Sum of Squared Residuals* BVAR(1)-I	BVAR(1)-II	$\frac{\text{BVAR(1)-II}}{\text{BVAR(1)-I}}$	*Coverage of 90% Intervals* BVAR(1)-I	BVAR(1)-II
Age 0	0.107×10^{-3}	0.961×10^{-2}	0.895	93.06	94.44
Ages 1-4	0.122×10^{-5}	0.101×10^{-5}	0.828	95.83	97.22
Ages 5-9	0.946×10^{-7}	0.731×10^{-7}	0.773	95.83	98.61
Ages 10-14	0.639×10^{-7}	0.505×10^{-7}	0.790	97.22	95.83
Ages 15-19	0.298×10^{-6}	0.238×10^{-6}	0.799	95.83	97.22
Ages 20-24	0.963×10^{-6}	0.807×10^{-6}	0.838	95.83	95.83
Ages 25-29	0.737×10^{-6}	0.625×10^{-6}	0.848	97.22	97.22
Ages 30-34	0.657×10^{-6}	0.598×10^{-6}	0.909	93.06	94.44
Ages 35-39	0.923×10^{-6}	0.876×10^{-6}	0.949	94.44	95.83
Ages 40-44	0.120×10^{-5}	0.112×10^{-5}	0.934	95.83	94.44
Ages 45-49	0.158×10^{-5}	0.149×10^{-5}	0.944	95.83	98.61
Ages 50-54	0.351×10^{-5}	0.352×10^{-5}	1.002	94.44	94.44
Ages 55-59	0.644×10^{-5}	0.612×10^{-5}	0.951	93.06	94.44
Ages 60-64	0.126×10^{-4}	0.100×10^{-4}	0.789	94.44	95.83
Ages 65-69	0.249×10^{-4}	0.211×10^{-4}	0.845	95.83	94.44
Ages 70-74	0.654×10^{-4}	0.534×10^{-4}	0.816	97.22	97.22
Ages 75-79	0.231×10^{-3}	0.174×10^{-3}	0.752	94.44	94.44
Ages 80-84	0.588×10^{-3}	0.514×10^{-3}	0.873	95.83	95.83
Ages 85-89	0.163×10^{-2}	0.151×10^{-2}	0.928	95.83	95.83
Ages 90-94	0.310×10^{-2}	0.287×10^{-2}	0.928	95.83	95.83
Ages 95-99	0.474×10^{-2}	0.434×10^{-2}	0.915	95.83	95.83
Life Exp. Age 0	0.683×10^{1}	0.664×10^{1}	0.973	92.96	94.37
Life Exp. Age 19	0.454×10^{1}	0.435×10^{1}	0.957	94.37	94.37
Life Exp. Age 35	0.360×10^{1}	0.333×10^{1}	0.927	94.37	95.77
Life Exp. Age 65	0.201×10^{1}	0.178×10^{1}	0.888	92.96	95.77
Life Exp. Age 80	0.136×10^{1}	0.127×10^{1}	0.931	95.77	97.18

Table 3: Long range projections of life expectancy at various ages (5th, 50th and 95th quantiles)

Life Expectancy at Birth

	BVAR(1)-II				Lee-Carter			
Year	5th	50th	95th	95th -5th	5th	50th	95th	95th -5th
2010	76.56	77.93	79.25	2.69	76.71	77.98	79.18	2.47
2015	76.89	78.66	80.35	3.46	77.16	78.73	80.19	3.04
2025	77.61	80.03	82.35	4.74	78.20	80.16	81.97	3.77
2050	79.43	83.05	86.70	7.27	80.90	83.38	85.64	4.74
2075	81.04	85.64	90.71	9.67	83.46	86.22	88.72	5.26

Life Expectancy at Age 19

	BVAR(1)-II				Lee-Carter			
Year	5th	50th	95th	95th -5th	5th	50th	95th	95th -5th
2010	58.38	59.65	60.88	2.50	58.60	59.69	60.75	2.15
2015	58.63	60.29	61.88	3.25	58.98	60.35	61.66	2.68
2025	59.22	61.50	63.74	4.52	59.88	61.63	63.29	3.41
2050	60.84	64.30	67.89	7.06	62.31	64.62	66.79	4.48
2075	62.27	66.78	71.81	9.54	64.69	67.34	69.79	5.10

Life Expectancy at Age 35

	BVAR(1)-II				Lee-Carter			
Year	5th	50th	95th	95th -5th	5th	50th	95th	95th -5th
2010	43.23	44.35	45.48	2.24	43.40	44.38	45.35	1.95
2015	43.46	44.93	46.41	2.95	43.73	44.98	46.19	2.45
2025	44.01	46.05	48.15	4.15	44.56	46.16	47.71	3.15
2050	45.48	48.67	52.17	6.69	46.79	48.95	51.03	4.24
2075	46.82	51.04	55.99	9.16	49.03	51.56	53.93	4.90

Life Expectancy at Age 65

	BVAR(1)-II				Lee-Carter			
Year	5th	50th	95th	95th -5th	5th	50th	95th	95th -5th
2010	17.30	18.18	19.12	1.82	17.55	18.19	18.85	1.30
2015	17.41	18.57	19.81	2.39	17.77	18.60	19.43	1.66
2025	17.68	19.32	21.14	3.46	18.32	19.41	20.52	2.20
2050	18.50	21.19	24.39	5.89	19.86	21.44	23.03	3.17
2075	19.27	22.97	27.64	8.36	21.49	23.45	25.38	3.88

Life Expectancy at Age 80

	BVAR(1)-II				Lee-Carter			
Year	5th	50th	95th	95th -5th	5th	50th	95th	95th -5th
2010	7.77	8.57	9.44	1.67	8.19	8.58	8.97	0.78
2015	7.73	8.79	9.97	2.24	8.32	8.82	9.33	1.01
2025	7.72	9.22	10.96	3.24	8.65	9.32	10.01	1.36
2050	7.84	10.35	13.46	5.61	9.59	10.61	11.67	2.07
075	7.99	11.49	16.08	8.08	10.64	11.96	13.33	2.69

A Dynamic Analysis of Permanently Extending EGTRRA and JGTRRA: An Application of a Coordinated Calibration of Macroeconomic and Microsimulation Models

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Introduction[1]

The President's budget for fiscal year 2007 included a number of proposals to extend expiring tax provisions. The most significant involved extending the lower marginal rates on ordinary income enacted under the 2001 Economic Growth and Tax Relief Reconciliation Act (EGTRRA) and the preferential rates on individual net capital gains realizations and dividend income enacted under the 2003 Jobs and Growth Tax Relief Reconciliation Act (JGTRRA). The President's budget also proposed raising the alternative minimum tax (AMT) exemption amount and continuing the AMT's unrestricted use of some nonrefundable personal tax credits. Without such an AMT fix, extending EGTRRA and JGTRRA will spur significant growth in the number of taxpayers subject to the AMT.

The Tax Increase Prevention and Reconciliation Act (TIPRA) of 2005 partially fulfills the President's tax agenda.[2] It extends JGTRRA's preferential rates on capital gains and dividend income, but only through the end of calendar year 2010. It also raises the AMT exemption amount, but only through the end of calendar year 2006. It includes no extension of the provisions of EGTRRA set to expire in 2010.

We use The Heritage Foundation's Center for Data Analysis' microsimulation model of the federal individual income tax and the Global Insight (GI) short-term U.S. Macroeconomic Model[3] combined with calibration techniques to analyze the economic and budget effects of permanently extending some of EGTRRA's and JGTRRA's expiring provisions. The extension plan analyzed is similar to that considered by the Treasury Department's Office of Tax Analysis (OTA) in its recent dynamic analysis of the President's tax relief proposals.[4] The plan permanently extends:

- JGTRRA's preferential tax rates on capital gains and dividends,
- EGTRRA's lower marginal tax rates on ordinary income,[5] and
- EGTRRA's provisions raising after-tax income.

Those provisions include the $1000 child tax credit, repeal of the phase out of itemized deductions and personal exemptions, and marriage penalty relief. The extension plan reduces marriage penalties by raising the standard deduction and widening the 15-percent tax bracket for married couples filing a joint return.

The economic and budget effects of this extension plan are measured against the Congressional Budget Office's (CBO's) January 2006 baseline projections.[6] CBO's baseline projections embody the rules and conventions governing a current-services federal budget. Thus, they project gross domestic product (GDP), prices, individual and corporate incomes, and net federal saving, among other economic and budget variables, over the 10-year

[1] The analysis and conclusions presented here are strictly those of the authors. They should not be interpreted as reflecting the views of The Heritage Foundation. All references to this paper in publications should be cleared with the authors.

[2] For additional details on TIPRA's provisions, see Joint Committee on Taxation, "Estimated Revenue Effects of the Conference Agreement for the 'Tax Increase Prevention and Reconciliation Act of 2005'," JCX-18-06, May 9, 2006, at *www.house.gov/jct/x-18-06.pdf*.

[3] The GI model is used by private-sector and government economists to estimate how important changes in the economy and public policy are likely to impact major economic indicators. The methodologies, assumptions, conclusions, and opinions presented here are entirely the work of analysts at The Heritage Foundation's Center for Data Analysis. They have not been endorsed by, and do not necessarily reflect the views of, the owners of the Global Insight model.

[4] See U.S. Department of the Treasury, Office of Tax Analysis, "A Dynamic Analysis of Permanent Extension of the President's Tax Relief," July 25, 2006, at *www.treasury.gov/press/releases/reports/treasurydynamicanalysisreporjjuly252006.pdf*.

[5] For additional information on EGTRRA's expiring provisions, see Joint Committee on Taxation, "Summary of Provisions Contained in the Conference Agreement for H.R. 1836, The Economic Growth and Tax Relief Reconciliation Act of 2001," JCX-50-01, May 26, 2001, at *www.house.gov/jct/x-50-01.pdf*.

[6] For additional details on CBO's January 2006 baseline projections, see Congressional Budget Office, *The Budget and Economic Outlook: Fiscal Years 2007 to 2016*, January 2006, at *www.cbo.gov/ftpdocs/70xx/doc7027/01-26-BudgetOutlook.pdf*. For a discussion of CBO's current-law federal budget baseline, see Christopher Williams, "What Is a Current-Law Economic Baseline?" Congressional Budget Office Economic and Budget Issue Brief, June 2, 2005, at *www.cbo.gov/ftpdocs/64xx/doc6403/EconomicBaseline.pdf*.

budget period assuming the continuation of current levels of federal spending.

They also assume current-law tax policy. Thus, CBO's January 2006 baseline projections assume that the preferential tax rates on individual capital gains and dividend income enacted under JGTRRA expire in 2008 and the lower marginal rates on ordinary income enacted under EGTRRA expire in 2010. As a result of its current-law assumptions, CBO projects a sharp increase in current-law federal income tax revenues and some slowdown in economic activity after 2010.

When compared to CBO's baseline, our results indicate that permanently extending EGTRRA and JGTRRA produces modest economic gains. Between 2011 and 2016, real (inflation-adjusted) GDP is on average over 0.5 percent higher, and an average of over 700,000 new jobs are created. Individual incomes and the federal personal income tax base also expand, helping to reduce the cost of the extension plan to the Treasury.

The remainder of the paper is organized as follows. The next section discusses the extension plan in greater detail. The third section discusses our procedures for calibrating to CBO's baseline projections and for simulating the economic and budget effects of a change in tax policy. The fourth section considers the revenue and marginal rate effects of the extension plan as estimated using the microsimulation model. The fifth and sixth sections in turn consider the dynamic economic and budget effects of the extension plan. We estimate the dynamic budget effects using both the Global Insight model and the microsimulation model. The final section offers concluding remarks.

The Extension Plan

The extension plan permanently extends a select set of the tax provisions enacted under the 2001 and 2003 tax laws. CBO's January 2006 baseline projections assume that most provisions of EGTRRA expire at the end of calendar year (CY) 2010. However, they assume that JGTRRA's preferential rates on capital gains and dividend income expire at the end of CY 2008. This is because TIPRA's 2-year extension of JGTRRA's capital gains and dividend provisions was not current law at the time CBO prepared its January 2006 baseline projections. In this paper, 'current law' refers to current law as defined by CBO in January 2006.

The extension plan includes three broad components.

Permanently Extend JGTRRA's Preferential Tax Rates on Capital Gains and Dividend Income. With no change in current law, tax rates on individual net capital gains realizations are set to revert to 10 or 20 percent and individual dividend income will be taxed at ordinary income tax rates beginning in 2009. The extension plan permanently lowers the maximum capital gains tax rate to 15 percent. It applies a capital gains tax rate of 0 percent to realizations otherwise taxed at the regular marginal income tax rate of 10 percent. Qualified dividends will be taxed at the same rates applying to capital gains.

Permanently Extend EGTRRA's Lower Marginal Tax Rates on Ordinary Income. With no change in current law, ordinary tax rates are set to revert to their pre-EGTRRA levels in 2011. Pre-EGTRRA law includes five regular marginal tax rates—15 percent, 28 percent, 31 percent, 36 percent, and 39.6 percent. Table 1 shows our projections of the tax rate structure for single filers and married couples filing a joint return assuming no extension of EGTRRA's marginal rate provisions.

Under the extension plan, EGTRRA's 10-percent tax bracket is made permanent for a portion of income that would otherwise be taxed at the 15 percent rate. The 10-percent taxable income bracket is projected to end at $8,500 for singles and $17,000 for married couples in 2011. The end-point for the 15 percent bracket remains roughly the same for singles but increases for married couples. The widths of the remaining four brackets change very little.[7] However, the associated regular marginal tax rates are reduced to 25 percent, 28 percent, 33 percent, and 35 percent, respectively.

Permanently Extend Provisions of EGTRRA Increasing After-tax Income. With no change in current law, the child tax credit will fall to $500 in 2011 for each qualifying child under the age of 17. It will generally not be refundable except for families with three or more qualifying children. Under the extension plan, the child tax credit is $1000 per child, and the credit is partially refundable.

In addition, with no change in current law, marriage penalties will increase. This is because the standard deduction and the 15-percent tax bracket are set to revert to their pre-EGTRRA levels in 2011. Under pre-EGTRRA law, the basic standard deduction for a married couple filing a joint return is 1.67 times the basic standard deduction for an individual filing a single return. Similarly, under pre-EGTRRA law, the top of

[7] In Table 1, inflation adjustment accounts for small differences between projections of the pre-EGTRRA tax brackets and the extension plan tax brackets. In law, the base amount for the widths of the 25-percent, 28-percent, 33-percent, and 35-percent brackets do not change.

the regular 15-percent tax bracket for a married couple filing a joint return is 1.67 times the top of the regular 15-percent bracket for a single filer. Under EGTRRA, the basic standard deduction and the top tax bracket amount for a married couple filing a joint return are twice the amount for a single filer. The extension plan makes permanent EGTRRA's increase in the standard deduction and widening of the 15-percent bracket.

Finally, with no change in current law, the phase-out of itemized deductions and personal exemptions will be re-instated. We project that most taxpayers with adjusted gross income (AGI) exceeding $169,550 in 2011 will have to reduce their itemized deductions. Single filers with AGI greater than $169,550 and married couples filing a joint return and having an AGI exceeding $254,300 will also have to reduce their personal exemptions. Under the extension plan, itemized deductions and personal exemptions will not phase out.

Model Calibration and Tax Policy Simulations

We calibrate two models to CBO's baseline projections.[8] We typically use both models to evaluate proposed changes in tax policy. The first model is the Global Insight short-term U.S. Macroeconomic Model. The second is a proprietary microsimulation model of individual income tax returns developed by analysts at The Heritage Foundation's Center for Data Analysis.

A CBO-like baseline forecast is constructed using the Global Insight model and the details that CBO publishes about its economic and budgetary projections. We calibrate the GI model to match CBO's published baseline projections. We use the resulting CBO-like forecast to infer the implications of CBO's current-law assumptions for key macroeconomic variables like personal consumption and the components of national income and product accounts (NIPA) personal income. In combination with Statistics of Income (SOI) data, the microsimulation model uses the CBO-like baseline revenue forecast and estimated relationships between NIPA personal income and non-NIPA taxable income to project individual income tax data that are consistent with CBO's published baseline projections.

Calibrating the Macroeconomic Model. We first calibrate the Global Insight model to CBO's published economic projections and NIPA federal revenue and spending projections.[9] Calibrating the Global Insight model to CBO's current-law baseline involves iteratively adjusting a control forecast.[10] In each step of the calibration procedure, we set variables in the GI model to replicate CBO's published baseline projections. We then solve the GI model so that those variables that have not been targeted adjust.

Calibration of the GI model to CBO's baseline projections proceeds in seven steps.

Step 1. We first set key forecast assumptions and economic variables. Key forecast assumptions include the price of oil, the value of the trade-weighted U.S. dollar exchange rate, and the federal social insurance tax rate. Key economic variables include the unemployment rate, the 3-month Treasury bill rate, the 10-year Treasury note rate, and price levels.

Setting price levels early in the calibration procedure is critical because many exogenous federal spending variables in the Global Insight model are in real terms. Thus, a price level variable is needed to convert CBO's nominal baseline budgetary projections for those variables into consistent real targets.

Step 2. We set federal spending net of federal interest payments. Federal spending broadly includes consumption spending, transfer payments, and other spending items in the federal government's budget.

CBO publishes its projections for most—but not all—of the GI model's NIPA federal spending variables. In those instances where CBO does not provide NIPA baseline projections, we derive needed targets using either the GI control forecast or CBO's published projections of budget (unified) federal outlays.

Step 3. We adjust the components of GDP so that they are consistent with not only CBO's projections of real GDP and federal spending but also CBO's current-law assumptions. This means that we consider the difference between current law and the control forecast when deriving a target for real personal consumption.

A target for real personal consumption obtained using information strictly from the control forecast is likely to

[8] For additional details, see Tracy L. Foertsch and Ralph A. Rector, "Calibrating Macroeconomic and Microsimulation Models to CBO's Baseline Projections," *The IRS Research Bulletin: Recent Research on Tax Administration and Compliance*, Publication 1500, forthcoming 2006. A more detailed working paper version is available upon request.

[9] Global Insight provided a detailed outline of a methodology for calibrating the GI model to CBO's baseline projections. We created a series of programs to automate the process based on that outline, making adjustments and additions to GI's basic methodology where appropriate. The routines are written in AREMOS, Global Insight's proprietary modeling language.

[10] GI's February 2006 U.S. Macroeconomic forecast is used as the control.

be too high. This is because the control forecast assumes a partial extension of those tax relief provisions in EGTRRA and JGTRRA set to expire in 2010. As a result, the control forecast projects a far more gradual increase than does CBO in NIPA personal income tax revenues as a share of GDP. Unsurprisingly, it also projects higher levels of NIPA personal disposable income as a share of GDP—particularly after 2010.

We derive a target for real personal consumption using both statements from the *Budget and Economic Outlook* about CBO's expectations for annual rates of growth in personal consumption and some judgment about the likely impacts on personal saving of not extending EGTRRA's and JGTRRA's expiring provisions.

Step 4. We derive a target for potential (full-employment) GDP that is consistent with CBO's projections of the rates of growth in potential GDP and the potential labor force. CBO does not regularly publish levels estimates of either potential GDP or the potential labor force. Thus, we adjust the levels of both variables in the control forecast to be consistent with CBO's published growth rate projections.

Step 5. We adjust the components of NIPA taxable personal income.[11] CBO's NIPA taxable personal income includes wage and salary income, personal interest income, personal dividend income, personal rental income, and proprietors' income. CBO typically publishes projections of only NIPA taxable personal income and wage and salary income.[12]

We rely upon information from the control forecast when deriving targets for the remaining components of NIPA taxable personal income. To the extent possible, we also adjust any targets we derive so that they better reflect CBO's current-law assumptions.

Step 6. We adjust the CBO-like forecast to be consistent with CBO's baseline projections of NIPA federal tax receipts. NIPA federal tax receipts include taxes from the rest of the world, taxes on production and imports, and taxes on personal and corporate incomes.[13] CBO publishes projections for all three.

Setting federal taxes on personal and corporate incomes in the CBO-like forecast requires that we separately target both average effective federal income tax rates and the GI model's federal personal and corporate income tax bases. In the GI model, the federal personal income tax base is a function of both NIPA taxable personal income and individual capital gains. Thus, we adjust our target for the federal personal income tax base to reflect CBO's projections of capital gains.

The GI model also includes an approximation of the federal corporate income tax base. It defines the federal corporate income tax base as before-tax corporate (book) profits minus rest-of-world corporate profits and the profits of the Federal Reserve. We target CBO's published projections of corporate profits only indirectly by iteratively modifying the statistical discrepancy in the CBO-like forecast. We do so because corporate profits are a residual of gross national product (GNP) and, as such, cannot simply be replaced in the CBO-like forecast with CBO's published projections.[14]

Step 7. We complete calibration of the GI model to CBO's baseline projections by setting the stock of publicly-held federal debt to be consistent with CBO's published projections of unified federal surpluses. In addition, we fine tune average effective federal tax rates on personal and corporate incomes and for federal contributions to social insurance so that the final CBO-like forecast is consistent with CBO's published projections of federal tax receipts.

Calibrating the Microsimulation Model. We next calibrate the microsimulation model of individual income tax returns to CBO's baseline projections. The final CBO-like forecast provides income, price level, and some budgetary variables used in this calibration.

Primary Components of the Microsimulation Model. The microsimulation model consists of three primary components—the core base-year data, a federal income tax and payroll tax calculator, and an optimizing routine that ages (extrapolates) the core base-year data. The first

[11] CBO publishes its projections of NIPA taxable personal income in the January release of *The Budget and Economic Outlook*. See Congressional Budget Office, *The Budget and Economic Outlook: Fiscal Years 2007 to 2016*, January 2006, Table 4-3, p. 86, at *www.cbo.gov/ftpdocs/70xx/doc7027/01-26-BudgetOutlook.pdf*.

[12] For its August 2006 economic and budgetary projections, CBO published for the first time details about how it forecasts the components of gross domestic income. See Angelo Mascaro, "How CBO Forecasts Income," Congressional Budget Office Background Paper, August 2006, at *www.cbo.gov/ftpdocs/75xx/doc7507/08-25-Income.pdf*.

[13] Contributions for federal social insurance are also included in NIPA federal tax receipts. They are set to CBO's baseline revenue projections in step 1.

[14] The GI model defines corporate (book) profits as GNP net of consumption of fixed capital, taxes on production and imports, transfer payments by business, interest payments by business, net surpluses of government enterprises, employer-paid payroll taxes, wage and salary income, other labor income, proprietors' income, personal rental income, and the statistical discrepancy.

component consists of individual tax return data and demographic data in the base year. The second component reads a data file and replicates the process of calculating individual income and payroll taxes in the base year and future years. The third component ages the base-year data to reflect projected changes in not only key demographic and economic aggregates but also the distribution of income.

Aging the core base year data involves four major steps. In each, we target tax and non-tax variables in the microsimulation model.

Step 1. We first use the CBO-like forecast to update all nominal income values on individual tax returns. We also update all targets for demographic variables.

Step 2. We next sequentially target four broad measures of individual income by percentile class. Total income is divided into wages and salaries, business income, non-capital gains investment income, and income from other sources. It encompasses both gross income reported on individual tax returns (gross tax return income) and non-taxable income.[15]

Step 3. We next target more detailed measures of the components of gross tax return income. Most of the targets are for components of NIPA personal income, with some important exceptions. Those exceptions include small business corporation (S-Corporation) net income, taxable pension and annuity income, net capital gains, and gains from the sale of other assets.[16]

The final CBO-like baseline forecast provides a number of NIPA measures of personal and business income. Those NIPA income measures include wage and salary income, investment income, proprietors' income, other business income, transfer payments to persons, and corporate profits.

We use NIPA data to estimate the amount of income reported on tax returns.[17] We also use NIPA data to estimate other NIPA-based components of gross tax return income. Those components include proprietors' (farm and non-farm) gains and net losses, [18] income from rents and royalties, income from trusts and estates, and the pass-through net income from S-Corporations that is included in NIPA corporate profits. Social Security income is introduced as a separate target because a portion of Social Security benefits are included in taxable income.

Differences between NIPA measures of personal income and measures of gross tax return income can be substantial. This is because NIPA personal income and gross tax return income are defined differently and are constructed using data from different sources. The BEA produces annual tables that compare the two measures of income. Those tables identify and provide estimates of the adjustments needed to reconcile the definitional and reporting differences. Those reconciliation adjustments are used to calculate an "adjusted" personal income that approximates AGI. The discrepancy between "adjusted" personal income and AGI is called the "AGI gap." We forecast a combination of data about personal income, reconciliation adjustments, and the AGI gap to develop separate estimates for the NIPA-based components of gross tax return income.

The sum of our forecasts of the components of NIPA-based income and non-NIPA-based income approximates the taxable income base that CBO uses to project federal receipts from the individual income tax. CBO does not provide its projections for most of the components of gross tax return income. As a result, there can be differences between income amounts we use and those projected by CBO.

Step 4. Finally, we compare CBO's projections of individual income tax collections with estimates of tax liability calculated by the microsimulation model. Tax payments are divided into withholding, estimated payments, and final payments. The payments are aggregated to estimate fiscal year revenue collections. An additional adjustment is made to reflect payments for fees, penalties, and other collections.

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[15] Gross tax return income here refers to a broad income measure that approximates the Internal Revenue Code's definition of gross income reported on Form 1040.

[16] We obtain projections of capital gains realizations from Congressional Budget Office, *The Budget and Economic Outlook: Fiscal Years 2007 to 2016*, January 2006, Table 4-4, p. 92, at *www.cbo.gov/ftpdocs/70xx/doc7027/01-26-BudgetOutlook.pdf*. We develop independent estimates for the remaining non-NIPA sources of personal income.

[17] In estimating detailed personal income targets, we rely upon unpublished tables comparing the components of NIPA personal income and Internal Revenue Service (IRS) federal adjusted gross income. Those tables are available from BEA upon request. We also rely upon annual *Survey of Current Business* articles describing the major categories used to reconcile the differences between personal income and federal AGI. Additional details can be found in Mark A. Ledbetter, "Comparison of BEA Estimates of Personal Income and IRS Estimates of Adjusted Gross Income, New Estimates for 2001, Revised Estimates for 1959-2000," *Survey of Current Business*, April 2004, pp. 8-22, at *www.bea.gov/bea/ARTICLES/2004/04April/0404PI&AG.pdf*.

[18] NIPA does not separately report the sum of gains and losses for proprietorships or other businesses. Losses are instead added to gains to give an aggregate net amount of proprietorship income. Thus, we use IRS data to estimate the historical relationship between the aggregate amount of proprietors' income and the amount of net gains and losses.

We modify our targets for the distribution of gross tax return income by size of income by marital filing status when there are material differences in the revenue projections. Adjustments may be needed because a large proportion of the total federal income tax is paid by a relatively small proportion of taxpayers at the top end of the income distribution. Slight changes in assumptions about the number of tax returns in the top classes can produce significant changes in total revenue projections.

Simulating the Economic and Budget Effects of a Change in Tax Policy. Calibrating a macroeconomic model of the U.S. economy and a microsimulation model of the federal individual income tax to a common baseline yields a consistent starting point for dynamic policy analysis. We apply an additional calibration process to ensure that final dynamic revenue estimates from the macroeconomic model are broadly consistent with revenue estimates from the microsimulation model.

We regularly calibrate both the Global Insight model and the microsimulation model to CBO's baseline projections. We also regularly use the calibrated macroeconomic and microsimulation models to analyze a variety of tax proposals. Tax data in the microsimulation model can be used to provide a "stand-alone" revenue estimate. A revenue estimate from the microsimulation model can also be introduced into the GI model to generate a "first-round" dynamic estimate of a proposal's economic and budget effects.[19] A fully-dynamic tax policy simulation proceeds in three steps.

First, we use the microsimulation model to estimate the revenue effects of the proposed change in tax policy under baseline economic assumptions. The proposed tax policy can involve a change in current-law federal income tax rates, a change in the federal personal income tax base, or both. The microsimulation model is used to estimate the change in federal income tax revenues. It also produces estimates of marginal tax rates on three types of income—ordinary income, long-term capital gains realizations, and dividend income.

Second, we use the Global Insight model to estimate the dynamic revenue effects of the same policy change. Estimated changes in federal tax revenues and marginal tax rates from the microsimulation model are used as inputs into a simulation with the GI model. The macroeconomic simulation produces an alternative to the CBO-like baseline forecast. That alternative (non-baseline) forecast includes the dynamic effects of the proposed policy on GDP, prices, interest rates, employment, and personal and corporate incomes.

Third, we update the microsimulation model to reflect the dynamic effects of the proposed tax policy on personal and business incomes. We update personal and business incomes in the microsimulation model using procedures similar to those developed for baseline calibration. Thus, NIPA components of personal and business income, price level variables, and some NIPA budget variables from the alternative forecast are used to estimate target values for non-taxable income and gross tax return income on individual income tax returns. We use those targets to update personal and business incomes in the microsimulation model so that they are consistent with the GI model's alternative forecast for the components of NIPA personal income.

For major tax proposals, we typically continue to iterate between the microsimulation model and the Global Insight model.[20] Thus, we use revenue estimates and marginal rates from the updated microsimulation model to adjust the alternative forecast from the GI model so that it better reflects the effects of the tax proposal.

We compare these revenue estimates when evaluating results from the Global Insight model and the microsimulation model. We consider the tax-policy simulation complete if differences between the estimated changes in federal tax revenues from the GI model and the microsimulation model are minimal or can be accounted for by definitional and other differences in the federal personal income tax bases.

We followed this iterative procedure in estimating the economic and budget effects of the extension plan. Revenue estimates from the two models converged after only three iterations (see Figure 1). In the first iteration, the total change in personal income tax revenues implied by the Global Insight model exceeded the total change in estimated individual income tax revenues implied by the microsimulation model by almost $54 billion over 10 years. By the third iteration, well under $1 billion dollars separated the estimated total changes in income tax revenues from the two models.

Revenue Estimates and the Marginal Rate Effects of the Extension Plan

We show two sets of revenue estimates (see Table 2A).[21] Revenue estimates from the *baseline* forecast

[19] See Tracy L. Foertsch and Ralph A. Rector, "The Economic and Budgetary Effects of the Katrina Emergency Tax Relief Act of 2005," White Paper, September 21, 2005, at *www.heritage.org/Research/Taxes/wp20050921.cfm*.

[20] See Tracy L. Foertsch and Ralph A. Rector, "Economic and Budget Effects of a Two-Period Revenue Neutral Flat Tax," Unpublished Working Paper, August 2006.

[21] In Table 2A, estimated changes in federal individual income tax revenues include net refundable credits.

exclude the macroeconomic ("dynamic") effects of the extension plan on individual, non-corporate business, and corporate incomes. This is because the baseline simulation starts from CBO's January 2006 baseline income projections and gives the revenue effects of the extension plan under conventional assumptions. Thus, the revenue estimates assume that changes in tax policy have no effect on baseline projections of GDP, prices, incomes, or net federal saving, among other economic and budget variables.

Revenue estimates from the *income-adjusted* forecast include the macroeconomic effects of the extension plan on CBO's baseline projections. This is because the income-adjusted forecast updates the federal individual income tax base in the baseline forecast to reflect the economic and budget effects of extension. For the same change in tax policy, revenue estimates from the income-adjusted forecast can differ substantially from those from the baseline forecast.

Revenue estimates starting from CBO's baseline income projections put federal income tax revenues $1,048.8 billion below CBO's baseline revenue projections over the 10-year budget period (see "Estimate from the Baseline Forecast" in Table 2A).[22] In comparison, in February 2006, Treasury estimated the revenue effects (including outlays for changes in net refundable credits) of extending EGTRRA's lower tax rates on ordinary income, JGTRRA's preferential tax rates on capital gains and dividend income, and EGTRRA's $1000 child tax credit and marriage penalty relief at about -$1,022.4 billion.[23] The income-adjusted forecast implies a smaller reduction in federal income tax revenues (see "Estimate from the Income-Adjusted Forecast" in Table 2A). It puts federal income taxes $866.9 billion below CBO's baseline federal revenue projections over 10 years.

The estimated change in federal income tax revenues would be significantly higher, nearly twice as large in the income-adjusted forecast, if not for the change in revenues from the AMT. The extension plan includes no additional increases in the AMT exemption amount or indexing of the AMT brackets to inflation. Without these, an ever larger number of middle-to-upper income taxpayers will fall prey to the AMT. For example, Treasury estimates that with permanent extension of EGTRRA and JGTRRA and no additional AMT relief, the number of individual AMT taxpayers will jump from 5.5 million in 2006 to almost 26 million in 2007 and over 56 million in 2016.[24]

For these taxpayers, the tax reductions under the extension plan have the effect of putting the regular income tax liability below the minimum tax liability, making the taxpayers subject to the AMT. The increased difference between the minimum tax liability and the regular income tax liability has been characterized as a "claw back."[25] The estimated change in federal income tax revenues is less than it otherwise would be because the AMT takes back tax reductions from the extension plan in this way.

Comparing the Extension Plan's Marginal Rate Effects to Treasury's Dynamic Analysis of the President's Tax Proposals. The OTA recently estimated the effect on average marginal tax rates of permanently extending EGTRRA's lower rates on ordinary income, JGTRRA's preferential rates on capital gains and dividend income, and EGTRRA's provisions raising after-tax income. We estimate the effects of a similar extension plan. Between 2011 and 2016, the income-adjusted forecast gives average percent changes in the marginal tax rates on capital gains and dividend income that are similar to those obtained by the OTA (see Table 2B). In addition, our estimated average percent change in the marginal tax rate on ordinary income is in line with OTA's estimated average percent changes in marginal tax rates on wages, interest income, and business income.

Dynamic Economic Effects of the Extension Plan

The extension plan has a positive economic impact (see Table 3). Between 2011 and 2016, total employment expands by an average of over 700,000 jobs annually, and the unemployment rate drops an average of 0.1 percentage points. That drop in the unemployment rate occurs despite the increase in the rate of labor force participation spurred by lower marginal tax rates on labor income. Over the same period, real disposable income rises by nearly $200 billion, and personal saving

[22] Here, baseline revenue projections equal the sum of CBO's current-law projections of estate, business, and individual income tax revenues.

[23] See U.S. Department of the Treasury, *General Explanations of the Administration's Fiscal Year 2007 Revenue Proposals*, February 2006, pp. 143-146, at *www.ustreas.gov/offices/tax-policy/library/bluebk06.pdf#search=%22general%20explanations%20of%20the%20administration's%20fiscal%20year%202007%22*.

[24] See U.S. Department of the Treasury, Office of Tax Policy, "Tax Relief Kit—The Toll of Two Taxes: The Regular Income Tax and the AMT," 2006, at *www.ustreas.gov/offices/tax-policy/library/tax_relief_kit.pdf*.

[25] As defined here, "claw back" is the result of a phase-out of the AMT exemption amount for taxpayers with high levels of AMT income. See Gregg Esenwein, "The Alternative Minimum Tax (AMT): Income Entry Points and "Take Back" Effects," Congressional Research Service Report for Congress, Order Code RS21817, February 10, 2005.

climbs sufficiently to push the personal saving rate 0.8 percentage points above baseline levels.

Permanently extending JGTRRA's preferential rates on capital gains and dividend income permanently reduces the cost of capital to business. Real non-residential fixed investment responds positively, climbing an average of nearly $9 billion annually between 2011 and 2016. The economy's stock of productive capital is bolstered as a result, and real potential GDP expands in every quarter between 2009 and 2016. Reflecting that increase in the economy's productive potential, real GDP exceeds CBO's baseline projections by $60.2 billion by 2016.

Two factors mitigate the economic benefits of the extension plan. First, in the simulations, rising output and falling rates of unemployment prompt the Federal Reserve to increase the federal funds rate despite little change in the rate of CPI inflation.[26] Yields on Treasury notes and bills and on corporate and other debt rise as a result, increasing the cost of capital to business. Second, the ever expanding reach of the AMT nearly halves the size of the tax reduction under the extension plan (see Table 2A), curtailing gains in personal disposable income, personal consumption, and saving. It also boosts the average effective marginal tax rate on ordinary income, in some cases offsetting the incentives for supplying more labor.[27]

Minimizing the Disincentives Caused by Taxation. The dynamic economic effects simulated here stem primarily from reducing the disincentives to work, save and invest created by the expiration of those provisions of EGTRRA and JGTRRA lowering marginal tax rates on capital gains, dividend income, and ordinary income.[28] Permanently extending the $1000 child tax credit, repeal of the phase out of itemized deductions and personal exemptions, and marriage penalty relief also have some effect on economic activity. However, they tend to do so by increasing after-tax incomes.[29]

In general, tax relief measures that reduce marginal tax rates on capital and labor income will produce bigger gains in GDP than do measures that only tinker with the size of after-tax income. This is because cuts in marginal tax rates both increase the after-tax wage rate and lower the cost of capital. They therefore tend to encourage individuals to work more and businesses to invest. Increases in labor supply, saving, and the domestic capital stock follow.

New or bigger personal deductions and tax credits typically do not have the same incentive effects. They do little to spur employment and new business investment. And they boost after-tax incomes, not after-tax wage rates. Thus, individuals can increase or even maintain the same level of after-tax income by working the same or fewer hours.

Comparing the Extension Plan's Economic Effects to Treasury's Dynamic Analysis of the President's Tax Proposals. The OTA recently simulated the dynamic economic effects of permanently extending EGTRRA's lower marginal rates on ordinary income, JGTRRA's preferential rates on capital gains and dividend income, and EGTRRA's provisions raising after-tax income. For the 2011 to 2016 period, our results are broadly similar to those obtained by the OTA for real GNP and personal consumption (see Table 4).

The OTA also estimates the impact of extending EGTRRA's and JGTRRA's expiring provisions on investment and capital accumulation. However, comparing our results to those of the OTA for both aggregates is somewhat problematic. This is because the OTA uses a large-scale intertemporal general equilibrium model.[30] In such models, the government is subject to an intertemporal budget constraint. Specifically, the government can initially—but not indefinitely—finance tax cuts or higher spending with new borrowing and deficits.

The OTA imposes the government's intertemporal budget constraint using "financing" rules. Between 2007 and 2016, the federal government finances the extension of EGTRRA's and JGTRRA's expiring

[26] We use an econometrically-estimated reaction function in the GI model that adjusts the effective interest rate on federal funds in response to changes in the unemployment rate and the rate of inflation in the CPI.

[27] For additional details on the impact of AMT on average marginal tax rates and labor supply, see Joint Committee on Taxation, "Present Law and Background Relating to the Individual Alternative Minimum Tax," JCX-37-05, May 20, 2005, at *www.house.gov/jct/x-37-05.pdf#search=%22jct%20capital%20gains%20phase%20out%20range%22*.

[28] An earlier draft of this paper includes additional details on how we simulate the responses of labor and investment to permanently extending EGTRRA's lower marginal rates on ordinary income and JGTRRA's preferential rates on capital gains and dividend income.

[29] We model refundable credits as a change in federal transfer payments to persons and, thus, a change in federal outlays.

[30] For additional details, see John Diamond and George Zodrow, "Description of the Tax Policy Advisers' Model," Unpublished Working Paper, Rice University, March 15, 2005. The OTA uses a four-sector version of the Tax Policy Advisers' overlapping-generations general equilibrium model.

provisions with deficits and new debt. However, beginning in 2017, it either cuts government consumption or proportionately increases tax rates on corporate, individual, and capital income to limit the growth rate of debt to the growth rate of GNP. Tax relief is permanent if it cuts government consumption. Tax relief is only temporary if it proportionately increases income tax rates.

How the government imposes its intertemporal budget constraint influences the timing of firms' investment decisions.[31] The simulated effects of the extension plan in this paper do not include intertemporal shifting in the timing of investment spending. This is because the Global Insight model is a large-scale macroeconometric model. It imposes the long-run structure of a neoclassical growth model but makes short-run demand dynamics a primary focus of analysis. With a forecast horizon that does not extend beyond 10 years, it does not require that the government's fiscal policy be sustainable in the long run and, hence, does not impose an intertemporal government budget constraint.

Dynamic Budget Effects of the Extension Plan

The extension plan puts federal tax revenues $696.4 billion below CBO's baseline projections ("Total Receipts with Income-Adjusted Projections" in Figure 2). We estimate that the revenue loss to the Treasury would be much higher, $991.9 billion ("Individual Income Tax with Baseline Projections" in Figure 2), if not for the dynamic effects of the extensions on incomes and federal tax collections.[32] Over 10 years, the dynamic revenue feedbacks equal the difference between -$696.4 billion and -$991.9 billion. In 2009 and 2010, dynamic revenue feedbacks do not exceed about $9 billion. But they more than treble in size in each of the final 6 years, reaching $56 billion in 2016.

Such dynamic revenue feedbacks can be divided into three components—revenue feedbacks from the microsimulation model, revenue feedbacks from other federal taxes not calculated using the microsimulation model, and an adjustment attributable to differences in the individual income tax bases used in the Global Insight and the microsimulation models.

Revenue feedbacks from the microsimulation model total around $179.4 billion over 10 years ("Individual Income Tax Feedback" in Figure 2). They are obtained by subtracting the revenue effects from the income-adjusted and baseline forecasts.[33] Revenue effects from the two forecasts differ because the income-adjusted forecast updates incomes in the baseline forecast to reflect the extension plan's dynamic effects on incomes. The income-adjusted forecast implies a decline in federal individual income tax revenues totaling $812.5 billion over 10 years ("Individual Income Tax with Income-Adjusted Projections" in Figure 2). That $812.5 billion revenue loss is calculated by comparing estimated federal individual income tax revenues from the income-adjusted forecast with the baseline projections of federal tax revenues underlying the baseline forecast.

Revenue feedbacks from other federal taxes not calculated using the microsimulation model include corporate income taxes, payroll taxes, and taxes on production and imports. They are estimated using the Global Insight model. They exceed $116 billion over 10 years (the sum of "Corporate Income Tax Feedback" and "Feedback from Other Taxes" in Figure 2). Combining revenue feedbacks from the microsimulation model with revenue feedbacks from other federal taxes gives dynamic revenue feedbacks of $295.5 billion over 10 years.

That $295.5 billion in dynamic revenue feedbacks implicitly includes a small adjustment for differences in the federal income tax bases used in the Global Insight and microsimulation models. This adjustment sums to under $1 billion over 10 years. It is necessary because of measurement and definitional differences in the baseline levels of personal income in the two models.

Concluding Remarks

We calibrate a macroeconomic of the U.S. economy and a microsimulation model of the federal individual income tax to CBO's January 2006 baseline economic and budgetary projections. We then do a separate calibration of the two models to simulate the economic and budget effects of permanently extending some of EGTRRA's and JGTRRA's expiring provisions. In our simulations, the extension plan boosts economic activity. However, the AMT's expanding reach offsets some of the economic gains from the extension plan.

[31] See Tracy L. Foertsch and Ralph A. Rector, "The Treasury Department's Dynamic Analysis of President Bush's Tax Relief Plan: A Summary and Evaluation," Center for Data Analysis, CDA06-06, August 16, 2006, at *www.heritage.org/Research/Taxes/upload/CDA_06-06.pdf*.

[32] In Figure 2, estimated changes in federal individual income tax revenues exclude net refundable credits.

[33] Thus, this $179.4 billion is the difference between revenue effects from the income-adjusted forecast (-$812.5 billion) and the baseline forecast (-$991.9 billion).

Table 1. Projected 2011 Ordinary Income Tax Schedules for the Pre-EGTRRA and the Extension Plan

Single Filers				Married Couples Filing a Joint Return			
Pre-EGTRRA		Extension Plan		Pre-EGTRRA		Extension Plan	
Tax Rate	Taxable Income	Tax Rate	Taxable Income	Tax Rate	Taxable Income	Tax Rate	Taxable Income
		10%	$1-8,500			10%	$1-17,000
15%	$1-34,500	15%	$8,501-34,550	15%	$1-57,650	15%	$17,001-69,100
28%	$34,501-83,600	25%	$34,551-83,600	28%	$57,651-139,300	25%	$69,101-139,350
31%	$83,601-174,400	28%	$83,601-174,450	31%	$139,301-212,300	28%	$139,351-212,350
36%	$174,401-379,100	33%	$174,451-379,250	36%	$212,301-379,100	33%	$212,351-379,250
39.6%	Over $379,100	35%	Over $379,250	39.6%	Over $379,100	35%	Over $379,250

Notes: EGTRRA = Economic Growth and Tax Relief Reconciliation Act. Taxable income bracket amounts are based on tax provisions and projected inflation under each plan.

Source: Center for Data Analysis, The Heritage Foundation

Table 2A. Change in Federal Individual Income Tax Revenues from Current Law Under the Extension Plan, Billions of Dollars

	2007-16 (Fiscal Year Totals)	
	Change in Federal Income Tax Revenues	Change in Alternative Minimum Tax
Estimate from the Baseline Forecast	-1048.8	767.3
As a Share of Federal Tax Revenues (%)	-5.4	4.0
Estimate from the Income-Adjusted Forecast	-866.9	797.3
As a Share of Federal Tax Revenues (%)	-4.5	4.1

Table 2B. Estimates of the Effects of the Extension Plan on Average Marginal Individual Income Tax Rates

	2011-16 (Calendar Year Average)
From the Income-Adjusted Forecast, Average Percent Change from Current Law	
Capital Gains	-24.1
Dividend Income	-52.8
Ordinary Income	-7.8
From Treasury's Analysis, Average Percent Change from Current Law	
Capital Gains	-23.7
Dividends	-54.1
Ordinary Income	
Wages	-5.1
Interest	-8.2
Business Income	-12.1

Estimated changes in federal individual income tax revenues include net refundable credits. In the baseline forecast, refundable credits increase by roughly $56.9 billion over 10 years. In the income-adjusted forecast, they increase by around $54.3 billion. Treasury recently put the total change in refundable credits from permanently extending the child tax credit and marriage penalty relief at $59.2 billion. See U.S. Department of the Treasury, *General Explanations of the Administration's Fiscal Year 2007 Revenue Proposals*, February 2006, pp. 143-146.

Ordinary income includes all income that does not qualify as a capital gain. Business income includes income from Internal Revenue Service Form 1040 Schedules C, E, and F.

Sources: Center for Data Analysis, The Heritage Foundation; U.S. Department of the Treasury, Office of Tax Analysis, "A Dynamic Analysis of Permanent Extension of the President's Tax Relief," Table 1, July 25, 2006, p. 18.

Table 3. Economic Effects of the Extension Plan Relative to CBO's January 2006 Baseline Projections, Fiscal Years 2011-16

	2011	2012	2013	2014	2015	2016	(Average) 2011-16
Real GDP[a]	67.8	97.2	85.5	78.8	70.2	60.2	76.6
Total Employment[b]	568	880	870	750	647	539	709
Unemployment Rate[c]	-0.1	-0.2	-0.2	-0.2	-0.1	-0.1	-0.1
Real Disposable Personal Income[a]	148	203	204	209	211	208	197
Real Personal Consumption[a]	73	115	122	125	125	123	114
Personal Saving Rate[d]	0.7	0.8	0.8	0.8	0.8	0.7	0.8
Real Gross Private Domestic Investment[a]	22.0	30.4	12.5	6.2	2.8	1.7	12.6
Real Non-Residential Investment[a]	12.8	21.4	11.6	4.1	1.5	2.0	8.9
Full-Employment Capital Stock[a]	18.7	39.0	47.6	46.7	44.8	44.0	40.1
CPI Inflation[e]	0.0	0.0	0.0	0.1	0.1	0.1	0.1
Treasury Bill, 3 Month[f]	0.1	0.3	0.2	0.2	0.2	0.1	0.2
Treasury Bond, 10 Year[f]	0.1	0.3	0.2	0.2	0.2	0.2	0.2

Notes: GDP = gross domestic product; CPI = consumer price index; CBO = Congressional Budget Office. The economic effects of the extension plan are measured relative to the Congressional Budget Office's January 2006 baseline economic and budgetary projections. A more detailed table is available upon request.

a. Difference in billions of inflation adjusted dollars (indexed to 2000 price levels); b. Difference in thousands of jobs; c. Difference in the percent of the civilian labor force; d. Difference in the percent of disposable personal income; e. Difference in the percent change from a year ago; f. Difference in an annualized percent

Source: Center for Data Analysis, The Heritage Foundation

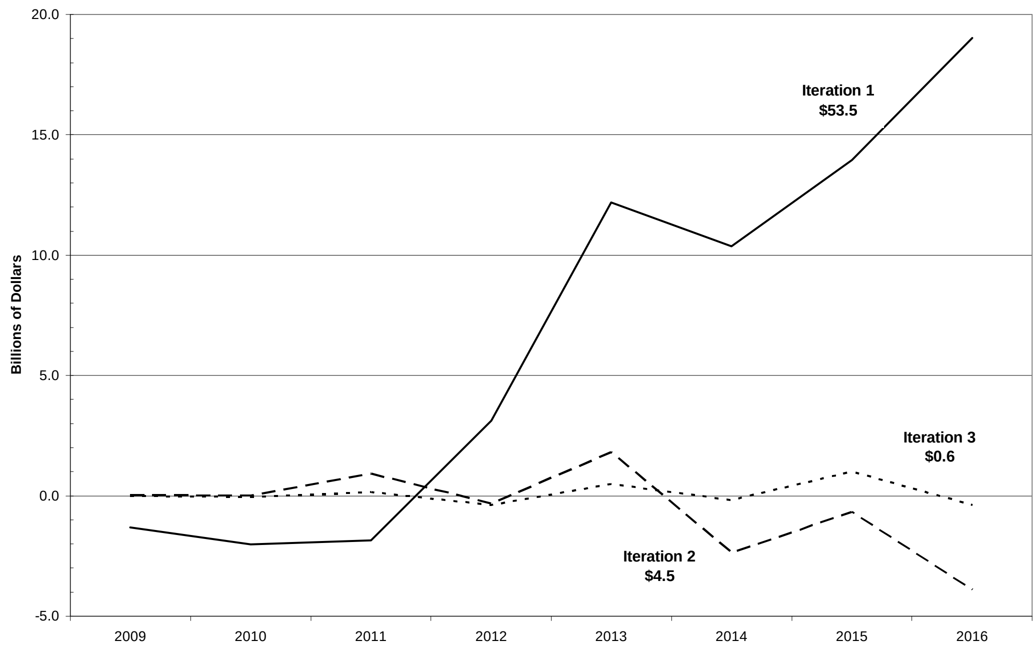
Table 4. Comparison of the Extension Plan to the Treasury's Dynamic Analysis of the President's Tax Proposals

	(Calendar Year Average) 2011-16
Economic Effects of the Extension Plan, Percent Change from CBO's January 2006 Baseline Economic and Budgetary Projections	
Real GDP	0.5
Real GNP	0.5
Full-Employment Capital Stock	0.2
Real Personal Consumption	1.2
Real Gross Private Domestic Investment	0.5
Economic Effects from Treasury's Analysis, Percent Change from the Initial Steady State	
Financed by Cutting Future Government Consumption	
Real GNP	0.5
Capital Stock	-0.3
Consumption	1.3
Investment	-3.0
Financed by Raising Future Income Taxes	
Real GNP	0.8
Capital Stock	0.6
Consumption	0.5
Investment	1.8

Notes: GDP = gross domestic product; GNP = gross national product.

Sources: Center for Data Analysis, The Heritage Foundation; U.S. Department of the Treasury, Office of Tax Analysis, "A Dynamic Analysis of Permanent Extension of the President's Tax Relief," Table 3, July 25, 2006, p. 20.

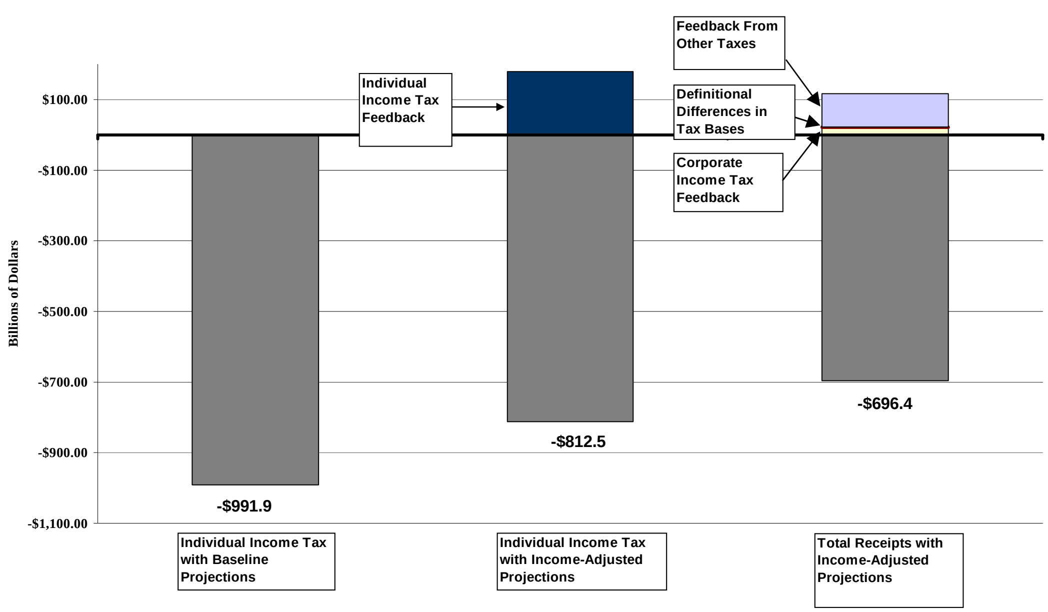
Figure 1. Differences Between Individual Income Tax Receipts After Calibration of the Microsimulation and Global Insight Models, Calendar Years 2009-16



Estimated changes are compared to the Congressional Budget Office's January 2006 economic and budgetary baseline projections.

Source: Center for Data Analysis, The Heritage Foundation

Figure 2. Dynamic Revenue Feedbacks from the Extension Plan, Billions of Dollars, Fiscal Years 2007-16



The microsimulation model is used to estimate the change in federal individual income tax revenues. "Individual Income Tax Revenues with Baseline Projections" is the same as the estimated change in total receipts when the macroeconomic effects are not included. Estimates of federal individual income tax revenues exclude changes in net refundable credits. Federal taxes not calculated using the microsimulation model include corporate income taxes, payroll taxes, and taxes on production and imports.

Source: Center for Data Analysis, The Heritage Foundation

Predicting Growth Defection

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INTRODUCTION

The U.S. Postal Service builds multiple forecast scenarios for its major mail categories.[1] An important trend underlying the forecast is the affect of a household mailer's age on mail volume. Mail volume receipt appears to shift across generations. However volume receipt is actually a function of income, and is highly correlated to age (lifecycle) and education.

As a young person ages, more financial transactions, billing accounts, and purchases for goods and services are generated. This maturation drives information seeking, financial transactions and statements, communications (marketing or customer relationship building), and merchandise delivery through the mail primarily from commercial mailers trying to reach consumers.

Over 70 percent of mail is sent by commercial mailers to consumers. Only 10 percent of mail is sent by consumers.[2] Marketing projections have suggested that younger generations could drive the decline of mail sent to and by them through adoption of the Internet and other electronic alternatives. However, the decline in mail use is happening at a much lower rate than originally predicted.

While older Americans currently send mail more than younger generations, aging Americans have traditionally become a lower recipient of mail when they retire. Some analysts predict that the "Boomer" generation, which is living and working longer, may change that mail receipt pattern as they may remain economically active for longer. Understanding consumer behavior at different times in life (age in the lifecycle) is important to many businesses, including the Postal Service and its commercial customers.

The Postal Service is also noticing a change in the mix of mail that businesses send to consumers. Higher contribution single-piece First-Class Mail is declining while Standard Mail is increasing.

Standard Mail, or advertising mail, is more volatile than First-Class Mail as it is highly dependent on economic cycles and customers' ability and willingness to use mail as an advertising channel to reach consumers and other businesses.

Universal Service

Even as we see shifts and declines among major mail categories, the Postal Service honors its mandate to provide and sustain universal service. The U.S. Postal Service is mandated by law to deliver mail to every household in America.

From the 1790's through the 1920's Congressional policy drove the beginnings of a postal network, an infrastructure to channel social and business correspondence. Post 1920's led the Postal Service into today's era, where we are challenged to sustain universal service in a modern society with multiple, competing communication channels.[3] Sweeping changes occurred in 1970 with passage of the Postal Reorganization Act (PRA). Among other things, PRA

- Established the U.S. Postal Service as an independent establishment of the executive branch of the United States government; and,

- Created the framework for a self-sufficient, businesslike organization.

Self-Sustaining Federal Agency

Unlike other Federal agencies, the Postal Service operates in the general market with its products and services as a self-sustaining organization. That is, the service maintains the costs of its operations and network without assistance from taxpayer subsidies.

[1] U.S. Postal Service, Strategic Transformation Plan 2006-2010

[2] U.S. Postal Service, FY2005 Household Diary Study

[3] Kielbowicz, Richard B. Universal Postal Service: A Policy History 1790-1970. Prepared for the Postal Rate Commission. November 2002.

Like many mature businesses, the Postal Service is doing more with less. Growth in delivery points is outpacing growth in total mail volume. Differences in these growth rates are shown in Table 1.

Table 1: Average Annual Growth

	1981 - 1990	**1991 - 2000**	**2001 - 2005**
Total Mail Volume	4.6%	2.3%	.5%
Delivery Points	1.7%	1.5%	1.2%

Source: U.S. Postal Service, FY2005 Household Diary Study

The business model for the U.S. Postal Service is evolving. In the meantime, it is increasingly challenging for postal revenues to cover costs in the face of shifting revenue streams, growing alternatives for businesses and consumers, and increasing delivery points.

Marketing Strategy & Support uses various modeling tools to inform and focus marketing management in customer retention and revenue growth. This paper describes the Growth Defection Predictive model and its application to commercial business data stored in our customer information system.

BACKGROUND

The structure of the U.S. Postal Service customer base is highly concentrated in commercial accounts. Commercial customers are continually showing signs of new growth, decline and variability. These changes in purchasing behavior warrant innovative marketing strategies. The Marketing Strategy and Support Group has sought to develop a way to proactively identify customer trends and maximize revenue opportunities through the creation of the Growth Defection Predictive model. This model aims to both understand customer migration patterns and reduce revenue leakage.

In an effort to predict the future performance of accounts, the model employs a way to track customers over time. Since account behavior is constantly changing, this is a necessary component to understanding long term performance. It enables account managers to identify and address those accounts that are most likely to generate revenue loss before the trend becomes irreversible. Likewise, it ensures that growing accounts will continue to grow. Ultimately, this allows for prioritization of sales and service resources, which minimize churn and maximize customer retention opportunities.

The model focuses on managed, commercial accounts tracked in our customer information system. Commercial accounts made up 73% of total FY2005 revenue. Managed accounts, the focus of the model, are assigned to account managers who promote and service their interaction with the Postal Service. Managed accounts made up 61% of total FY2005 revenue. They are segmented into three tiers, each having a unique strategy for growing revenue. National accounts are the largest customers. The majority are characterized by acquisition marketing companies. Premier accounts are characterized by large companies with mature marketing, and some acquisition marketers. Preferred Plus accounts are made up of small and mid-market businesses who have more limited, but potentially growing mailing needs.

METHODOLOGY

The overall modeling process has two main components:

1. growth defection descriptive model
2. growth defection predictive model

The *growth defection descriptive model* is implemented as a performance monitoring and tracking system, which is executed periodically. In this component, growth defection scores and color codes are defined.

Growth defection scores are time stamped attributes derived from historical transactional revenue data. These scores are translated into four color tiers that represent a customer's relative performance with respect to its peers. Peers are defined by industry and employee size.

These indicators are then applied to the *growth defection predictive* model to define customer outlook as positive, negative or neutral and predict the likelihood of growth or decline.

This model estimates how account characteristics such as:

- Type of the account
- Industry
- Employee size
- Purchase behavior (ie. revenue)
- Historical growth defection scores
- Volatility of growth defection scores

relate to performance in a given three month period (coded as a categorical variable). The model forecasts expected performance in the upcoming three months. From this forecast, customer outlook is defined.

Data, model development and implementation steps are explored in detail throughout the following sections.

DATA

The Corporate Business Customers Information System (CBCIS) is the primary source of data for model input. This database contains monthly summarized forms of transactional revenue and volume data enriched by account type, industry including its sub-levels, and product categorization schemas.

The dataset used consists of more than 36,000 customer records. Each record contains information for a single customer. For modeling purposes records are limited to managed commercial accounts.

The layout and field definitions are illustrated in Figure 1. This data is used for model training, validation and testing.

Id	AcctType	Industry	M1	M2	...	M46

$\underbrace{\text{M1} \quad \text{M2} \quad \ldots \quad \text{M46}}_{\text{46 months history of revenue}}$

FIELD	Description
Id	Record identifier each representing a unique account (customer)
AcctType	Type of the account. N: National P: Premier D: Preferred Plus (Developmental)
Industry	String of codes representing industry, sub-industry, and employee size
M1	Total revenue in month 1.
…	…
M46	Total revenue in month 46 – last available month

Figure 1: Raw data

GROWTH DEFECTION DESCRIPTIVE MODEL

The *growth defection descriptive model* is used to monitor monthly customer performance through a scoring and ranking system. It is also a key driver in the prediction model.

Customer growth defection scores and associated color codes are derived for a period using the 36-period history of revenue data starting with the current period (i.e. fields M11-M46 for the example explained in previous section, where 46 is the most recent period).

Growth defection scores have two major components:

- A modified percentage change
- A ranked magnitude of change

Customer purchasing behavior follows a seasonal pattern where each accounting period is a month and each year is a seasonal cycle. Both of these changes are calculated through the revenues of the same periods for consecutive years. A weighted average is calculated to obtain final scores.

Calculations regarding the percentage change and modified percentage are given by (1) and (2)

$$mms_i = \begin{cases} \dfrac{ms_{i-12} + ms_{i-24}}{2} & \text{, for } ms_i \neq 0 \\ ms_{i-12} & \text{, for } ms_i = 0 \end{cases}$$

$$d_i = ms_i - mms_i$$

$$pms_i = \frac{d_i}{mms_i} \tag{1}$$

$$pmsx_i = \begin{cases} 1 & \text{, for } pms_i > 1 \\ 0 & \text{, for } -0.05 < pms_i < 0.05 \\ -1 & \text{, for } pms_i < -1 \\ pms_i & \text{, else} \end{cases} \tag{2}$$

where,

ms_i : the revenue in period i
pms_i: % change in revenue
$pmsx_i$: modified % change in revenue

To obtain a ranking based on absolute monetary change in the same period during consecutive years, a ranking function of 20 groups is used. The ranking function varies by the peer group.

$$v_i = f_j(d_i) \in V = \{0,1,2,3,\ldots,19\} \tag{3}$$

where, v_i is the rank in period i and $f_j(\bullet)$ is the ranking function on peer group j.

The final ranked magnitudes of changes are calculated through transformation of the ranks assigned to absolute monetary changes, as shown in (4).

$$rms_i = \begin{cases} \dfrac{v_i}{20} + 0.05, & \text{for } d_i > 0. \\ 0, & \text{for } d_i = 0. \\ \dfrac{v_i}{20} - 1, & \text{for } d_i < 0. \end{cases} \qquad (4)$$

Growth defection scores are obtained through combining the two components, $pmsx_i$, and rms_i, in a weighted average equation for a twelve-period time frame. The weighting and calculation of final scores are given in (5) and (6) respectively.

$$\omega_j = 13 - j \quad \text{where,} \quad j = 1,2,..,12 \qquad (5)$$

$$g_i = \frac{\sum_{k=1}^{12} \omega_k \left(\dfrac{pmsx_{i-k+1} + rms_{i-k+1}}{2} \right)}{\sum_{k=1}^{12} \omega_k} \qquad (6)$$

where,

g_i : Growth defection score at the end of period i

The growth defection scores are used to obtain color codes, s_i. The color assignment calculations involve relative positioning of an individual with respect to its peer group. A peer group is defined by categorization codes that contain industry splits and employee size information.

$$mg_{ij} = median(G_{ij})$$

where,

$G_{ij} = \{\forall g_i \mid \text{customers in peer group } j\}$

median(X) is the median of the elements in set X

The relative position of a particular customer's growth defection score in its peer for a given period *i*, is given by (7).

$$p_i = \frac{mg_{i\bullet} - g_i}{mg_{i\bullet}} \qquad (7)$$

The color code assignments are performed using a set of rules based on the medians, mg_i, growth defection scores, g_i and the degree of dispersion of the scores with respect to medians, p_i. The set of rules to assign color codes are as follows:

If $mg_{i\bullet} > 0 \wedge g_i \le 0 \wedge p_i \ge 0.15 \Rightarrow s_i = \text{Red}$
If $mg_{i\bullet} < 0 \wedge g_i \le 0 \wedge p_i \le -0.15 \Rightarrow s_i = \text{Red}$
If $mg_{i\bullet} = 0 \wedge g_i \le 0 \wedge g_i \le -0.15 \Rightarrow s_i = \text{Red}$
If $mg_{i\bullet} > 0 \wedge g_i \le 0 \wedge p_i < 0.15 \Rightarrow s_i = \text{Orange}$
If $mg_{i\bullet} > 0 \wedge g_i > -0.15 \Rightarrow s_i = \text{Orange}$
If $mg_{i\bullet} < 0 \wedge g_i \le 0 \wedge p_i > -0.15 \Rightarrow s_i = \text{Orange}$
If $mg_{i\bullet} = 0 \wedge g_i \le 0 \wedge g_i > -0.15 \Rightarrow s_i = \text{Orange}$
If $mg_{i\bullet} > 0 \wedge g_i > 0 \wedge g_i < mg_{i\bullet} \Rightarrow s_i = \text{Yellow}$
If $mg_{i\bullet} < 0 \wedge g_i \le 0 \wedge g_i \ge mg_{i\bullet} \Rightarrow s_i = \text{Yellow}$
If $mg_{i\bullet} > 0 \wedge g_i > 0 \wedge g_i \ge mg_{i\bullet} \Rightarrow s_i = \text{Green}$
If $mg_{i\bullet} < 0 \wedge g_i \ge 0 \Rightarrow s_i = \text{Green}$
If $mg_{i\bullet} = 0 \wedge g_i > 0 \Rightarrow s_i = \text{Green}$

where,

s_i : Color code at the end of period i

Considering the previous example in Figure 1, it is possible to populate color codes, s_i, for 22 consecutive periods, where *i*= [25, 46].

id	S25	S26	S27	…	…	S44	S45	S46

Color codes

Figure 2: Color Codes

The attribute, cr_i , is a categorical variable, which contains information about the patterns customers may follow and exhibit. It is defined by different combinations of the last three consecutive periods' color codes, as shown in Figure 3.

s_{i-2}	s_{i-1}	s_i	cr_i
Green	Green	Green	1
Green	Green	Yellow	1
Green	Yellow	Green	1
Yellow	Green	Green	1
Red	Red	Orange	3
Red	Orange	Red	3
Orange	Red	Red	3
Red	Red	Red	3
.	.	.	2

Figure 3: Rules for the Three-Period Patterns

Using the three-period patterns, cr_i, along with the color code of the period preceding those periods, the outlook variable, o_i, is derived.

s_{i-3}	cr_i	o_i
Green	1	Positive
Green	2	Negative
Green	3	Negative
Yellow	1	Positive
Yellow	3	Negative
Yellow	2	Neutral
Orange	1	Positive
Orange	3	Negative
Orange	2	Neutral
Red	1	Positive
Red	2	Positive
Red	3	Negative

Figure 4: Rules for Outlook

Over a trajectory of the twelve most recent periods, the frequency ratio of each color in this trajectory form another set of variables. The set of color code ratios in period *i* is given by (8).

$$ratio_i^j = \frac{count_i^j}{12} \tag{8}$$

where, $j \in \{\text{Green}, \text{Yellow}, \text{Orange}, \text{Red}\}$ and $count_i^j$ is the number of color code *j* over the twelve-period length trajectory up to period *i*. Here, length of the trajectory is twelve because of seasonality. Standard deviation of the growth defection scores is calculated over the trajectory in order to measure variation between observations, as shown in (9).

$$stg_i = std.dev\{g_k \mid k = i - 11 \text{ to } i\} \tag{9}$$

where, *std.dev{X}* is the standard deviation of the elements in set X.

GROWTH DEFECTION PREDICTIVE MODEL

The main purpose of the *growth defection predictive model* is to understand and anticipate customer purchasing patterns.

As referenced briefly in the previous sections, the three-period patterns, which are derived from color codes, form the variable of interest in the predictive model. This variable leads to derivation of outlook, o_i, for a comprehensive business insight.

Modeling Process

The model development process is composed of three phases to assess model performance, allow comparisons with other model families and permit continuous implementation for repetitive execution in time:

- Training
- Validation
- Testing

The training, validation, and testing sets are identified by fixed twelve-period time frames with three-period shifts. When the actual current period is *i* then the relative *current periods* specific to the data sets are

- *i*-9 for the training set
- *i*-6 for the validation set
- *i*-3 for the test set

For the data explained in previous sections, current period, *i*, is 46. In the model development and implementation process, current periods for training, validation, and testing are 37, 40, and 43 respectively.

In the training phase, parameter estimations for the model are generated through the training data set. The validation phase involves the application of the developed model to a distinct, second dataset in order to evaluate model performance. Adjustment of any settings, if required happens here based on the results. The testing phase applies the model to a third data set to evaluate stability of the final model.

The results from the training, validation and testing processes are required to fully assess model performance and permit comparisons between model alternatives.

Modeling Techniques

For the selection of the technique and implementation of the model, several factors are considered:

- Multivariate capability of technique and model
- Ability to handle categorical and nominal variables
- Strengths and limitations of the assumptions
- Interpretability of the model

It is necessary that the chosen method accommodate multivariate analysis because of the diverse nature of and relationships between the inputs, which include historical growth defection scores, color codes, account type, industry , as well as, the three-period patterns and outlook outputs.

A number of variables, including the prediction variable are categorical or ordinal. This requires a modeling technique that allows these variables.

One of the most important restrictions in applying some of the techniques (i.e. linear regression) is the underlying assumptions specific to particular techniques. The technique has to be flexible in terms of assumptions for the implementation and suitable to the case.

There are many flexible and powerful prediction techniques available from different disciplines such as data mining and machine learning; however some of those powerful techniques are known as black-box methods (e.g. neural networks). Although model performance indicators may exhibit favorable assessments, the complexity of these algorithms makes it difficult to interpret results. Model performance is a key factor in selecting a modeling technique, but in this case, it is equally important to understand the behavior behind those results and whether they make sense in a business context. With these reservations in mind, a neural network model will be considered in the model comparison.

A second model family comes from decision theory. Decision and classification trees are simple to understand and interpret. They are also able to handle categorical variables. Typical challenges encountered using decision trees include over-fitting and sub-optimality. It is important that the final model be robust and stable in order to generalize well over time.

Logistic regression is the third type to explore. The predictor variables in logistic regression can take any form. There are no assumptions about the distribution of the independent variables.

The three methods, logistic regression, neural network and classification tree are used in the modeling process and compared based on generality, accuracy, misclassification and stability over time.

The variables used in modeling are as follows,

$\mathbf{gds}_i = \left[gds_{i-11}, gds_{i-10}, \ldots\ldots, gds_i\right]$ represents the vector of growth defection scores from the most recent twelve-periods

$\mathbf{ratio}_i = \left[ratio_i^{green}, ratio_i^{yellow}, ratio_i^{orange}, ratio_i^{red}\right]$ represents the vector of color code ratios at the period i

stg_i is the standard deviation of the growth-defection scores of the most recent twelve-periods

N represents the vector of coded variables for industries given by the set Industry={C,F,G,M,N,P,R,S,T,U,X}

T represents the vector of coded variables for account types given by the set Accttype={N,D,P}

The logistic regression model is formulized in (10).

$$g(\Pr(cr_i \le c) = \alpha_k + \beta.\mathbf{gds_{i-3}} + \boldsymbol{\gamma}.\mathbf{ratio_{i-3}} + \boldsymbol{\varphi}.stg_{i-3} + \boldsymbol{\mu}.\mathbf{N} + \boldsymbol{\lambda}.\mathbf{T} \qquad (10)$$

where,

c=1, 2, 3 are the categories of the prediction variable, cr_i

$\alpha_k, \boldsymbol{\beta}, \boldsymbol{\gamma}, \boldsymbol{\varphi}, \boldsymbol{\mu}, \boldsymbol{\lambda}$ are the associated model parameter vectors to be estimated

$g(p) = \log \dfrac{p}{1-p}$ is the logit link function

The neural network is a simple multilayer perceptron network with two hidden nodes. The illustration of the network is given in Figure 5.

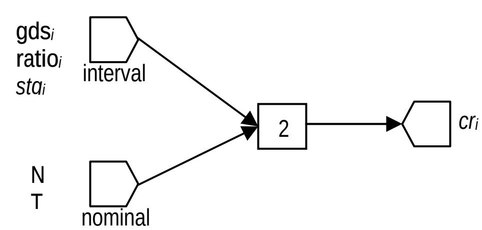

Figure 5: Neural Network

The decision tree model has a depth of 6 with 46 leaves. The maximum number of branches from a node is limited by three to avoid over fitting and keep the tree rules simple. Entropy reduction is used as the splitting criterion in the developed tree.

Detailed statistics and outputs of the implemented models are given in Appendix. The assessments and comparison regarding the models based on those outputs are discussed in the next section.

RESULTS

A comparison of the three models is summarized in Table A.1. As exhibited in the table all three models are quite similar in terms of performance statistics. Looking at the misclassification rates, variance between training, validation and testing is highest in the decision tree, second in neural network and lowest in logistic regression. This means the logistic regression model is more stable and generalizes well with the new data. Considering the root ASEs (average squared errors) in all phases, logistic regression performs slightly better than other models in testing. Furthermore, the Schwarz Bayesian Criterion of the logistic regression is smaller than in the neural network. This means logistic regression fits better.

Detailed model statistics and several information criteria for the three models are given in Tables A.1. When all the performances are evaluated together, logistic regression becomes the preferred model, based on accuracy and generality.

Classification tables exhibiting the observation counts and percentages for actual outcomes and predictions for the training, validation, and testing sets are given in Table A.2 for all models. Considering all the models across all phases, the percent of correctly classified predictions are very similar. In all cases, correct classification rates for the target cr_i =1, and cr_i =3, are higher than the rates for cr_i =2. The minimums of the correct classification rates are 81.86% and 79.65% for cr_i =1 and cr_i =3 respectively where the maximum for cr_i =2 is 54.33%. While the correct classification rates in neural network and decision tree for cr_i =3 are slightly higher than the logistic regression, correct classification rates for harder to predict cr_i =2 are better in logistic regression model than other methods (54.34% in testing phase). The graphs of classification counts for testing phase are given in Figures A.1, A.3, and A.5 for all the models.

The cumulative captured response charts are given for testing in Figures A.2, A.4 and A.6 for all models. The cumulative captured response charts exhibit the power of the predictive models on a specific dataset. The captured response, (Y-axis) is the percent of correctly classified customers. This is plotted against the percent of all customers. The Base line shows the percent of correctly classified customers if no model is used. The curve, reg,/neural/tree represents the implemented model. The Exact plot represents the perfect model. The covered proportion of the area defined by the model curve and Base line within the area defined by the Exact and Base curves is an indicator of the performance of the model. All charts exhibit almost similar results among models and phases. Similarity or stability between phases means the associated model maintains consistent performance with the new data.

Maximum likelihood estimates of the parameters of the logistic regression are exhibited in Appendix Table A.3. The *growth defection* scores and ratios of color codes have more significance than industry splits in general. Some of the variables have very small significance levels; however those variables are not excluded from the model to allow for a standardized model development process and repetitive usage in practice. Instead of a simpler and smaller model, a fixed set of inputs and outputs is used to repeat the model training, validation and testing steps without complications when new data arrive with every new period. This provides a dynamic model implementation process based on parameter estimations with fixed inputs.

Figure A.7 exhibits the neural network iteration history and similarly Figure A.14 exhibits the decision tree progress.

Using the model outputs, cr_i , along with the color code of the current period, the predictions for the outlook variable, o_i, are derived through the rules given in Figure 4. The assessments and results of the comparisons between the observed and predicted values of outlook, o_i, will be similar with the analyses given for cr_i since only a transformation, which is effective for both predictions and observed values, is involved between those variables.

In the final model evaluation, it is important to revisit the assumptions defined earlier in selection of a technique. One of these assumptions observed the importance of output interpretability. Logistic regression is the best choice to accomplish this requirement. Therefore, since it is clear that model performance remains consistently accurate and stable across different methods, for business implementation the logistic regression model is the optimal one for implementation.

CONCLUSION

The Growth Defection Model provides a systematic way for USPS to proactively identify customer trends and maximize revenue opportunities within a highly volatile customer base. As a result, USPS marketing and sales teams can optimize the alignment and allocation of limited resources against a large pool of diverse customers. In essence, this tool can be used to drive business decisions through prioritization of customers, based on need and allow marketing and sales to specifically tailor practices towards those customer segments.

For instance, an account manager looking to target customers who will potentially follow an undesired, defective path tracks those accounts where cr_{43} is predicted to be 3. This is then compared to the actual situation. Without the aid of the model, the account manager, looks at 25% of customers randomly and would find 25% of customers with $cr_{43}=3$. With the model, he can more accurately target those accounts and would capture over 60% of the customers who have the undesired defection pattern within the same number of accounts. Furthermore, it is also possible to capture approximately 95% of the defective pattern customers proactively by targeting approximately 50% of overall customer group (see Figure A.9). This provides a more effective and efficient way of allocating resources to the customers of interest depending on the business purposes and priorities.

Marketing Intelligence and Customer Analytics continues to optimize the accuracy of the model in the upcoming periods. Areas of development and further research include analyzing the impact of differentiated costs for types of misclassification on model selection and assessment, as well as, enriching explanatory nature of the data through including additional attributes.

APPENDIX A

Table A.1: Model Statistics and Comparison

	Train			Validation			Test		
	Reg	Neural	Tree	Reg	Neural	Tree	Reg	Neural	Tree
Misclassification Rate	0.23613934	0.23762294	0.23517775	0.23809	0.23784273	0.23957360	0.24072751	0.24204626	0.244052
Schwarz's Bayesian Criterion	38318.5082	39212.6464							
Akaike's Information Criterion	38033.4503	38605.7489							
Model Degrees of Freedom	31	66							
Degrees of Freedom for Error	72765	72730							
Total Degrees of Freedom	72796	72796	72796						
Sum of Frequencies	36398	36398	36398	36398	36398	36398	36398	36398	36398
Divisor for ASE	109194	109194	109194	109194	109194	109194	109194	109194	109194
Average Squared Error	0.10470298	0.10566356	0.11	0.10510201	0.10530281	0.11	0.10594043	0.10655941	0.11
Maximum Absolute Error	0.99992393	0.99518194	1	0.99976160	0.99341129	1	0.99970687	0.99158499	1
Mean Square Error	0.10474759	0.10575945		0.10510201	0.10530281		0.10594043	0.10655941	
Root Average Squared Error	0.32357840	0.32505932	0.3243465	0.32419440	0.32450394	0.32794113	0.32548492	0.32643438	0.329145
Sum of Squared Errors	11432.9377	11537.8273	11487.28	11476.5092	11498.4353	11743.31	11568.0597	11635.6482	11829.69
Root Final Prediction Error	0.32371623	0.32535417							
Final Prediction Error	0.10479219	0.10585533							
Error Function	37971.4503	38473.7489		38267.0799	38493.4944		38595.0665	39032.4222	
Average Error Function	0.34774301	0.35234306		0.35045039	0.35252389		0.35345409	0.35745940	
Number of Estimate Weights	31		61						
Sum Case Weights * Frequencies	109194	109194	109194	109194	109194	109194	109194	109194	109194

Table A.2: Actual/Prediction Classification Table – Counts and Percents

			PARTITION: TRAIN TARGET: cr_{40}				PARTITION: VALIDATION TARGET: cr_{43}				PARTITION: TEST TARGET: cr_{46}			
	Target		Output			Total	Output			Total	Output			Total
			1	2	3		1	2	3		1	2	3	
Logistic Regression	1	Frequency	12814	2056	117	14987	12511	1924	110	14545	11572	2397	168	14137
		Percent	35.21	5.65	0.32	41.18	34.37	5.29	0.3	39.96	31.79	6.59	0.46	38.84
		Row Pct	85.5	13.72	0.78		86.02	13.23	0.76		81.86	16.96	1.19	
		Col Pct	84.74	22.11	0.98		84.03	20.96	0.89		86.08	26.02	1.22	
	2	Frequency	2170	5059	1928	9157	2214	4745	1742	8701	1750	4626	2137	8513
		Percent	5.96	13.9	5.3	25.16	6.08	13.04	4.79	23.91	4.81	12.71	5.87	23.39
		Row Pct	23.7	55.25	21.05		25.45	54.53	20.02		20.56	54.34	25.1	
		Col Pct	14.35	54.39	16.1		14.87	51.68	14.13		13.02	50.22	15.55	
	3	Frequency	138	2186	9930	12254	164	2512	10476	13152	122	2188	11438	13748
		Percent	0.38	6.01	27.28	33.67	0.45	6.9	28.78	36.13	0.34	6.01	31.42	37.77
		Row Pct	1.13	17.84	81.03		1.25	19.1	79.65		0.89	15.92	83.2	
		Col Pct	0.91	23.5	82.92		1.1	27.36	84.98		0.91	23.75	83.23	
	Total	Frequency	15122	9301	11975	36398	14889	9181	12328	36398	13444	9211	13743	36398
		Percent	41.55	25.55	32.9	100	40.91	25.22	33.87	100	36.94	25.31	37.76	100

Table A.2: Actual/Prediction Classification Table – Counts and Percents **(Continued)**

			PARTITION: TRAIN TARGET: cr40				PARTITION: VALIDATION TARGET: cr43				PARTITION: TEST TARGET: cr46			
	Target		Output			Total	Output			Total	Output			Total
			1	2	3		1	2	3		1	2	3	
Neural Network	1	Frequency	12906	1925	156	14987	12619	1784	142	14545	11723	2200	214	14137
		Percent	35.46	5.29	0.43	41.18	34.67	4.9	0.39	39.96	32.21	6.04	0.59	38.84
		Row Pct	86.11	12.84	1.04		86.76	12.27	0.98		82.92	15.56	1.51	
		Col Pct	84.55	23.48	1.21		83.23	22.07	1.08		85.34	27.19	1.47	
	2	Frequency	2203	4509	2445	9157	2344	4234	2123	8701	1869	4077	2567	8513
		Percent	6.05	12.39	6.72	25.16	6.44	11.63	5.83	23.91	5.13	11.2	7.05	23.39
		Row Pct	24.06	49.24	26.7		26.94	48.66	24.4		21.95	47.89	30.15	
		Col Pct	14.43	54.99	18.9		15.46	52.38	16.14		13.61	50.38	17.62	
	3	Frequency	155	1765	10334	12254	199	2065	10888	13152	145	1815	11788	13748
		Percent	0.43	4.85	28.39	33.67	0.55	5.67	29.91	36.13	0.4	4.99	32.39	37.77
		Row Pct	1.26	14.4	84.33		1.51	15.7	82.79		1.05	13.2	85.74	
		Col Pct	1.02	21.53	79.89		1.31	25.55	82.78		1.06	22.43	80.91	
	Total	Frequency	15264	8199	12935	36398	15162	8083	13153	36398	13737	8092	14569	36398
		Percent	41.94	22.53	35.54	100	41.66	22.21	36.14	100	37.74	22.23	40.03	100
Decision Tree	1	Frequency	12801	1983	203	14987	12493	1854	198	14545	11554	2289	294	14137
		Percent	35.17	5.45	0.56	41.18	34.32	5.09	0.54	39.96	31.74	6.29	0.81	38.84
		Row Pct	85.41	13.23	1.35		85.89	12.75	1.36		81.73	16.19	2.08	
		Col Pct	84.66	22.9	1.61		83.41	22.05	1.52		85.45	26.95	2.04	
	2	Frequency	2169	4805	2183	9157	2286	4394	2021	8701	1809	4288	2416	8513
		Percent	5.96	13.2	6	25.16	6.28	12.07	5.55	23.91	4.97	11.78	6.64	23.39
		Row Pct	23.69	52.47	23.84		26.27	50.5	23.23		21.25	50.37	28.38	
		Col Pct	14.34	55.49	17.3		15.26	52.25	15.53		13.38	50.49	16.8	
	3	Frequency	151	1871	10232	12254	199	2162	10791	13152	159	1916	11673	13748
		Percent	0.41	5.14	28.11	33.67	0.55	5.94	29.65	36.13	0.44	5.26	32.07	37.77
		Row Pct	1.23	15.27	83.5		1.51	16.44	82.05		1.16	13.94	84.91	
		Col Pct	1	21.61	81.09		1.33	25.71	82.94		1.18	22.56	81.16	
	Total	Frequency	15121	8659	12618	36398	14978	8410	13010	36398	13522	8493	14383	36398
		Percent	41.54	23.79	34.67	100	41.15	23.11	35.74	100	37.15	23.33	39.52	100

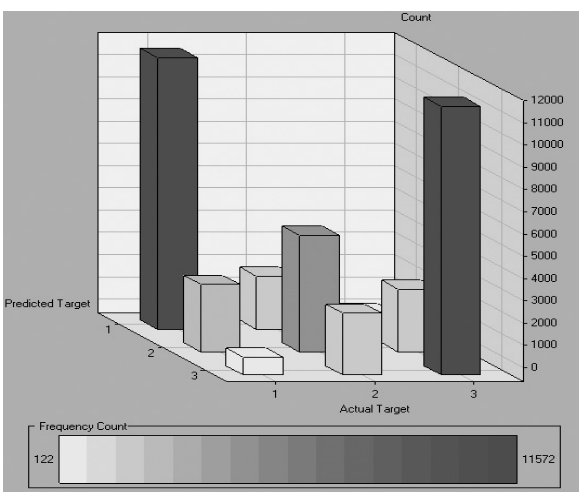

Figure A.1: Logistic Regression - Actual/Prediction Classification Counts – Testing

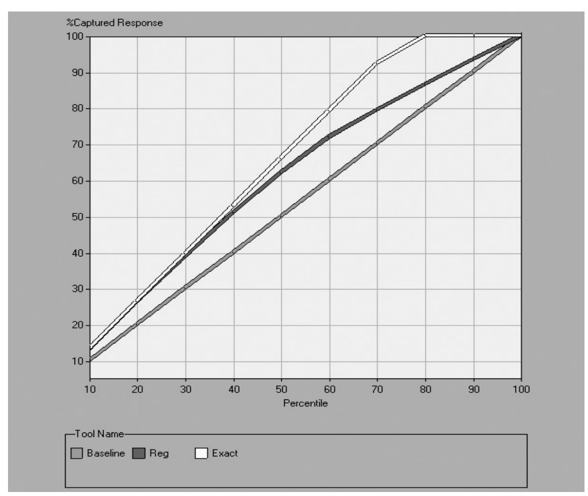

Figure A.2 : Logistic Regression – Cumulative response – Testing

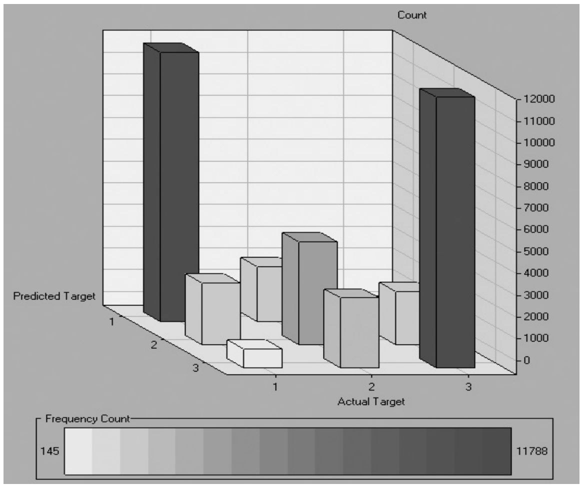

Figure A.3: Neural Network - Actual/Prediction Classification Counts – Testing

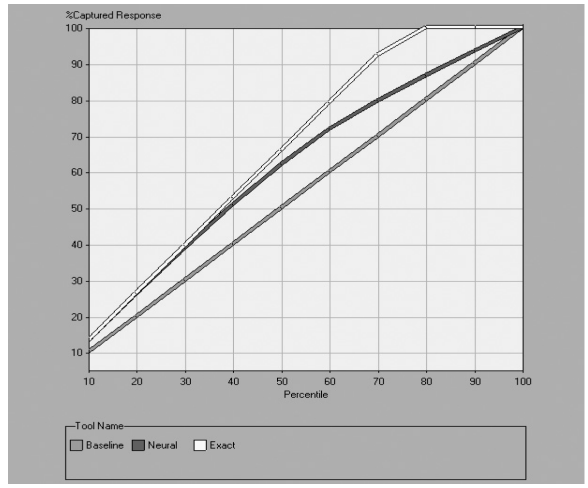

Figure A.4: Neural Network – Cumulative response – Testing

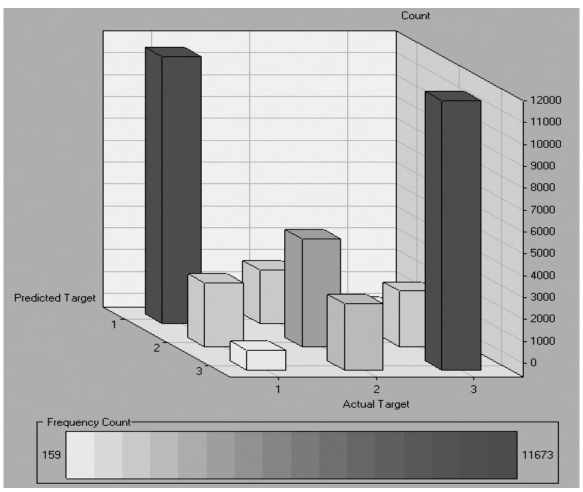

Figure A.5: Decision Tree- Actual/Prediction Classification Counts – Testing

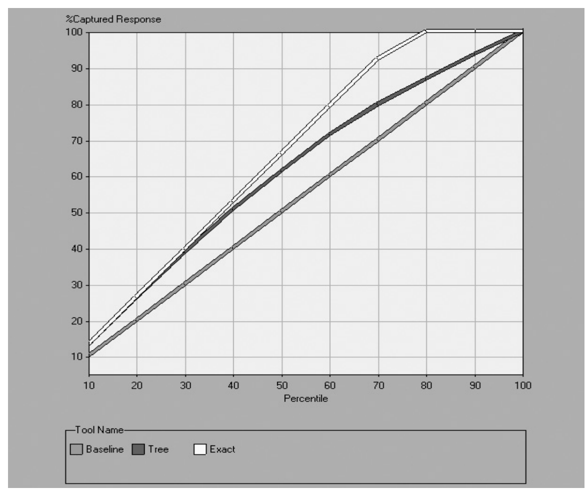

Figure A.6 : Decision Tree – Cumulative response – Testing

Table A.3: Logistic Regression Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-square	Pr > Chi-square	Standardized Estimate	exp(Est)
Intercept	3	1	-2.2963	0.1056	472.75	<.0001	.	0.101
Intercept	2	1	0.5457	0.1039	27.56	<.0001	.	1.726
ACCTTYPE	D	1	0.1600	0.0669	5.72	0.0168	.	1.174
ACCTTYPE	N	1	-0.1986	0.1297	2.34	0.1257	.	0.820
gds1		1	-0.4809	0.1869	6.62	0.0101	-0.071819	0.618
gds10		1	0.9463	0.2258	17.56	<.0001	0.167324	2.576
gds11		1	-2.0575	0.2291	80.69	<.0001	-0.366588	0.128
gds12		1	-13.9744	0.2017	4801.50	<.0001	-2.505608	0.000
gds2		1	0.3137	0.2401	1.71	0.1913	0.047968	1.369
gds3		1	0.8534	0.2420	12.44	0.0004	0.133407	2.348
gds4		1	0.7540	0.2400	9.87	0.0017	0.120479	2.125
gds5		1	0.4863	0.2411	4.07	0.0437	0.079265	1.626
gds6		1	0.8129	0.2405	11.43	0.0007	0.134945	2.255
gds7		1	0.6637	0.2358	7.92	0.0049	0.112503	1.942

Table A.3: Logistic Regression Maximum Likelihood Estimates **(Continued)**

Parameter		DF	Estimate	Standard Error	Wald Chi-square	Pr > Chi-square	Standardized Estimate	exp(Est)
gds8		1	0.8837	0.2353	14.10	0.0002	0.152281	2.420
gds9		1	1.3938	0.2319	36.11	<.0001	0.243505	4.030
INDUSTRY1	C	1	-0.1873	0.0932	4.04	0.0444	.	0.829
INDUSTRY1	F	1	-0.0167	0.0412	0.16	0.6853	.	0.983
INDUSTRY1	G	1	-0.0879	0.0571	2.37	0.1238	.	0.916
INDUSTRY1	M	1	0.000650	0.0433	0.00	0.9880	.	1.001
INDUSTRY1	N	1	-0.1444	0.0781	3.42	0.0645	.	0.866
INDUSTRY1	P	1	0.0345	0.0484	0.51	0.4768	.	1.035
INDUSTRY1	R	1	0.0491	0.0545	0.81	0.3675	.	1.050
INDUSTRY1	S	1	0.0137	0.0320	0.18	0.6689	.	1.014
INDUSTRY1	T	1	-0.1902	0.1534	1.54	0.2151	.	0.827
INDUSTRY1	U	1	-0.1941	0.1078	3.24	0.0718	.	0.824
INDUSTRY1	X	1	0.0958	0.0755	1.61	0.2045	.	1.101
ratio_g		1	-0.8002	0.0991	65.19	<.0001	-0.174151	0.449
ratio_o		1	0.5391	0.1057	26.01	<.0001	0.058300	1.714
ratio_r		1	1.5830	0.0993	254.32	<.0001	0.319753	4.870
ratio_y		0	0	.	.	.	.	.
stdg		1	0.1612	0.3207	0.25	0.6152	0.006194	1.175

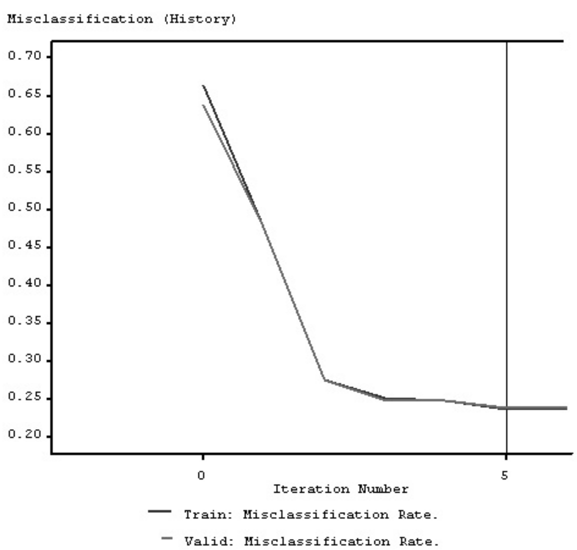

Figure A.7: Neural Network – Average Error – Training and Validation

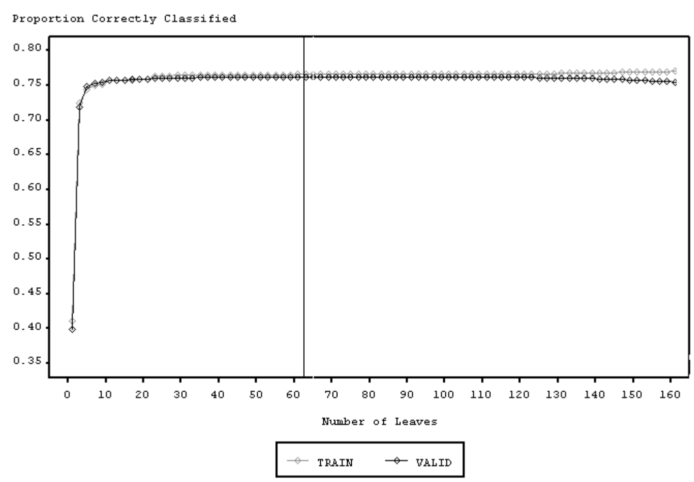

Figure A.8: Decision Tree – Proportion Correctly Classified – Training and Validation

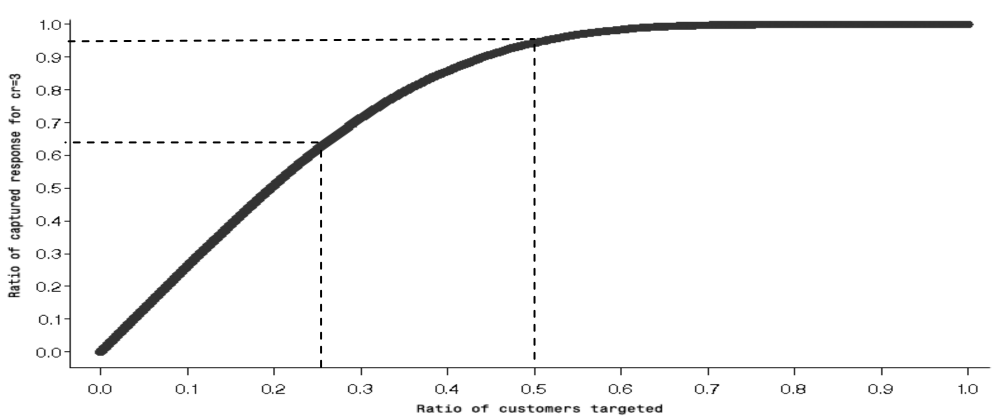

Figure A.9: Captured Response for cr_{43}=43

Consumer Spending and Business Investment

Session Chair: Sioux Groves, Bureau of Labor Statistics

Impacts of Aging on Health Care Spending

Sean Keehan, Aaron Catlin, and Micah Hartman, Centers for Medicare & Medicaid Services

The aging of the U.S. population is often cited as the primary driver of future rapid growth in health care spending. This paper challenges the notion that the aging of the population alone will account for significant increases in aggregate health spending. In this paper, we discuss the methodology used to isolate the aging effect, report the results of our simulation over the coming decades, including the results of a sensitivity analysis. In closing, we discuss broader, more dynamic effects related to aging that may amplify the impacts on health care spending.

Employment Related to Personal Consumer Spending

Eric Figueroa, U.S. Department of Labor, Bureau of Labor Statistics

This study examines employment related to personal consumption expenditures. From 1994 to 2004, personal consumption expenditures grew faster than overall GDP, a trend expected to reverse over the projection period of 2004 to 2014. Using input-output methods developed by the Bureau of Labor Statistics, employment related to personal consumption expenditures for the 1994-2004 period is compared with expected employment for 2014. The impact of changing patterns of consumption spending is examined, and occupational employment data for 2004 and 2014 are compared.

Employment and Output Derived from Business Investment

Katy Byun, U.S. Department of Labor, Bureau of Labor Statistics

In order to arrive at the published biennial employment projections, the Office of Occupational Statistics and Employment Projections first forecasts final demand. Consequently, the employment and output arising from each component of final demand (consumption, investment, government expenditures, and trade) can be calculated. This paper analyzes the domestic employment for detailed occupations and industries generated by business investment. The results are compared to overall employment from total final demand. Individual components of investment will also be evaluated to see if they are growing or declining from 1998 to 2004 as well as in the 2014 projected levels.

Impacts of Aging on Health Care Spending

Sean Keehan, Aaron Catlin, and Micah Hartman
Office of the Actuary, Centers for Medicare & Medicaid Services

INTRODUCTION

The aging of the population over the next several decades is widely believed to be the primary reason for future increases in health spending. In this paper, we will show that the effect of the aging of the population alone will only contribute to minor increases in health spending growth, relative to other factors such as medical price inflation and utilization growth. To provide the necessary background information, we will first explicitly define the population aging effect used in this paper and present the methodology used in the calculation of this effect. In the next section, we will present the major findings of a simulation that will isolate this impact on health care spending over the next several decades. In this analysis, we will include the results of a sensitivity analysis demonstrating that the magnitude of the effect does not depend on the chosen base year. Finally, we will offer some secondary effects related to aging that could generate greater increases in health spending growth.

For the purposes of this paper, the aging effect is the anticipated impact of the changing age distribution of the population over time. This type of analysis allows for one to answer questions such as what will be the impact on spending from an increase in the percentage of the elderly population over the next 20 years. The aging effect is estimated by taking detailed spending estimates by age in a base year and simulating the impact in future years if only the nation's age distribution changed. Therefore, this effect does not include the impact of population increases, price inflation, or the effect of higher utilization of certain services over time. Since changes in the population's age distribution are small from year to year, our analysis is done in 10-year increments. This simulation, therefore, is not a complete health care projection; instead, this exercise isolates the impact of aging on spending by holding all other factors constant. This type of analysis is important to disentangle the true drivers of future health care spending.

This paper is part of a larger effort to develop updated health spending estimates by age in the National Health Expenditure Accounts (NHEA), a multidimensional economic accounting matrix that tracks health spending over time, by service, and by source of funds. The NHEA is updated and published annually in the Office of the Actuary at the Centers for Medicare & Medicaid Services (Smith et al, 2006); however, spending estimates by age are published less frequently (Keehan et al, 2004). This paper builds on the previous age studies and is based on unpublished health spending estimates by age for 2002. We anticipate publishing a complete version of these estimates in mid-to-late 2007.

METHODOLOGY

For this purpose, we have developed methods for estimating the personal health care (PHC) portion of the NHEA by age. Personal health care includes spending for hospital care, physician and clinical services, other professional services, nursing home care, home health care, dental care, and health care products purchased in retail outlets (prescription drugs, non-prescription drugs, eyeglasses, etc.). We are unable to estimate the non-PHC components (investment, public health activity, and program administration) of the NHEA by age.

In order to estimate health spending by age for each service and source of fund category we employed a variety of data sources and methods (Centers for Medicare & Medicaid Services, 2006). For Medicare and Medicaid, we obtained an age distribution using administrative data. The paragraphs below describe the methods used to generate an age distribution for the private and other public source of payment. For most service category estimates we start by obtaining average cost per use data from the Medical Expenditure Panel Survey (MEPS). The calculation of average cost per use from this survey required a substantial amount of processing. First, we reviewed the MEPS event files to ensure that we were using data that corresponded to the NHEA definitions of each service. Then, for each service we created a matrix that detailed spending for that service by age grouping and primary and secondary payers. Finally, for each source of funds category we summed the values of the primary and secondary payers for each age grouping and calculated the average cost per use for each age grouping and each source of funds.

The next step in this process was to multiply the MEPS average cost per use by utilization from provider surveys, like the National Hospital Discharge Survey or the National Ambulatory Medical Care Survey. This method uses utilization estimates from provider surveys rather than from MEPS because the provider surveys capture the utilization of the institutionalized population, while the MEPS data does not. This method implicitly assumes that cost per use is the same for the institutionalized and non-institutionalized population. For service categories where there was no associated provider survey, we adjusted the MEPS community-based utilization to account for the institutionalized.

The resulting "interim expenditure" estimates were then controlled by scaling both the service and source of funds estimates to the NHEA PHC levels. We used different methods to control to these levels depending upon how different the interim expenditures were from the NHEA expenditures. For those service categories where the interim expenditures were less than 15 percent above or below the NHEA spending levels we scaled the interim expenditures to the NHEA, based on the assumption that the interim spending distributions were correct. In cases where the interim expenditures were more than 15 percent above or below the NHEA levels we researched the discrepancy and employed a more appropriate method to control to the NHEA. Finally, we reviewed the results that this method generated to ensure reasonableness and evaluate comparability with other published reports (MEPS published reports, the Medicare Current Beneficiary Survey, etc.). Preliminary PHC estimates by age are available through 2002, although these estimates have not yet been published.

One of the most valuable applications of these estimates is to run a simulation to isolate the effect on health care spending growth from changing the age-mix of the population over time. For all years in the simulation, we assume that the cost and use of all personal health care services remain constant at the 2002 level. Because we are specifically holding all other factors that increase health spending constant over time, the simulated expenditures should not be viewed as a complete health care projection.

Simulations were produced for 1999, 2009, 2019, 2029, 2039, and 2049. Here, we will walk through how the simulation was completed for 2009 in order to explain the details behind determining the aging effect. The starting point for the 2009 simulation is the population projections for 2009 from the Social Security Trustees Report (Board of Trustees, 2006), adjusted to be consistent with population estimates in the historical NHEA. This population projection was grouped into the seven age groups (0-18, 19-44, 45-54, 55-64, 65-74, 75-84, and 85 and over). Then, we set up a matrix for each of the ten types of PHC services (hospital, physician, etc.) in the NHEA. The top portion of the matrix contained the major source of funding categories (out-of-pocket, private health insurance, other private, Medicare, Medicaid, and other public) while the left side of the matrix contained the seven age groups. Then, for each of the 42 cells inside each service category's matrix, the 2002 per capita estimate was multiplied by the 2009 population projection for that particular age group. The result is a matrix of 2009 simulated health care spending for each type of service assuming the same per person spending that existed in 2002 with the population of 2009. Since we held everything constant except for the age distribution of the population, the levels are not very meaningful because an assumption of zero price or utilization growth in the future is unrealistic. Therefore, the results of the simulation are presented in index levels, which show the cumulative impact of aging, and average annual growth rates.

GENERAL FINDINGS

Overall, our simulation shows that the impact of population aging alone will cause cumulative growth of per capita personal health spending to be 25.4 percent from 1999 to 2049 (Table 1). The results can also be shown as average annual growth of 0.5 percent per year (Table 2). Average annual growth in PHC spending over the last ten years of historical data (1995-2004) has been 6.7 percent. Therefore, if annual nominal growth were to remain close to this rate over the next 45 years, then the aging effect would only account for approximately 7 percent of the total growth in PHC spending. Although the average annual growth rate of 0.5 percent that is attributable to aging is relatively low, it is nearly double the 0.3 percent growth rate attributed to aging from 1965 to 1999 (Keehan et al, 2004). In addition, the overall small age effect conceals more significant impacts on certain types of services and source of funding, which will be described in more detail below.

Many questions have arisen regarding whether these results would change significantly if a different base year was chosen. Therefore, we completed a sensitivity analysis on our simulation by running the same calculations using 4 different base years: 1987, 1996, 1999, and 2002. The average annual growth rates and cumulative growth rates are quite similar regardless of the base year chosen. For example, the average annual growth rate from 1999 to 2049 rounded to 0.5 percent for all four simulations using a different base year for each. The cumulative growth rates from 1999 to 2049 ranged from 25.4 percent for the simulation with the 2002 base year to 28.5 percent for the simulation with the 1987 base year.

EFFECTS BY TYPE OF SERVICE AND SOURCE OF FUNDING

The aging of the population alone has a relatively small impact on the average annual growth in aggregate health spending. However, aging does have a significant impact on the growth of certain provider types within the health sector. The simulated impact of aging on health spending shows a comparatively large impact on nursing home and home health spending when viewed in the context of all other health goods and services. An aging population will have its most dramatic impact on nursing home care, contributing an additional 1.3 percent growth annually over the simulation period. Spending growth for home health care will also be substantially impacted by aging with additional age-related growth expected to average 0.8 percent per year. Hospital care, prescription drugs, other professional services, non-durable goods, and durable goods are expected to have an aging effect within the range of 0.3 percent to 0.5 percent annually, similar to the expected overall impact on health spending of 0.5 percent. The aging of the population alone will have a relatively small impact on spending growth for physician and clinical services and other personal health care with each expected to experience additional growth of 0.2 percent annually. Dental care is the only health spending category expected to have virtually no measurable impact on spending growth due to the aging of the population over the simulation period. The age distribution of per capita dental spending is different from other health providers, in that it does not increase progressively with age and actually falls for individuals between 75 and 84 years old, as well as for individuals 85 years and older.

The changing age mix of the population impacts nursing home growth more than any other category of health spending over the simulation period. Not surprisingly, the per capita spending levels for nursing home care are heavily skewed toward the older age categories. As the population in the United States ages (Table 3) and more individuals move in to the 75 years and older category, spending for nursing home care should increase significantly, with 1.3 percent of growth per year between 1999 and 2049 caused solely by the changing age mix. This simulation shows that the impact of aging on nursing home spending growth will become more significant over time as its impact on growth increases from a 0.7 percent average annual growth between 2009 and 2019 to a peak impact of 2.2 percent per year between 2029 and 2039, falling slightly in the last 10 years of the simulation to 1.1 percent. Nursing home spending is financed primarily by public payers with Medicaid accounting for 45 percent of nursing home spending in 2002 and Medicare accounting for 13 percent.

Home health spending is fairly evenly distributed between the under 65 and over 65 age groups. This service is defined as health care delivered in the home, including hospice, by a non-hospital based home health agency. It is important to note that the home health delivered by hospital based facilities remains in our hospital estimate. The majority of the funding for this care comes from the public sector at 68 percent of total home health spending in 2002. Over the entire period of the simulation home health spending due to the aging effect grew on average 0.8 percent annually. Our simulation shows home health care to be one of the most affected services by the aging effect, with average annual growth of 1.3 percent for the period 2019 – 2029 and 1.4 percent for 2029 – 2039 (Table 2).

The impacts of the aging effect on the sources that pay for PHC are also somewhat small. Medicare is by far the most affected payer with an average annual growth of 1.0 percent over the entire simulation period, more than twice that of any other payer. Out-of-pocket (OOP) spending has the second highest growth due to this effect over the entire period at 0.5 percent. This is mainly driven by nursing home growth which is also expected to experience significant growth since one third of funding currently comes from OOP spending. Somewhat surprising results occurred in Private Health Insurance (PHI) with aging accounting for an expected 0.1 percent average annual growth over the entire period. In fact, PHI is the only payer to have a negative growth period during the simulation (occurs from 2019-2029). Aging is expected to affect Medicaid, other public, and other private similarly over the period. However, the timing of how each payer is affected looks somewhat different. Our analysis shows that Medicaid increases substantially in the later years of the simulation, other private continues with relatively flat growth throughout and other public declines significantly over the later years of the simulation.

Medicare is expected to be the most affected payer by the impending demographic shift of an aging baby boom generation. Our estimates highlight some of the challenges that face the program over the next 45 years. This includes the aging effect causing average annual growth in the simulation from 2009 to 2019 of 1.3 percent, more than twice that of any payer over the same period. However, the real crunch begins in 2019 to 2039 when Medicare spending accelerates to 1.7 percent average annual growth through the period, nearly three times more than all other payers. At this same time the HI trust fund is projected to be exhausted and unable to meet obligations (Boards of Trustees, 2006).

The health care services in which Medicare is a major payer will also see significant growth as the share of the elderly rise in the country. Medicare paid 30 percent of all hospital spending, 19 percent of all other professional, 26 percent of all durable medical equipment, and 34 percent of all home health spending in 2002. Also, Medicare is the majority payer for all hospital, other professional, durable medical equipment, and home health spending for adults age 65 or older. Since our analysis assumes no changes in the distribution or treatment of the Medicare eligible population these trends present a simulated view of what services may potentially be most affected by the aging baby boom.

INDIRECT IMPACTS OF AGING ON MEDICARE FINANCING

As we approach the point where Baby Boomers are reaching age 65, we naturally turn our attention to Medicare, the payer likely to be most affected by this demographic shift. Under current law, no other payer will take on a larger responsibility, so it is important to analyze some of the anticipated associated dynamic affects of aging on the Medicare program. First, one fact that reinforces our point that aging alone will play a lesser role in the factors influencing the growth of future health spending is the simple average annual growth of the Medicare population over time. In the 2006 Trustees Report, Table III.A3 shows past and projected enrollment in the Medicare program. Enrollment is expected to grow at a somewhat similar average annual rate from 2010 to 2040 as it did from 1970 to 2000. Although this may seem surprising, there are some important differences in the timing of the enrollment growth along with the number of workers available to support each beneficiary. In the 1970 to 2000 period, almost all of the growth in enrollment came from the 1970's, but the recent projections from the 2006 Trustees Report expect the 2010 to 2040 growth to mostly occur over two decades from 2010 to 2030, adding around 32 million people to the rolls of Medicare. More importantly, the 2006 Trustees Report (Figure III.B4) shows that workers per HI beneficiary drop from 3.9 in 2005 to around 2.4 in 2030 (Boards of Trustees, 2006). So, we are entering a period very different from the 1970's, where there will be fewer workers available to support these retirees. The effect of the baby boom and then the "baby-bust" is very hazardous to a pay-as-you-go benefit system such as the Medicare program. Over the past 40 years, Medicare has been financed primarily through payroll taxes from these workers. Partly due to this demographic shift, general revenues are expected to surpass these dedicated worker taxes to become the primary sponsor of Medicare by 2006 (Boards of Trustees, 2006). This new funding environment may significantly alter the approach of those who legislate the benefits covered in years to come.

Additional pressure will be added to the program as the 85+ population is expected to grow at a 2.7 percent average annual rate from 2010 – 2040, according to SSA Trustees projections (Table 3). Per capita spending shows 85+ spending at almost twice all other age groups and almost five times as much as the 45 to 54 group (Keehan et al., 2006). This is concerning since the Medicare program is currently paying the majority of total personal health care for most Americans aged 65 and over. Finally, at a point when Medicare's enrollment begins to increase most fast in 2010, Medicare spending will have never been a larger part of the Federal budget and GDP. For example, in 1970 the Medicare program made up 3.2 percent of total Federal spending and less than 1 percent of the GDP. By 2010, the Office of Management and Budget predict that Medicare will rise to 14.7 percent of Federal spending and 2.8 percent of the GDP (Office of Management and Budget, 2006).

OTHER EFFECTS OF AGING

The simulations completed for this paper are derived from the static aging effect; that is, only the population's age distribution is allowed to change. However, some researchers have argued that it is more appropriate to look at the aging effect with a much wider viewpoint. As the ratio of workers to retirees falls over the next few decades, the growth in unit costs in a labor-intensive sector like health care is likely to be higher than in years when this ratio is stable (Reinhardt, 2003). This possible increase in medical price inflation related to aging is something not covered in the simulation. Also, other secondary effects of aging could be new cost-increasing or cost-decreasing technologies targeted to older populations, changes in medical practice, changing consumer preferences, life extending medical advances, changing reimbursement structure or incentives, and the globalization of health care delivery.

As we have defined aging in this simulation it is expected to have a relatively minor impact on health spending over the next four decades. However, the expected impact on total health spending is more significant on specific medical care providers and payers of the care they deliver. However, there are broader dynamic effects related to aging that may amplify the impacts of the changing age mix of the population on health spending and may lead to changes in the way that health care is delivered and paid for.

REFERENCES

Board of Trustees, The *2006 Annual Report of the Boards of Trustees of the Federal Old-Age and Survivors Insurance and Federal Disability Insurance Trust Funds*, May 1, 2006, http://www.ssa.gov/OACT/TR/TR06/tr06.pdf.

Boards of Trustees, The *2006 Annual Report of the Boards of Trustees of the Federal Hospital Insurance and Federal Supplemental Medical Insurance Trust Funds*, May 1, 2006, http://www.cms.hhs.gov/ReportsTrustFunds/downloads/tr2006.pdf.

Centers for Medicare & Medicaid Services, "Age Estimates in the National Health Accounts: Definitions, Sources, and Methods," March 2006, http://www.cms.hhs.gov/NationalHealthExpendData/downloads/age-methodology.pdf.

S. Keehan, et al., "Age Estimates in the National Health Accounts," Health Care Financing Review Web Exclusive. December 2, 2004. http://www.cms.hhs.gov/NationalHealthExpendData/downloads/keehan-age-estimates.pdf.

Office of Management and Budget, *Analytical Perspectives, Major Savings and Reforms in the President's 2007 Budget, Budget of the United States Government, Fiscal Year 2007*. Government Printing Office, Washington, D.C., February 2006.

U. Reinhardt, "Does The Aging Of The Population Really Drive The Demand For Health Care?" *Health Affairs* 22, no. 6 (2003) 27-39.

C. Smith, et al., "National Health Spending In 2004: Recent Slowdown Led By Prescription Drug Spending," *Health Affairs* 25, no. 1 (2006) 186-196.

Table 1
Index Levels by Type of Service and Source of Funding (1999 = 100.0)

	1999	2009	2019	2029	2039	2049
Personal Health Care	100.0	104.3	109.3	115.4	121.6	125.4
Hospital Care	100.0	104.0	110.4	117.5	123.1	126.5
Physician & Clinic	100.0	104.5	108.0	109.7	110.9	112.2
Prescription Drugs	100.0	106.6	111.2	114.3	117.3	119.5
Nursing Home Care	100.0	104.6	111.9	134.9	168.1	187.1
Home Health Care	100.0	103.7	109.5	124.0	142.2	151.5
Dental	100.0	101.9	102.6	102.9	102.3	101.7
Other Professional	100.0	103.2	106.4	110.2	114.0	115.7
Other PHC	100.0	101.4	102.7	104.7	108.1	110.1
Nondurables	100.0	105.0	114.1	123.2	127.7	129.6
Durables	100.0	103.9	110.8	120.8	127.7	129.6
Private Health Insurance	100.0	105.1	106.7	105.5	106.1	107.5
Medicare	100.0	104.8	119.5	141.3	156.3	163.6
Medicaid	100.0	101.2	102.6	106.2	112.7	116.8
Out-Of-Pocket	100.0	104.5	109.4	117.1	126.2	131.1
Other Public	100.0	105.9	111.9	116.0	120.6	123.5
Other Private	100.0	103.8	106.6	110.7	115.8	118.0

Table 2
Average Annual Growth Rates by Type of Service and Source of Funding

	1999-2009	2009-2019	2019-2029	2029-2039	2039-2049	1999-2049
Personal Health Care	0.4	0.5	0.5	0.5	0.3	0.5
Hospital Care	0.4	0.6	0.6	0.5	0.3	0.5
Physician & Clinic	0.4	0.3	0.2	0.1	0.1	0.2
Prescription Drugs	0.6	0.4	0.3	0.3	0.2	0.4
Nursing Home Care	0.4	0.7	1.9	2.2	1.1	1.3
Home Health Care	0.4	0.5	1.3	1.4	0.6	0.8
Dental	0.2	0.1	0.0	-0.1	-0.1	0.0
Other Professional	0.3	0.3	0.4	0.3	0.2	0.3
Other PHC	0.1	0.1	0.2	0.3	0.2	0.2
Nondurables	0.5	0.8	0.8	0.4	0.1	0.5
Durables	0.4	0.6	0.9	0.6	0.2	0.5
Private Health Insurance	0.5	0.1	-0.1	0.1	0.1	0.1
Medicare	0.5	1.3	1.7	1.0	0.5	1.0
Medicaid	0.1	0.1	0.3	0.6	0.4	0.3
Out-Of-Pocket	0.4	0.5	0.7	0.7	0.4	0.5
Other Public	0.6	0.5	0.4	0.4	0.2	0.4
Other Private	0.4	0.3	0.4	0.4	0.2	0.3

Table 3
Total Population Levels and Age Distribution, 1999-2049

	1999	2009	2019	2029	2039	2049
Total Population	285.6	312.3	336.9	358.8	375.4	388.3
Ages 0-18	28.7%	26.8%	25.7%	24.7%	23.8%	23.6%
Ages 19-44	37.0%	34.3%	33.0%	32.2%	31.3%	31.1%
Ages 45-54	13.2%	14.6%	12.6%	12.2%	12.7%	12.1%
Ages 55-64	8.6%	11.6%	13.1%	11.5%	11.4%	12.0%
Ages 65-74	6.6%	6.8%	9.4%	10.8%	9.8%	9.9%
Ages 75-84	4.4%	4.1%	4.5%	6.5%	7.7%	7.2%
Ages 85 and older	1.6%	1.8%	1.8%	2.1%	3.3%	4.2%

Source: Social Security Trustees Report, Table V.A2, 2006

Employment Related to Consumer Spending

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Introduction

In 2004, consumer spending generated 96.6 million jobs, accounting for 67.1% of total employment in the US economy (Table 1). By 2014, consumer spending is expected to generate 9.0 million new jobs, bringing total consumption-related employment[1] to 105.6 million jobs, or 64.8% of total employment. From 2004 to 2014, the projected annual average growth rate of employment related to consumer spending will slow to 0.9% from the 1.2% rate of the 1998 to 2004 period.

In contrast, the projected growth rate of employment generated by consumer spending on medical care is expected to increase over the 2004 to 2014 period. In 2004, consumer spending on medical care generated 18.5 million jobs, or 12.9% of total employment. Over the 2004 to 2014 period, such spending is projected to add 4.6 million new jobs to the economy, generating a total of 23.1 million jobs, or 14.2% of total employment. From 2004 to 2014, the annual average growth rate of employment related to spending on medical care will increase to 2.2% from the 1.7% growth rate of the 1998 to 2004 period.

The increasing growth rate of employment related to medical care spending corresponds to increasing purchases of these services on the part of consumers. One result is that the healthcare and social assistance sector will increase its share of consumption-related industry employment from 10.4% to 11.7% over the 2004 to 2014 period. Large employment gains will be seen in occupations related to healthcare. These include registered nurses; home health aides; nursing aides, orderlies and attendants; and personal and home care aides.

This article examines domestic employment related to both overall consumer spending and to consumer spending on medical care. Employment for 1998 and 2004 is compared with that expected for 2014, using the most recent economic and employment projections from the BLS Office of Occupational Statistics and Employment Projections. The number and type of jobs dependent on consumer spending were estimated using an input-output model that enables one to trace the purchase of a good or service through the entire production chain. With this approach, it is possible to determine employment required in each industry, including the industries that supply inputs to the production process of a good or service. In addition, an industry-occupation matrix was used to determine the effect of consumer spending on occupational employment in 2004 and 2014.

Consumer spending

The measure of consumer spending used in this analysis is Personal Consumption Expenditures (PCE), published by the Bureau of Economic Analysis, U. S. Department of Commerce, as part of the national income product accounts. PCE measures the goods and services purchased by persons resident in the United States. Persons are defined as individuals and the nonprofit institutions serving them.

Over the 1994 to 2004 period, consumer spending grew at a 3.7% annual average rate, faster than the 3.2% rate of overall gross domestic product (GDP) during the same period (Table 2). The growth rate was particularly strong during the late 1990’s due to the tight job market, steady incomes, low interest rates, low inflation and sharply increasing wealth from rising asset prices. Despite a series of shocks beginning in late 2000, consumers continued to spend at a moderate, but slower pace. Tax cuts, low mortgage rates, and incentives offered by auto makers encouraged the continued spending. Rebounds in household wealth and continued gains in income in the second half of 2003 helped boost solid spending growth.

Although purchases of durable goods saw strong growth from 1999 to 2004 due to spending on computer and peripheral equipment, purchases of services continued to make up the majority of consumer spending. The fastest-growing services component from 1999 to 2004 was medical care. Growing at a 4.5% annual average rate over the period, this component’s growth outpaced overall PCE, which grew at 3.3% annual rate.

[1] In this paper, the terms “consumption-related employment” and “PCE-related employment” both refer to employment generated by consumer spending. .

Expenditures for medical care services have been growing steadily over the past few decades. An aging population and advances in medical technology have increased the demand for health care services, as well as increasing the average per-person cost of many health care services.

While spending on durable goods will see strong growth over the 2004 to 2014 projection period, services will maintain its position as the largest component of PCE in 2014. Spending on medical services is expected to grow at 3.4% annual average rate, faster than the rate of change of either GDP or overall PCE. These are expected to have annual average growth rates of 3.1% and 2.8%, respectively.

Commodity purchases

Consumer spending on a good or service, such as a motor vehicle or medical care, involves the purchase of a variety of commodities. Certain industries produce the final good and service—the items actually purchased by consumers. Other industries produce commodities for use as inputs to the production of the final product. It is in all these industries that consumer spending generates employment—a purchase triggers the need for both commodity output and the workers needed to make the good or service.

In 2004, purchases of healthcare and social assistance services were the largest among consumption-related purchases by major commodity sectors (Table 3). Among detailed sectors within this grouping, the largest purchases were for hospital services; services of offices of health practitioners; and outpatient, laboratory and other ambulatory care services. Increased demand for these commodities has been fueled by increased consumer spending on medical care. Over the 2004 to 2014 projection period, spending on health care and social assistance services is expected to grow at a 3.6% average annual rate, higher than the rate of growth of consumer spending for all sectors. Most of the purchases for these services result from medical care-related commodity purchases.

In 2004, purchases of retail trade services were the second largest among consumption-related commodity purchases by major sector. These purchases cover the cost of margins charged by retail establishments. Strong consumer spending over the 1998 to 2004 period led to strong spending on retail margins.

Spending on manufactured goods represents the next largest purchase by major commodity grouping, in 2004. Among detailed sectors within this grouping, the largest purchases were on motor vehicle manufacturing, as buyers responded to incentives offered on the purchase of cars and light trucks. This was followed by purchases of computer and peripheral equipment as the popularity of the internet and software applications led consumers to continue their purchases of desktops, laptops and peripheral equipment. Within manufacturing, the next largest consumer-related commodity purchases were found in other miscellaneous manufacturing, and pharmaceutical and medicine manufacturing. Consumer-related purchases of manufactured commodities are expected to grow strongly over the 2004 to 2014 projection period, at a 4.1% annual average growth rate, faster than the rate for overall consumer spending. Driving this will be strong growth in the purchases of computers and peripheral equipment.

Industry employment

Using an input-output system, analysts can derive the level of industry output necessary to satisfy consumption-related demand for commodities. Given these output levels, the system then derives the required level of employment to produce the output. Using these methods, industry employment was calculated by major sector for 1998, 2004, and 2014 (Table 1).

Employment levels are not simply a function of consumption demand. From 1998 to 2004, the rate of increase in employment related to PCE, 1.2 % (Table 1), is less than the rate of increase of consumption spending on commodities, 3.4% (Table 3). This is due to productivity growth—as real consumption spending increased, firms met this demand by producing more with a given number of workers and by investing in labor-saving technologies. In addition, some of the difference may have been attributable to changes in the input requirements of producing industries. As new technologies are developed and input requirements change, employment is affected if the labor intensity of the contributing industries vary.

Among manufacturing industries, productivity increases have led to an overall decline in industry employment related to consumer spending. From 1998 to 2004, the demand for manufactured commodities grew at a 1.7% annual average rate; however, related manufacturing employment declined 2.2% over the same period. High rates of productivity growth in manufacturing industries are responsible for these declines. As a result, strong growth in consumer spending on durable goods, led by purchases of computer and peripheral equipment, did not translate into employment increases in the manufacturing sector. From 2004 to 2014, manufacturing employment is expected to decline by 1.0% despite positive growth in the demand for goods such as cars and computer equipment.

By contrast, employment related to consumer spending in service-producing industries grew at annual rate of 1.6% between 1998 and 2004. Positive growth is expected to continue, and a 1.1% growth rate is expected over the forecast period. Employment growth in services industries is largely due to increased demand for services offered in office of healthcare practitioners and hospitals, found within the healthcare and social assistance services sector. Production in services industries are generally not as easy to automate as manufacturing processes; therefore output growth translates more directly into increased employment.

Employment by major occupational group

In 2004, the largest employment related to consumer spending among major occupation groups was in services occupations, which are expected to grow at a 1.5% annual average rate over the 2004 to 2014 period (table 4). This relatively large employment reflects the continued importance of consumer spending on services such as healthcare, leisure and hospitality, and information.

Among major occupational groups, the next largest employment related to consumer spending was in professional and related occupations, expected to grow at a 2.1% rate. This growth also reflects the importance of healthcare services as registered nurses are included in this occupational category. Registered nurses are the detailed occupation projected to see the largest employment gain related to consumer spending.

The third and fourth largest occupational employment groups were, respectively, office and administrative support occupations, and sales and related occupations. Employment in office and administrative occupations will increase at a slower rate of 0.1%, reflecting continued office automation and the use of temporary workers. Employment in sales and related occupations is only forecast to increase at a 0.2% annual average growth rate over the forecast period. These jobs are found in a variety of retail establishments such as groceries; department, clothing, and general merchandise stores; and gas stations.

Over the forecast period, the ranking of these four occupational groups will not change; however their growth rates will vary. The relatively strong growth in consumption-related employment in service and professional and related occupations is due in part to spending on medical care. Employment in these occupational groups generated by medical care spending is expected to grow at an annual average rate of 2.7% and 2.6%, respectively, over the forecast period. Growing faster than any of the other major occupational groups, these two sectors will maintain the largest employments related to consumer spending in 2014.

Employment by detailed occupation

Which occupations will see most employment growth related to consumer spending? Not surprisingly, of the ten occupations expected to see the largest gains, four are healthcare-related (Table 5): registered nurses; home health aides; nursing aides orderlies and attendants; and personal and home care aides

Gains among these occupations are attributable to strong consumer demand for medical care and resulting commodity purchases in healthcare services, particularly in hospitals and in the offices of health practitioners. Together, these four occupations will add about 1.5 million new jobs between 2004 and 2014, accounting for nearly 16.5% of all occupational job growth generated by consumption-related spending.

From 2004 to 2014, registered nurses will gain more employment related to consumer spending than any other occupation, nearly 600,000 workers. Large employments of registered nurses are found in general medical and surgical hospitals, and the offices of health care practitioners. Home health aides and personal home care aides will see employment gains of about 330,000 and 264,000, respectively. These workers are found residential institutions, community care facilities and in establishments that provide services for the elderly and persons with disabilities. Nursing aides, orderlies and attendants will see an employment gain of about 281,000. These workers have large employments in nursing facilities as well as hospitals. Most of the employment gain in these four occupations is related to consumer-spending on medical care.

Two education occupations are found among the ten occupations with the fastest growing employment related to consumer-spending. These two are postsecondary teachers and elementary school teachers excluding special education. Together, these contribute about 578,000 jobs related to consumer spending. Postsecondary teachers are largely employed in colleges, universities and professional schools; and by state government educational services. Growth in these occupations is the result of larger percentages of high school graduates attending college, and more adults returning to college to enhance their skills. Elementary school teachers, excluding special education teachers, are employed by elementary and secondary schools, and state government educational services. Growth in these occupations will result from increases in the school-age population, greater proportions of school age children attending school, and smaller class sizes.

Food preparation and serving occupations found among the ten occupations with the fastest growth related to consumer spending include waiters and waitresses; and combined food preparation and service workers. Together, these occupations will gain about 501,000 jobs related to consumer spending. Waiters and waitresses work primarily in full-service restaurants; combined food preparation and service workers are largely employed in limited service restaurants, include fast food establishments.

Janitors and cleaners, except maids and housekeeping cleaners will add about 254,000 jobs related to consumer spending over the projection period. These workers are concentrated in establishments providing services to buildings.

Employment growth in retail salespersons reflects historically large employment in this occupation rather than higher projected growth rates. Retail salesperson jobs are projected to grow 0.9% over the projection period, in line with the overall growth rate of occupational employment related to consumer spending. Industries with large retail salespersons employment include department stores and clothing stores.

Conclusion

Between 2004 and 2014, employment related to consumer spending is expected to increase at a slower rate than total employment. However, consumer spending on medical care services will generate employment at a faster rate than either total employment or overall consumption-related employment. Strongly rising consumer purchases of medical care services are expected to translate directly into employment increases in the services sector. Gains will be greatest in healthcare and social assistance industries, such as hospital services; services of offices of health practitioners; and outpatient, laboratory and other ambulatory care services.

These increases will result in occupational growth in the services occupations and professional and related occupations. The former include home health aides; nursing aides orderlies and attendants; and personal and home care aides. Professional and related occupations include registered nurses. All four of these detailed occupations are found among the ten occupations expected to show the largest employment growth related to consumer spending between 2004 and 2014.

Table 1. Consumption-related employment, by spending category and by major industry sector
Source: Bureau of Labor Statistics

Category	Wage and salary employment (thousands)			Percent of total employment			Change		Average annual rate of change	
	1998	2004	2014	1998	2004	2014	1998-2004	2004-2014	1998-2004	2004-2014
Total Employment	138,491	143,888	162,799	100.0	100.0	100.0	5,397	18,911	0.6	1.2
Consumption-related employment	89,964	96,562	105,555	65.0	67.1	64.8	6,598	8,993	1.2	0.9
By spending category:										
Drug preparations & sundries	1,579	1,993	1,616	1.1	1.4	1.0	415	-377	4.0	-2.1
Medical care	16,738	18,516	23,123	12.1	12.9	14.2	1,779	4,607	1.7	2.2
Other PCE	71,648	76,052	80,816	51.7	52.9	49.6	4,404	4,764	1.0	0.6
By major industry sector:										
Goods Producing	10,871	9,579	8,603	7.8	6.7	5.3	-1,292	-976	-2.1	-1.1
Manufacturing	8,257	7,232	6,536	6.0	5.0	4.0	-1,025	-696	-2.2	-1.0
Other goods producing	2,614	2,347	2,068	1.9	1.6	1.3	-267	-279	-1.8	-1.3
Service producing	79,093	86,983	96,951	57.1	60.5	59.6	7,889	9,968	1.6	1.1
Utilities	445	422	414	0.3	0.3	0.3	-23	-7	-0.9	-0.2
Wholesale trade	3,384	3,466	3,103	2.4	2.4	1.9	82	-363	0.4	-1.1
Retail trade	13,503	14,954	15,263	9.8	10.4	9.4	1,451	309	1.7	0.2
Transportation & warehousing	2,737	2,866	2,816	2.0	2.0	1.7	129	-50	0.8	-0.2
Information	2,248	2,266	2,226	1.6	1.6	1.4	18	-40	0.1	-0.2
Financial activities	6,632	7,211	7,471	4.8	5.0	4.6	579	260	1.4	0.4
Professional & business services	10,155	10,798	12,190	7.3	7.5	7.5	643	1,391	1.0	1.2
Educational services	2,139	2,722	3,462	1.5	1.9	2.1	583	740	4.1	2.4
Health care & social assistance	12,912	14,942	19,049	9.3	10.4	11.7	2,031	4,106	2.5	2.5
Leisure and hospitality	10,952	12,260	13,676	7.9	8.5	8.4	1,308	1,416	1.9	1.1
Other services	6,220	6,744	7,435	4.5	4.7	4.6	524	690	1.4	1.0
Government	7,766	8,332	9,847	5.6	5.8	6.0	565	1,516	1.2	1.7

Table 2. Personal Consumption Expenditures (PCE), 1994, 1999, 2004, and projected 2014

Category	Billions of chained 2000 dollars				Average annual rate of change			
	1994	1999	2004	2014	1994-99	1999-2004	1994-2004	2004-14
Gross Domestic Product (GDP)	$7,835	$9,470	$10,756	$14,651	3.9	2.6	3.2	3.1
Personal consumption expenditures	$5,291	$6,439	$7,589	$10,020	4.0	3.3	3.7	2.8
Durable goods	529	805	1,090	1,711	8.7	6.3	7.5	4.6
Motor vehicles and parts	276	372	457	617	6.2	4.2	5.2	3.1
Other durable goods	259	432	636	1,122	10.8	8.0	9.4	5.8
Nondurable goods	1604	1,877	2,200	2,628	3.2	3.2	3.2	1.8
Services	3,177	3,758	4,311	5,750	3.4	2.8	3.1	2.9
Housing services	869	979	1,078	1,396	2.4	2.0	2.2	2.6
Medical services	887	989	1,234	1,724	2.2	4.5	3.4	3.4
Other services	1,423	1,791	1999	2622	4.7	2.2	3.5	2.8
Residual/1	-27	-1	-16	-88	-	-	-	-

[1]The residual is the difference between the first line and the sum of the most detailed categories.
Sources: Historical data, Bureau of Economic Analysis; projected data, Bureau of Labor Statistics

Table 3. Commodity purchases related to PCE and to Medical care spending, by major sector

Category	PCE-related commodity purchases			Average annual rate of change		Medical Care-related commodity purchases			Average annual rate of change	
	1998	2004	2014	1998-2004	2004-2014	1998	2004	2014	1998-2004	2004-2014
All Sectors	5,910	7,230	9,810	3.4	3.1	971	1,230	1,748	4.0	3.6
Goods Producing	894	999	1,469	1.9	3.9	0	0	0	--	--
Manufacturing	868	959	1,426	1.7	4.1	0	0	0	--	--
Other goods producing	26	40	43	7.5	0.6	0	0	0	--	--
Service producing	5,016	6,230	8,341	3.7	3.0	971	1,230	1,748	4.0	3.6
Utilities	159	175	207	1.6	1.7	0	0	0	--	--
Wholesale trade	229	347	498	7.2	3.7	0	0	0	--	--
Retail trade	692	965	1,364	5.7	3.5	0	0	0	--	--
Transportation & warehousing	133	157	199	2.8	2.4	0	0	0	--	--
Information	211	293	420	5.6	3.7	0	0	0	--	--
Financial activities	762	903	1,144	2.9	2.4	76	105	130	5.5	2.1
Professional and business services	139	151	176	1.3	1.6	0	0	0	4.9	2.9
Educational services	141	161	207	2.2	2.5	0	0	0	--	--
Health care and social assistance	989	1,248	1,786	4.0	3.6	894	1,125	1,619	3.9	3.7
Leisure and hospitality	498	596	699	3.0	1.6	0	0	0	--	--
Other services	336	371	487	1.7	2.8	0	0	0	--	--
Government	44	48	62	1.5	2.6	0	0	0	--	--
Special industries	683	815	1,093	3.0	3.0	0	0	0	--	--

Source: Bureau of Labor Statistics

Table 4. PCE-related and Medical care-related employment, by major occupational group
Employment in thousands

Category	PCE-related Employment		Average annual rate of change	Medical Care related Employment		Average annual rate of change
	2004	2014	2004-2014	2004	2014	2004-2014
Total, all occupations	97,738	106,649	0.9	18,646	23,253	2.2
Management, business, and financial occupations	9,479	10,267	0.8	1,486	1,789	1.9
Professional and related occupations	16,947	20,941	2.1	6,476	8,559	2.8
Service occupations	22,949	26,637	1.5	4,580	6,005	2.7
Sales and related occupations	12,472	12,675	0.2	602	679	1.2
Office and administrative support occupations	16,802	16,946	0.1	3,744	4,252	1.3
Farming, fishing, and forestry occupations	770	676	-1.3	39	41	0.6
Construction and extraction occupations	2,132	2,286	0.7	267	312	1.6
Installation, maintenance, and repair occupations	3,679	3,878	0.5	315	361	1.4
Production occupations	5,938	5,602	-0.6	557	582	0.4
Transportation and material moving occupations	6,571	6,741	0.3	580	673	1.5

Source: Bureau of Labor Statistics

Table 5. Ten occupations with the largest PCE-related employment change, 2004 to 2014
Employment in thousands

Occupational Title	PCE-related Employment		Change	Average annual rate of change	Medical Care-related employment		Change	Average annual rate of change
	2004	2014	2004-2014	2004-2014	2004	2014	2004-2014	2004-2014
Registered nurses	2,003.8	2,603.5	599.7	2.7	1,770.3	2,318.6	548.3	2.7
Retail salespersons	3,856.4	4,223.2	366.8	0.9	48.8	74.1	25.3	4.3
Postsecondary teachers	775.0	1,127.5	352.5	3.8	126.7	232.9	106.2	6.3
Home health aides	587.3	917.3	330.0	4.6	352.4	561.6	209.2	4.8
Nursing aides, orderlies, and attendants	1,302.3	1,583.2	280.9	2.0	1,080.8	1,296.3	215.5	1.8
Personal and home care aides	666.9	930.7	263.8	3.4	250.2	401.0	150.8	4.8
Janitors & cleaners, exc. maids & housekeepers	1,556.8	1,810.8	254.0	1.5	289.9	371.6	81.7	2.5
Combined food preparation and serving workers	1,945.0	2,196.6	251.6	1.2	97.9	141.5	43.6	3.8
Waiters and waitresses	2,112.2	2,361.3	249.1	1.1	76.7	115.7	39.0	4.2
Elementary school teachers, exc. special ed.	447.5	673.0	225.5	4.2	142.6	247.1	104.5	5.7

Source: Bureau of Labor Statistics

Employment and Output Derived from Business Investment

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The Office of Occupational Statistics and Employment Projections (OOSEP) publishes biennial forecasts of medium term economic activity. Included in their publications are historical and forecasted levels of final demand. The bulk of historical data is provided by the Bureau of Economic Analysis (BEA). OOSEP disaggregates this data to a more detailed GDP, or final demand, categories and forecasts to the projection year, 2014. OOSEP then builds an input output system to provide the corresponding total output. Next, the industry employment necessary to supply this desired output is determined. Finally, the occupational employment is estimated given the industry employment levels. Because OOSEP produces a historical input-output system in order to arrive at the employment projections, one can also examine how each detailed component of final demand contributes to the output and employment levels and projections.

The purpose of this paper is to closely analyze business investment, except change in private inventories, and how it impacted economic activity in the past and how OOSEP projects it will impact economic activity in 2014. We will examine what portion of output and employment are necessary to satisfy only the investment category of final demand. Final demand and output will be observed in 1998 (the first year of historical data OOSEP developed for the 2014 projections), 2004 (the last year of historical data available), and 2014 (the projection year). Employment will not be evaluated in 1998 because the staffing pattern matrix was only developed for 2004 and 2014.

Final Demand

In order to create annual input-output tables[1], OOSEP first categorizes final demand into the standard groups of expenditures by consumers, businesses, government, exporters, and importers. These categories are further disaggregated into 204 product categories which serve as the columns in the final demand matrices. Business investment is split into Private investment in equipment and software (PIES), Nonresidential construction, Residential construction, and Change in private inventories. OOSEP treats the Change in private inventories separately from the rest of business investment. Therefore it will not be examined in this paper. PIES is further disaggregated into twelve detailed product categories which serve (along with Nonresidential and Residential construction) as columns in the final demand matrices. The PIES product categories include: Computers and peripheral equipment, Software, Communication equipment, Other information processing equipment, Autos, Trucks, buses, and truck trailers, Aircraft, Ships, boats, and railroad equipment, Industrial equipment, Other equipment, Scrap, and Residential equipment. In this paper, however, PIES is only examined as a whole. Next these column totals are distributed over 200 rows of commodities according to their NAICS (North American Industrial Classification System) codes. OOSEP primarily relies upon data from BEA's National Income and Product Accounts (NIPA) and Input-Output (I-O) tables to provide historical data for these tables.

Final demand by major sector is listed in Table 1a following the paper[2]. As a percentage of GDP, PIES is forecasted to grow much faster than any other sector. PIES made up $613.2 billion of final demand or 6.4% of total final demand in 1998. In 2004, it contributed only slightly more with 6.8%. By 2014, PIES is expected to make up 12.8% of total final demand, almost double its 2004 percentage. Personal consumption expenditures and Government spending are projected to decline as a percent of total GDP. While Government spending was more than ten percent higher than PIES in 1998, it is forecasted to be less than one half of a percent higher in 2014. Exports and Imports increase, but not nearly as quickly as PIES. OOSEP anticipates that PIES will become a much more significant factor in final demand by 2014.

Table 1b shows that most of the PIES growth is due to increased demand in manufacturing. The distribution of PIES final demand among manufacturing components changes considerably during this time. For example commodities such as Motor vehicle manufacturing will fall drastically as a percent of PIES while Communications equipment will rise slightly.

[1] BEA publishes annual output tables, but they are highly aggregated. OOSEP builds tables at a much more detailed level.

[2] Please note that the research for this paper included only domestic levels of output and employment. Imports and their related intermediate goods and employment were factored out.

Investment in Computer and peripheral equipment grows much faster than any other component. It rises from 3.6% of PIES demand in 1998 to 12.5% in 2004 and is forecasted to reach 37.7% in 2014. The corresponding annual growth rate, however, declines from 28.2% in 1998-2004 to 23.5% in 2004-2014. Growth in business demand for computers will help the manufacturing annual growth rate increase from 2.9% in 1998-2004 to 11.5% from 2004-2014. The growth rates of several other detailed sectors are also projected to rise: Communications equipment from 3.2% to 15.1%, Motor vehicle manufacturing from -2.4% to 2.8%, Wholesale trade from 2.3% to 9.0%, and Retail trade from 1.4% to 9.2%.

In table 1a, we see that Nonresidential construction fell from 3.1% to 2.1% of final demand from 1998 to 2004 and is forecasted to fall even further to 1.7% in 2014. Final demand in the construction industry is made up of not only commodities in the Construction NAICS category, but also in commodities such as Mining, Real estate, Scrap, and a few others. Table 1b shows that from 1998 to 2004 final demand in Nonresidential construction for Construction commodities fell as percentage of this sector while Mining increased. There was a spending boom in Nonresidential construction by high tech firms in the late 1990s. When the bubble burst in early 2000, demand fell significantly. Meanwhile, there was a rapid rise in gasoline prices. When the price of imported crude oil suddenly grew, there was an interest to further explore and extract oil from U.S. territory. Much of the easier and less expensive oil in the U.S. had already been used. Therefore, while Nonresidential construction of most business structures fell, construction for the Mining industry grew rapidly. However, Mining remains only a small percentage of total final demand in this sector while Construction is still dominant. Nonresidential construction is expected to stay near this new distribution between mining and construction in 2014.

Record low mortgage rates, low returns on investment alternatives, and robust price increases in the housing market led to substantial growth in Residential construction in the early to mid 2000s. Residential construction's share of final demand increased from 4.3% in 1998 to 4.8% in 2004. In 2014, it is projected to fall slightly to 3.9% as interest rates rise and the baby boomers pass their prime home buying age. The distribution of final demand in Residential construction among the commodities stays relatively constant over the three years of data.

Output

Final demand summed with intermediate goods gives the total industry output. Therefore, the intermediate goods and services demanded are also broken out by using industry in order to complete the input-output system. Once historical tables are compiled, the tables are projected forward ten years from the last year of historical data. The finished tables provide a glance of all economic transactions within the country at a given point in time. Total industry output, not final demand alone, is the key determinant of employment.

In order to arrive at industry output, OOSEP starts with the make and use table from BEA's I-O system. Taking the column distribution of the use table and value added row vector produces the direct requirements table. This table shows the mix of inputs necessary to produce a dollar's worth of that industry's output. Next, OOSEP converts the make table into a market shares matrix by finding the column distribution. The resulting table shows the percentage of each commodity produced in a given industry. Using the direct requirements and market shares tables, OOSEP creates the total requirements table[3]. Through this table, OOSEP can determine the amount of output generated from a given level of final demand. This captures the dynamic indirect requirements that all other industries need to demand in order to fulfill the original industry's input demands. Therefore, an increase in demand results an even greater increase in output. Once the total requirements table is produced, it is multiplied by final demand in order to arrive at industry output.

In table 2a, we see that the share of total output from PIES, Nonresidential construction, and Residential construction is slightly higher than their percentage of final demand in table 1a. This implies that the demand from the investment categories require more economic activity than the demand from one/some of the other GDP sectors. The average annual growth rate of PIES related output increases from 2.4% in 1998-2004 to 10.6% in 2004-2014. Table 2b shows the growth of PIES output in the major commodity sectors. The difference between historical and forecasted growth rates is greater than five percent in each of these categories. The fastest growth is in Construction, Accommodation and food services, and Special industries which all increased fourteen to fifteen percent. Wholesale and Retail trade also contribute significantly with over ten percent increases in their annual growth rates. PIES related output made up about

[3] The mathematical derivation of the total requirements table is very involved and will not be discussed in this paper.

7.6% of the total output in 1998 and 2004 but jumps to 14.3% of total output in 2014. This growth occurs in many detailed commodity sectors including: Manufacturing where PIES' output increases from 16.6% of total manufacturing output in 1998 to 17.0% in 2004 to 28.9% in 2014, Wholesale trade from 15.1% to 14.7% to 26.3%, and Professional, scientific, and technical services from 15.9% to 17.5% to 26.4%.

Table 2c presents PIES related output for the fastest and slowest growing detailed commodities. Most of the growth in PIES output is occurring within the Manufacturing sector in Computer and peripheral equipment manufacturing which surges from 2.6% of PIES output in 1998 to 5.9% in 2004 to 19.0% in 2014. Consequently, the PIES contribution to total output of this commodity swells from about 40% in 1998 to 50% in 2004 to almost 56% in 2014. The associated average annual growth rate increases from 17.2% in 1998-2004 to 24.4% in 2004-2014. The distribution of PIES output among the remaining commodities stays relatively constant over the time period except in Motor vehicle manufacturing which falls from 8% in 1998 to 6% in 2004 to just below 3% in 2014. The foreign motor vehicle companies were gaining market shares as domestic firms lost ground from 1998 to 2004. This pattern is forecasted to continue over the projection period.

Because PIES output is growing faster than the output from other GDP component, the share of PIES related output to total output for several of the detailed commodities in table 2c will increase significantly. The few commodities in which PIES' contribution to total output falls notably (5% to 10%) over the projection period are Motor vehicle manufacturing, Motor vehicle body and trailer manufacturing, Motor vehicle parts manufacturing, and Railroad rolling stock manufacturing. Commodities that increase appreciably include Computer and peripheral equipment manufacturing, Communications equipment manufacturing, Audio and video equipment manufacturing, Semiconductor and other electronic component manufacturing, Manufacturing and reproducing magnetic and optical media, Wholesale trade, Lessors of non-financial intangible assets (except copyrighted works), and Computer systems design and related service.

Output related to Nonresidential construction's final demand as a percentage of total output falls from 3.2% in 1998 to 2.2% in 2004. It is projected to decrease further to 1.7% in 2014. This output listed in table 2b is mostly contained in three major categories; Mining, Construction, and Manufacturing. Mining output will continue to grow slightly. The mining output related to Nonresidential construction made up only 14% of total mining output in 1998 and grew to 18.4% in 2004. It is forecasted to make up 17.5% of total mining output in 2014. These gains, however, will be more than offset by decreases in construction output. Nonresidential construction contributed 30.3% of total construction output in 1998 and only 21.7% in 2004. It is projected to contribute 21% in 2014.

The level of output required to satisfy Residential construction demand rose over the historical period and in the projection. As a percentage of total output, however, it is forecasted to fall in the projection from 4.9% in 2004 to 3.9% in 2014. Output from this sector is mostly distributed between Construction, Manufacturing, and Real estate, rental, and leasing. Output in Construction due to demand in Residential construction rose from 39.1% of total output in 1998 to 49.2% in 2004 and is expected to contribute 47.4% in 2014. This nearly offsets the drop in output of Construction related to Nonresidential construction demand. As Construction output rises, Manufacturing output is forecasted to decline. As the housing market cools off slightly, Real estate and rental and leasing output due to demand in Residential construction will rise slightly but its average annual growth rate will slow considerably from 6.8% in 1998-2004 to 1.1% over the ten year projection.

Employment by Industry

To calculate Industry Employment, OOSEP divides industry output and by industry employment. This results in the Employment multiplier which reveals each industry's employment to output ratio or the productivity factors. Next, the total requirements table (which shows output required per dollar of final demand) is multiplied by the employment multiplier which results in the Employment Requirements table. This table illustrates the employment required in order to produce a dollar worth of final demand. For example, purchases of food not only support employment in the agricultural industries but also in the paper and logging industries which supply packaging materials. Finally, the employment requirements table is multiplied by final demand to calculate industry employment.

Industry employment generated from PIES demand as a percentage of total industry employment rises from 5.4% in 2004 to 8.4% in 2014 (see table 3). While this growth is significant, it is slower than the growth of PIES final demand or its affiliated output. Examining PIES' share of total industry employment, we see that the PIES contribution to two industries is rising quickly over the projection. The first is Professional and business services[4] where PIES employment is projected to rise from 12.6% of the total industry employment in 2004 to 20% in 2014. The second is Wholesale Trade where PIES employment is expected to grow even more from 14.7% of total Wholesale trade employment in 2004 to 26.3% in 2014.

PIES related employment in Professional and business services is forecasted to almost double from 2.3 million in 2004 to 4.6 million in 2014. Consequently, employment in this sector will rise a percent of total PIES employment from 29.7% to 34.1%. This growth is mostly due to a rapid increase in jobs in the Employment services industry. Meanwhile, PIES' Manufacturing employment is projected to grow only slightly from 2.4 million in 2004 to 2.7 million in 2014. Also, Manufacturing falls substantially from 30.5% of total PIES employment in 2004 to 20% in 2014. Given that PIES final demand and its related output were growing so quickly due to increases in Manufacturing, this may seem counterintuitive. Remember that the growth in PIES demand and output of Manufacturing were due to huge increases in Computer and peripheral equipment manufacturing as well as slower but considerable growth in Communication equipment. Much like its output growth, PIES' industry employment in Communication equipment manufacturing rises from 82,700 in 2004 to 95,200 in 2014. On the other hand, PIES' Industry employment in Computer and peripheral equipment falls from 107,100 to 98,500. This decline is due to increased productivity in computers. Fewer workers will be required to create more output. The industry will be less labor intensive which is a continuation of past productivity trends within this industry. Other industries expected to contribute to the PIES manufacturing employment relative to total Manufacturing employment drop are Metalworking and machinery manufacturing and Other general purpose machinery manufacturing. Slower but significant growth is also expected in Navigational, measuring, electromedical, and control instruments manufacturing, Motor vehicle parts manufacturing, Medical equipment and supplies manufacturing, Agriculture, construction, and mining machinery manufacturing, and Office furniture (including fixtures) manufacturing.

Wholesale trade related to PIES demand also exhibited rapid growth in output from 2004 to 2014. Unlike Manufacturing, however, the industry employment generated from this demand also surges from 861,200 to 1,672,100. OOSEP is not expecting noteworthy productivity gains in this sector. The employment in the Wholesale trade industry resulting from PIES related output will surge from 14.7% of the total industry employment to 26.3%. PIES related employment within the Retail trade industry also will rise from 579,000 to 1,061,200.

Industry employment derived from Nonresidential construction demand is forecasted to grow slowly from 3.3 million in 2004 to 3.4 million in 2014. Mining jobs within this sector fall slightly despite increases in mining output. Once again this is due to rapid productivity gains. While mining jobs arising from demand by the Nonresidential construction sector were about 36.3% of all jobs in the mining industry in 2004, they are forecasted to make up 39.6% of these jobs in 2014. Employment in the Construction industry necessary to produce the projected Nonresidential construction total output rise slightly from 1.9 million in 2004 to 2.1 million in 2014. Demand in the Nonresidential construction category will decrease its share of the total jobs in the Construction industry from 21.7% to just below 21%.

Jobs needed to fulfill demand by the Residential construction sector are forecasted to increase slightly from 7.3 million to 7.7 million. Around sixty percent of these jobs will be in the Construction sector in both 2004 and 2014. However, as percent of total jobs in the Construction industry, those created by demand for Residential construction will fall from 49.2% in 2004 to 47.4% in 2014.

Employment by Occupation

The technique used to calculate occupational employment is based on a 2004 industry-occupation matrix showing the occupational staffing patterns by industry. This matrix is based on data collected by state employment security agencies and analyzed by BLS. In order to forecast occupational employment in 2014, OOSEP must account for staffing pattern changes over time. To do so, they analyze historical data for trends which are then studied by specific industries and occupations. Analysts examine potential causes of staffing pattern shifts such as changes in technological developments affecting production, innovations in the ways business is conducted, modifications of organizational patterns, responses to government policies, decisions to add new products or services or stop offering old ones, and so on. Judgments are then made as to how the staffing patterns will change over the ten year projection. If analysts expect there to be

[4] Professional and business services includes all industries primarily involved in the services listed in NAICS codes 54, 55, and 56.

small changes in the given industry and occupation, they will apply a coefficient of about 10 percent, if they expect a more moderate changes, 20 percent, and if they expect significant changes, 30 percent. These coefficients are used to build a change factor matrix[5]. These change factors are applied to the 2004 industry-occupation matrix to arrive at the 2014 industry-occupation matrix. Next a matrix is created with the distribution within each industry. Finally, industry data is fed through the matrix and summed by occupation to find occupational employment.

Occupational employment resulting from PIES final demand increases from 7.8 million (5.4% of total occupational employment) in 2004 to 13.7 million (8.4%) in 2014. The associated annual average growth rate is 5.8%. The categories with the most growth (Table 4) are: Professional and related occupations and Office and administrative occupations which both increase by more than 1 million jobs. The annual average growth rate of Service occupations from 2004 to 2014 is 9.2 % per year, much faster than any other category listed in Table 4. Over the 10 year projection they increase from 6.8% of PIES' occupational employment to 9.3%. Production occupations, however, grow at an average of only 2.4% per year, much slower than any other category. By 2014, they fall from 17.7% of total PIES' occupational employment to only 12.8%. Although Production jobs are growing slower than other occupations within PIES employment, PIES' contribution to total Production jobs increases from 13.2% to 16.8%. Hence, other final demand categories see even slower growth in Production occupations. Jobs in Production occupations are often related to manufacturing. The behavior of PIES' employment in the Manufacturing industry nearly mirrors its behavior here. Notice that the PIES related employment in each of the listed occupational categories in Table 4 increase their share of total occupational employment within the given category by just less than two to nearly four and a half percent.

As previously mentioned, Service occupations grew much faster than the other occupational categories listed in table 4 while Production occupations grew much slower. The following table shows which detailed occupations are contributing the most to this accelerating and decelerating growth within Service and Production occupations.

[5] For more detailed documentation on occupational employment, please see the BLS Handbook of Methods Chapter 13 and the February 2006 Occupational Projections and Training Data.

Occupation	Job Growth (Thousands)	Avg. Ann. Change
Service Occupations, Total	**750.5**	**9.2%**
Security Guards	55.9	8.0%
Combined food preparation and servicing workers, including fast food	52.7	11.5%
Waiters and waitresses	59.1	12.0%
Janitors and Cleaners	107.9	8.2%
Landscaping and groundskeeping	63.3	8.8%
Production Occupations, Total	**365.5**	**2.4%**
Textile machine setters, operators, and tenders	-1.7	-1.9%
Textile winding, twisting, and drawing out machine setters, operators, and tenders	-1.0	-3.1%
Medical, dental, and ophthalmic laboratory technicians	-1.2	-0.9%
Dental laboratory technicians	-1.3	-1.5%

Occupational employment derived from Nonresidential construction demand increases only slightly over the projection from 3.3 million to 3.5 million. Residential construction related employment also rises slightly from 7.5 million to 7.9 million. The distribution the occupational groups listed in Table 4 stays roughly the same from 2004 to 2014. Notice that both Nonresidential and Residential construction related jobs within the Construction and extraction occupations make up only about 35% of the total jobs in the occupation. Meanwhile, the construction related jobs contributed about 60% of the total jobs within the Construction industry. Therefore there are many jobs within the Construction industry that are not Construction occupations including management positions, office support, and so forth. Nonresidential construction jobs within Construction and extraction occupations as percent of total employment within this occupation fall by .7% from 2004 to 2014 while those in Residential construction fall even further by 1.4%.

Conclusion

OOSEP projects that by 2014 PIES will make up 6% more of GDP than it did in 2004. The related output will also increase by 6.7%. This growth will largely be related to increases in output of Computers and peripheral equipment as well as significant growth in Communications equipment and Wholesale and Retail trade. Meanwhile, output of Motor vehicle manufacturing will fall. The employment (by both industry and occupation) related to PIES output will also rise, but only by 3%. Most of the growth of employment will be in the Professional and business services industry which will nearly double from 2004 to

2014. Manufacturing jobs, on the other hand, will increase only slightly. Productivity growth in the Computer and peripheral equipment industry will cause the number of jobs to actually fall while PIES related output in this industry has an annual average growth rate of 24.4%. Occupational employment derived from PIES' final demand will see the largest rises in Professional and related occupations and Office and administrative occupations and the slowest growth in the Production occupations (those often related to manufacturing output).

Between 1998 and 2004, the bubble burst in high tech firms causing a significant slowdown in demand of Nonresidential construction. Oil prices rose drastically in this time creating demand for Nonresidential construction within the Mining industry. Mining, however, remained a small portion of Nonresidential construction demand and did not offset the losses. Consequently, Nonresidential construction fell from 3.1% of total GDP in 1998 to 2.1% in 20004. The sector is expected to rise a bit by 2014, but not quite to its 1998 level. Its growth will be slower than that of other final demand sectors. Therefore, it will fall further to only 1.7% of total GDP in 2014. The slow growth in demand and output from 2004 to 2014 will cause a slight increase in both industry and occupational employment derived from Nonresidential construction demand. Related Mining jobs, however, will fall due to increased productivity.

Final demand for Residential construction grew in all three years of data but it is projected to fall from 4.8% of final demand in 2004 to 3.9% in 2014. From 1998 to 2004, this sector grew significantly as interest rates dropped to historical low levels and house values swelled. As the interest rates rise, the housing market cools, and the baby boomers move past their prime home buying age, the Residential construction sector is expected to cool slightly. Output in the Real estate and rental and leasing NAICS sector related to Residential construction will continue to grow but the average annual growth rate will decline from 6.8% in 1998-2004 to 1.1% in 2004-2014. Employment generated from demand in both the Residential and Nonresidential construction sectors will decrease as a percent of the total employment within the Construction industry and Construction and extraction occupations from 2004 to 2014.

Table 1a: Final Demand by Major Component

	Billions of Chained 2000 dollars			Percent of Total Final Demand		
	1998	2004	2014	1998	2004	2014
Final Demand	9,651.9	11,581.5	16,779.2	100.00%	100.00%	100.00%
PCE	5,910.0	7,229.6	9,810.1	61.23%	62.42%	58.47%
PIES	***613.2***	***786.8***	***2,149.9***	***6.35%***	***6.79%***	***12.81%***
Nres. Constr.	***294.4***	***240.6***	***282.3***	***3.05%***	***2.08%***	***1.68%***
Res. Constr.	***411.0***	***551.1***	***653.3***	***4.26%***	***4.76%***	***3.89%***
Inventory Change	57.5	42.2	141.8	0.60%	0.36%	0.84%
Exports	898.6	1,011.0	1,991.2	9.31%	8.73%	11.87%
Imports	-141.4	-191.0	-474.6	-1.46%	-1.65%	-2.83%
Government	1,608.4	1,911.0	2,225.2	16.66%	16.50%	13.26%

Table 1b: Final demand of PIES, Residential & Nonresidential Construction by Major Commodity Sector (billions of chained 2000 dollars)

Category	PIES			NRES			RES		
	1998	2004	2014	1998	2004	2014	1998	2004	2014
All sectors	613.2	786.8	2,149.9	294.4	240.6	282.3	411.0	551.1	653.3
Agriculture, forestry, fishing, and hunting	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mining	0.2	0.2	0.3	23.3	34.5	34.5	0.0	0.0	0.0
Utilities	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	269.7	205.3	247.0	346.6	464.3	556.4
Manufacturing	399.6	473.5	1,406.2	0.4	0.3	0.3	10.1	3.7	5.2
Computer and peripheral eq. manufacturing	22.1	98.4	811.0	0.0	0.0	0.0	0.0	0.0	0.0
Communications eq. manufacturing	37.5	45.4	184.9	0.0	0.0	0.0	0.0	0.0	0.0
Motor vehicle manufacturing	100.8	87.0	115.1	0.0	0.0	0.0	0.0	0.0	0.0
Wholesale trade	75.1	85.8	203.2	0.1	0.1	0.1	0.1	0.1	0.1
Retail trade	32.4	35.3	85.2	0.0	0.0	0.0	4.8	2.1	2.7
Transportation and warehousing	10.0	11.3	17.3	0.0	0.0	0.0	0.1	0.0	0.0
Information	44.2	70.0	171.4	0.0	0.0	0.0	0.0	0.0	0.0
Software publishers	37.7	61.4	155.8	0.0	0.0	0.0	0.0	0.0	0.0
Financial activities	0.0	0.0	0.0	2.3	1.8	2.2	52.6	83.1	92.0
Professional and business services	121.5	164.8	343.3	0.0	0.0	0.0	0.0	0.0	0.0
Educational services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Health care and social assistance	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Leisure and hospitality	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Federal government	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
State and local government	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Special industries	-69.7	-53.9	-77.0	-1.3	-1.4	-1.8	-3.3	-2.3	-3.2

Table 2a: Output by Final Demand Category

Category	Billions of chained 2000 dollars 1998	2004	2014	Percent of Total Output 1998	2004	2014
Total Output	16,771.8	19,332.4	28,190.9	100.00%	100.00%	100.00%
PIES	1,274.9	1,470.9	4,015.9	7.60%	7.61%	14.25%
Nres. Constr.	539.3	418.9	487.5	3.22%	2.17%	1.73%
Res. Constr.	747.5	942.1	1,111.3	4.46%	4.87%	3.94%

Table 2b: Output by Major Commodity Sector (billions of chained 2000 dollars)

	Total Output			PIES			NRES			RES		
Commodity	1998	2004	2014	1998	2004	2014	1998	2004	2014	1998	2004	2014
Agriculture, forestry, fishing and hunting	240.9	274.6	322.4	3.6	4.2	9.1	3.3	2.6	2.4	5.7	6.6	6.2
Mining	215.5	223.2	230.8	6.5	6.3	10.8	30.2	41.0	40.3	8.6	12.3	11.3
Utilities	317.4	323.4	353.2	10.3	10.0	18.8	9.4	6.7	6.9	13.7	16.6	17.0
Construction	793.0	841.0	1,043.8	3.5	2.9	8.1	240.5	182.6	219.1	310.0	413.8	494.6
Manufacturing	4,002.0	4,193.7	6,524.1	664.2	712.0	1888.4	712.0	1,888.4	59.6	129.5	142.5	133.1
Wholesale trade	819.5	971.0	1,812.5	123.8	143.0	476.9	15.7	10.9	13.7	20.8	23.1	29.5
Retail Trade	940.6	1,125.3	1,757.5	41.3	40.7	106.4	20.0	4.6	19.5	30.9	12.5	47.3
Transportation and warehousing	558.9	621.4	891.2	37.6	41.6	88.3	14.3	11.0	12.9	19.1	23.5	28.0
Information	751.0	948.6	1,588.5	90.0	122.9	347.4	11.3	9.2	11.6	15.3	19.8	25.4
Finance and insurance	1,099.8	1,459.3	2,132.8	31.9	46.4	141.6	12.0	11.4	14.3	18.8	29.8	37.0
Real estate and rental and leasing	879.9	1,020.0	1,446.1	29.1	37.0	125.9	15.6	11.8	13.9	72.8	107.8	120.8
Professional, scientific, and technical services	888.6	1,061.5	1,708.5	141.1	186.0	451.3	27.6	22.1	25.6	37.2	49.1	57.0
Management of companies and enterprises	279.4	397.4	681.4	25.9	39.2	123.7	7.8	9.1	10.3	6.9	9.0	11.7
Administrative and support and waste management and remediation services	418.3	496.0	761.5	28.0	36.7	108.6	9.6	7.6	9.5	16.0	22.2	27.5
Educational services	130.6	144.8	188.3	2.5	2.9	7.4	0.4	0.2	0.3	0.5	0.5	0.7
Health care and social assistance	916.1	1,148.1	1,641.2	1.2	1.5	3.7	0.4	0.2	0.4	0.6	0.5	0.9
Arts, entertainment, and recreation	142.1	176.0	254.6	2.7	3.9	13.1	1.1	1.1	1.5	1.5	2.0	2.8
Accommodation and food services	457.9	509.9	627.4	6.9	6.1	21.0	2.3	1.3	1.9	3.6	3.4	4.7
Other services (except public administration)	397.9	430.4	565.3	10.1	10.1	21.9	4.0	2.7	2.9	5.4	6.2	6.5
Government	1,801.6	2,108.5	2,536.0	14.4	17.4	43.2	7.1	5.3	6.5	11.1	14.4	17.2
Special Industries	720.5	858.3	1,123.9	0.2	0.2	0.5	15.3	11.7	14.2	19.7	26.5	32.1

Table 2c: PIES Related Output by Detailed Commodity Sector (billions of chained 2000 dollars)

	PIES Output Levels			Avg. Ann. Growth		Percent of Total Output		
Category	1998	2004	2014	1998-2004	2004-2014	1998	2004	2014
Fabric mills	2.2	1.2	1.0	-10.45%	-1.60%	7.91%	5.67%	7.06%
Rubber product manufacturing	5.0	3.4	2.9	-6.50%	-1.57%	14.23%	11.13%	10.12%
Foundries	7.7	6.9	6.4	-1.97%	-0.76%	26.50%	23.44%	23.95%
Commercial and service industry machinery manufacturing	11.7	11.2	8.3	-0.63%	-2.99%	45.16%	43.37%	37.18%
Computer and peripheral equipment manufacturing	33.2	86.1	762.5	17.19%	24.37%	39.79%	50.11%	55.74%
Communications equipment manufacturing	40.8	50.4	222.5	3.59%	16.02%	51.15%	54.63%	69.78%
Audio and video equipment manufacturing	0.5	0.3	3.7	-9.05%	30.30%	5.94%	4.47%	61.05%
Semiconductor and other electronic component manufacturing	23.1	40.8	126.1	9.96%	11.96%	18.35%	24.47%	47.59%
Manufacturing and reproducing magnetic and optical media	1.3	1.7	6.3	3.54%	14.23%	11.50%	11.85%	33.10%
Motor vehicle manufacturing	102.3	87.4	115.0	-2.60%	2.78%	44.11%	34.70%	35.34%
Motor vehicle body and trailer manufacturing	11.5	8.5	14.3	-4.95%	5.32%	44.79%	32.75%	36.38%
Motor vehicle parts manufacturing	43.1	36.7	51.7	-2.63%	3.48%	23.83%	18.53%	18.08%
Railroad rolling stock manufacturing	5.5	3.7	3.6	-6.26%	-0.33%	59.73%	60.02%	50.35%
Medical equipment and supplies manufacturing	13.7	18.1	22.2	4.71%	2.08%	26.10%	26.22%	20.34%
Wholesale trade	123.8	143.0	476.9	2.43%	12.80%	15.10%	14.73%	26.31%
Software publishers	49.5	68.6	190.0	5.61%	10.72%	61.75%	67.85%	67.56%
Internet and other information services	5.4	9.9	44.9	10.64%	16.29%	8.49%	8.29%	16.53%
Lessors of nonfinancial intangible assets (except copyrighted works)	5.1	8.4	48.4	8.64%	19.10%	5.77%	6.86%	16.58%
Computer systems design and related services	66.3	91.6	212.1	5.55%	8.75%	51.28%	59.30%	69.47%

Table 3: Investment Related Employment by Major Industry Sector (thousands of jobs)

Industry	Total		PIES		NRES		RES	
	2004	2014	2004	2014	2004	2014	2004	2014
All sectors	143,888.1	162,798.6	7,785.5	13,621.2	3,252.4	3,425.7	7,286.8	7,699.6
Agriculture, forestry, fishing, and hunting	2,139.9	1,909.9	28.7	50.3	14.6	11.0	37.2	28.5
Mining	536.6	491.7	12.6	19.7	194.8	194.5	30.7	28.7
Utilities	570.1	562.6	17.0	27.7	11.5	11.0	28.6	26.8
Construction	8,827.6	9,801.0	29.9	75.7	1,916.6	2,057.5	4,343.4	4,644.3
Manufacturing	14,649.2	13,876.1	2,372.1	2,718.5	281.8	215.0	631.8	501.2
Wholesale trade	5,848.1	6,355.2	861.2	1,672.1	65.6	48.1	138.9	103.3
Retail trade	16,018.7	17,531.1	579.0	1,061.2	65.2	194.8	177.8	471.8
Transportation and warehousing	4,662.7	5,166.7	325.1	549.9	80.5	73.1	169.7	156.1
Information	3,284.1	3,659.8	344.3	636.1	29.4	25.4	62.3	54.6
Financial activities	8,847.6	9,739.0	289.0	653.1	78.9	74.5	387.1	374.8
Professional and business services	18,421.5	23,238.8	2,313.9	4,647.3	350.0	337.3	828.7	821.1
Educational services	2,965.1	3,871.6	52.9	137.3	3.7	5.3	8.8	12.5
Health care and social assistance	15,102.5	19,411.7	17.1	38.8	3.3	5.3	7.5	12.1
Leisure and hospitality	13,146.2	15,328.6	172.5	536.8	37.5	48.1	87.3	110.9
Other services	7,249.8	8,064.8	108.2	203.1	29.7	26.3	67.4	59.9
Federal government	2,727.5	2,770.9	55.4	108.8	8.4	7.3	22.3	19.0
State and local government	18,890.9	21,019.1	206.5	484.6	80.9	91.2	257.2	274.0
Special industries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 4: Investment Related Employment by Major Occupation (thousands of jobs)

Occupation	Total		PIES		NRES		RES	
	2004	2014	2004	2014	2004	2014	2004	2014
00-0000 Total, all occupations	145,612	164,540	7,853	13,742	3,326	3,502	7,461	7,878
11-1300 Management, business, and financial	14,987	17,142	958	1,739	381	394	877	912
15-2900 Professional and related	28,544	34,590	1,548	2,795	291	310	652	697
31-3900 Service	27,673	32,930	531	1,282	209	236	570	629
41-0000 Sales and related	15,330	16,806	840	1,564	205	267	497	639
43-0000 Office and administrative support	23,907	25,287	1,327	2,338	387	370	905	872
45-0000 Farming, fishing, and forestry	1,026	1,013	28	55	13	12	32	30
47-0000 Construction and extraction	7,738	8,669	182	353	1,199	1,286	2,523	2,710
49-0000 Installation, maintenance, and repair	5,747	6,404	343	580	187	203	427	466
51-0000 Production	10,562	10,483	1,392	1,757	226	194	488	425
53-0000 Transportation and material moving	10,098	11,214	703	1,279	230	231	490	500

Forecasting Trends, Cycles, and Recessions

Session Chair: Brian Sloboda, Bureau of Transportation Statistics

Forecasting Food Stamp Caseloads: Trends in Relation to the Unemployment Rate as Influenced by Policy Changes

Kenneth Hanson, U.S. Department of Agriculture, Economic Research Service

Forecasts of the Food Stamp Program (FSP) caseload for budgeting purposes rely on the relationship between the unemployment rate and FSP caseloads. Forecasting the downturn in the FSP caseload following a turn in the unemployment rate is a challenging task. In addition to addressing the turning point issue, forecasting the FSP caseload should also account for several empirical regularities in the relationship between the FSP caseload and unemployment rate, such as lags and asymmetry. This paper brings together several methods to analyze the relationship between the unemployment rate and the FSP caseload so as to forecast the FSP caseload.

Turning Points in the Transportation Services Index (TSI) and the Economy

Ken Notis, Peg Young, Gary Feuerrberg, Long Ngyuen, and Jennifer Brady, Bureau of Transportation Statistics

The Bureau of Transportation Statistics, an agency within the Research and Innovative Technology Administration (RITA) of the U.S. Department of Transportation, publishes the Transportation Services Index (TSI), a monthly output index on U.S. transportation services for-hire. This presentation examines known recessions and growth cycles in the US economy since 1979, and compares the three components of the TSI (total, passenger and freight) to the US economy by identifying TSI turning points in a systematic way and comparing the turning points with all of the various peaks and troughs of the cycles.

The Recessions of 1990 and 2007(?)

Foster Morrison and Nancy L. Morrison, Turtle Hollow Associates, Inc.

A phase-plane model of the business cycle has demonstrated remarkable robustness through more than a decade of revisions of the indices of leading, lagging, and coincident indicators upon which it based. The changes in the phase angles and the proportions of the radii have been almost negligible. The recession of 1990 was the first one tracked in “real time,” so its development is compared with what has happened to date in the next recession, which may begin in 2007, if not sooner.

Turning Points in the Transportation Service Index (TSI) and the Economy

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In 2002, a team of academics, under a research grant from the U.S. Department of Transportation, Bureau of Transportation Statistics (BTS), developed the Transportation Services Output Index (TSOI) to measure the economic activity of the transportation sector (Lahiri and Stekler, 2002). This monthly output index of the U.S. transportation services for-hire represented both the passenger and freight movement. Their early research indicated a relationship between changes in the transportation services sector and the recession cycles (Lahiri et al., 2003 and 2004).

BTS recognized the importance of the TSOI to the transportation community. Using the same components, BTS developed an experimental version called the Transportation Services Index (TSI). Further, two indexes were derived using the passenger and freight components separately. The three indexes are now published monthly on the BTS website. Figure 1 provides a current graph of the TSI.

After a year of publication and additional research, it became clear that the TSI moves in conjunction with other indicators of the national economy. The goal of this paper is to measure quantitatively the relationships between the turning points of the TSI and measures of the broader economy.

Extending the TSI series by going back into the past

Analyses of the TSI are constrained by the limited duration of the published index, which covers only the period from January 1990 to the present. For research purposes, a longer history of the TSI was needed that could be analyzed alongside the same period of economic activity. Using the longer version of the TSI ("historical TSI"), it became possible to determine how the TSI behaves in relation to the U.S. economy by comparing the turning points in its cycles against those of key national economic variables.

Note that the availability of historical data for the TSI required some modifications to the source data, which is discussed in the data sources section of this paper.

Cycles of various kinds, depths and durations occur frequently in the U.S. However, the most important cycles are recessions and growth cycles. The TSI, as presently published on the BTS website, covers only two recessions. Extending TSI through the 1980s allows coverage of four recessions[1] and numerous growth cycles. Then, by comparing the turning points in the historical TSI with other economic data series, it became possible to ascertain whether transportation services relate to movements of the overall economy.

The following sections of this paper discuss the data components of the TSI, along with the procedures for deseasonalizing, indexing and weighting these components to create three indexes: Total TSI, Freight TSI and Passenger TSI. Economic hypotheses on the nature of the relationships between the TSI measures and the recessions and growth cycles are considered next. How the turning points are measured is provided in the following section, which is concluded by an analysis of the turns of the TSI against the turns in the economy and growth cycles. The final section provides conclusions as well as suggestions for future research.

Components of the TSI

Transportation services are employed to either move freight or move passengers. Given that the freight and passenger sectors are influenced by different forces in the economy and as a result may exhibit different trends, the TSI is represented by three indexes: all transportation services (total TSI), freight transportation services (freight TSI) and passenger transportation services (passenger TSI). The total TSI is a composite of the freight and passenger indexes.

The TSI includes only "for-hire" transportation. For-hire transportation is operated on behalf of or by a company that provides transport services to an external company for a fee. Not included in the for-hire population is transportation in vehicles owned by private firms, providing services to that firm, or transportation provided by private individuals (e.g., trips in the family car).

[1] The National Bureau of Economic Research (NBER) declared recessions from January 1980 – July 1980, July 1981—November 1982, July 1990 – March 1991, and March 2001 – November 2001.

The monthly index published by BTS (i.e., TSI), and the index first developed by Lahiri, Yao, Steckler and Young (i.e., TSOI), do not have identical data sources. In addition, the TSI is weighted differently than the TSOI. Given these differences, it is appropriate to discuss the data utilized in the TSI, along with the methodology employed to aggregate the data.[2] Table 1 provides a synopsis of the data employed. The following text offers greater detail.

<u>Passenger</u>
The passenger TSI encompasses three modes of travel: air, rail and transit. Since the index reflects service for-hire, the passenger TSI does not include movement by personal automobile, which is a major component of passenger travel. We now discuss the tree for-hire segments of travel.

Air
The largest component of the passenger TSI is aviation. Aviation data are collected and compiled from two sources: T-100 data submitted to BTS' Office of Airline Information (OAI) and from airline websites. The primary source of data, the T-100 dataset, contains information on all elements of domestic airline operations. While providing extensive information on passenger air travel, it also contains information on freight movement by air and is discussed again in the next section. The TSI passenger index uses revenue passenger-miles data from the T-100 dataset.

In those instances where the current data may not yet be available in the T-100 data base, we refer to the carriers' web sites for postings of current passenger-miles. When the official data become available, these website values are replaced with the official data in the T-100.

Rail
Rail revenue passenger-miles are compiled from the U.S. Department of Transportation, Federal Railroad Administration (FRA). BTS chose to include only Amtrak and the Alaskan Railroad Corporation in the measure of passenger rail output. Amtrak and the Alaskan Railroad Corporation include approximately 35% of passenger train travel. Commuter rail is not included in this measure, however, since it is already covered in the transit data.

Transit
The smallest component of the TSI passenger index is transit. Monthly transit data are collected by the American Public Transportation Association (APTA). Monthly revenue passenger-miles are not available for public transit from a federal agency; instead, BTS uses APTA's monthly measure of unlinked trips.[3]

<u>Freight</u>
The movement of goods is a vital component of the nation's economy. Domestically goods are moved by air, rail, waterway, pipeline, or road. Over the duration of the TSI's history the share of goods moved by each mode changed (based on weight and value); however, trucking has consistently represented the largest share of for-hire freight transportation. The fastest growing share of freight transportation is by air.

Trucking
Again, since monthly truck ton-miles data are not available through a federal agency, we go to the American Trucking Association (ATA) for data. Data on movements by truck are provided through a truck tonnage index, calculated by the ATA. The ATA index is a relative measure of the total tonnage transported by the motor carrier industry for a given month.

Air
U.S. air carriers operating between airports located within the boundaries of the United States and its territories report freight ton-miles monthly to BTS. As with the air revenue passenger-miles, the ton-mile data are drawn from the T-100 data base. The current ton-mile data may be pulled from the carriers' website, if not yet available in the T-100 data base.

Rail
The more recent data (1990 - present) behind the rail measure are derived from carloads and intermodal units, made available by the AAR. These data not a direct measure of ton-miles, but their monthly behavior is assumed to be similar to monthly ton-miles, if such data were available. For data prior to 1990, we use quarterly rail on-mile data, taken from the FRA. These quarterly values are then interpolated, using a quadratic polynomial to expand to monthly values.

Water
Waterborne freight includes ton and ton-mile data for internal U.S. waterways collected by the U.S. Army Corp of Engineers (USACE). All vessels are required by law to report freight and tonnage to UCACE, with the exception of military cargo on military vessels; cargo carried on general ferries; fuel products, such as coal and petroleum, loaded from shore facilities directly into vessel bunkers; and insignificant amounts of government materials.

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[2] For further detail regarding the data sources, the reader can refer to the TSI webpage on the BTS website: http://www.bts.gov/programs/economics_and_finance/transportation_services_index/html/source_and_documentation_and_data_quality.html

[3] FTA began producing monthly data in January 2003).

Pipeline
Petroleum supply data are collected by the Petroleum Division in the Office of Oil and Gas of the Energy Information Administration (EIA), U.S. Department of Energy (DOE). The data in the TSI attempt to represent the movement of natural gas and petroleum, for the data from the EIA represent the monthly sum natural gas consumption, Alaska petroleum production, along with PADD to PADD movement.

Creation of the TSI

After the data on the individual passenger and freight components have been collected (or estimated), these data series need to be seasonally adjusted. This section of the paper provides detail on the seasonal adjustment procedure employed.

Seasonal Adjustment
The previous figures indicate graphically how seasonal the data are. In order to remove that seasonality (so that real growth can be portrayed), we used X-12-ARIMA to deseasonalized he data (Landiray and Quenneville, 2001). In applying the X-12 methodology to the transportation services time-series data, we discovered that each time series component of the Transportation Services Index displays strong seasonal patterns.

Models From Current TSI Modal Data
With the exception of transit, all time series used in the current (2006) TSI begin at January 1990. With the exception of Natural Gas, the ARIMA model that best suits the data is (011) (011). No suitable ARIMA model has been found for the Carloads component of Rail Freight.

Models of the Historical TSI Data Series
The historical time series data had the same distribution characteristics as the current data with one exception (noted next). For this reason, the decision was made to incorporate the same holidays in the historical time series models, and to use the same parameter values for each holiday which are being used in the current data.

Trucking pattern was a little different from what we use in the published TSI. The historical data had to be modeled with a log transformation, because as the trend climbed, the variability of the data increased. With the data transformation, the variance is the same regardless of the level.

Indexing, Weighting and Chaining

After the individual data series are deseasonalized, the data are indexed, using the 12-month average of 2000 as the base. Each modal series is indexed individually. Then weights for each transportation mode are created using GDP value added – as reported in the November issue of the *Survey of Current Business*. Value added is used because value added for different economic sectors sums to GDP. Inputs to transportation, which are already counted in measures of other sectors, are not included, and so the index acts as a measure of the economic activity added by the transportation sector itself. These annual weights are 'smoothed' to remove the abrupt change from December to January. These weights are then applied to integrate the individual modal indexes into combined freight, passenger, and overall indexes. The Fischer Ideal methodology is used to combine the indexes.

Chaining is used to generate changes from period to period that are independent of the base year, since period to period changes are the focus of the index.

Three Research TSI Measures
When the indexing, weighting, and chaining have been completed, the final three historical indices can be created: the Total TSI, the Passenger TSI and the Freight TSI. Figure 2 provides the results graphically. As can be seen in the graph, the TSI has experienced upwards growth throughout most of the period of time. Occasional dips and drops are obvious, and the impact of the terrorist act of September 11, 2001 is very conspicuous. What needs to be asked now is whether the changes in direction of the TSI measures can be related to the turning points in the economy.

Business Cycles and the TSI

Freight and the Economy
Transportation services involve the movement of goods and services among spatially separated points. All transportation freight services, and many transportation passenger services are directly connected with other economic activities. Freight services move the products produced by the mining, agriculture and manufacturing sectors of the economy, connect manufacturers to their sources of raw materials, intermediate goods, and spare parts, and provide the goods sold by wholesalers and retailers. Many passenger transportation services are used by business travelers whose travel is directly connected to economic activity.

Therefore, one would expect a measure of transportation services to have some relationship to other measures of economic activity, and perhaps track macroeconomic cycles. Indeed, GDP has been identified in the transportation economics literature as one of the main drivers of demand for freight transportation services (Wilson, 1980).

A measure of the output of the transportation sector such as freight might be even more valuable if it *leads* the other economic measures, as it could then be used in forecasting those measures as well as macroeconomic cycles. There are good *a priori* reasons to expect transportation freight to be a precursor of economic activity. Freight transportation activity is directly tied to the supply chain and to the build-up and maintenance of inventories, and so transportation of finished goods may anticipate growth in sales at the retail and wholesale levels. A very large portion of freight volume consists of raw materials and other intermediate goods, which may be ordered in anticipation of growing activity in the manufacturing sector. Alternatively, a decline in freight shipments may result from anticipations of declines in economic activity in the downstream sectors. The build-up and decline of inventories probably explains why rail traffic figures have historically been used as a general economic indicator (Page and Wirtz, 2003).

Multimodal Measurement of Transportation and Macroeconomic Patterns

It thus makes good sense then to presume that the transportation sector overall is strongly related to the general economy. But what should be used to measure transportation activity? Individual transportation modes have been used as indicators of the business cycle. However, there is reason to expect a *multimodal* measure of transportation to be a superior indicator of the overall economy than any one mode, aside from the well-known statistical fact that indexes of several factors are nearly always more stable than single factors.

A multimodal measure is superior as an indicator because, by incorporating all modes, it "absorbs" the competition among the modes, and reflects the overall economic change more accurately than a single measure can. Railroad carloads, for instance, can decrease because of a change in the economic situation facing railroad customers and their logistics patterns in the face of problems in the economy, or it can decrease due to a shift in traffic to waterborne transportation or to trucks. By contrast, an index that incorporates *all* modes is less subject to such vicissitudes in modal share.

Hence, it is reasonable to expect that changes in a multimodal index are more likely to represent the influence of macroeconomic factors. The TSI Freight Index works especially well in this regard because "for hire" freight makes up a large portion of all freight movement. The same would be true for the TSI Passenger Index, except that it suffers from the exclusion of the very large portion of passenger transportation that is by private automobile.

Based on a need for an index, like TSI, to monitor "for hire" transportation output on a monthly basis for the U.S. Department of Transportation (DOT), and, as discussed above, based on the economic theory that such an index would provide insights into macroeconomic patterns, the DOT supported the research of Lahiri, Stekler and Yao to probe into the relationship of an index of transportation output services to GDP. Their research found a *leading* relationship between freight transportation and the macroeconomy, (particularly with recessions), and confirmed our expectations.

Recessions and Growth-Cycles

The original research looked at the relationship of TSI to the business cycle and its downturns, i.e., recessions. In recent years, the United States economy has experienced fairly long cycles between recessions. Macroeconomists have identified growth cycles that occur within the larger business cycle. If downturns in TSI also signal downturns in the growth cycle, then looking only at recessions and ignoring the growth cycle would cause TSI to appear to generate "false positives," i.e., to indicate a recession when none followed directly. This would make TSI an imprecise indicator, even if all recessions were preceded by TSI downturns. By adding growth cycle slowdowns to the relatively few recessions, we can more completely test the relationship of TSI to the economy. There is no particular reason to expect TSI to have a different relationship to growth slowdowns, which likely impact inventory levels, ordering processes, and other transportation related supply chain factors, than to recessions.

The new study presented in this paper, in addition to using improved data, extends our understanding of the lead relationship of the TSI to the "growth cycle slowdown." This research enabled us to better comprehend the relationship of the TSI with the economy.

Freight and Upturns / Downturns in the Economy

This study incorporates the growth slowdowns as well as recessions from identified growth cycles that may be led by TSI. But why is it that the freight index is always found to be more of an aid as an advanced indicator of downturns than upturns in the economy?

To answer this question, we note that recessions are defined as two consecutive quarters of negative growth, (along with other factors considered by analysts such as at the National Bureau of Economic Research (NBER)), yielding a limited number of downturns, to be explained by the TSI. There are no similar established definitions of times of rapid growth in the business cycle.

Apparently, it is easier to define and identify downturns than upturns.

Another reason that TSI may be more clearly associated with downturns than upturns is that any downturn is likely to lead to uncertainty on the part of supply chain managers, and thereby impact the logistics processes associated with ordering goods to maintain inventories across most sectors of the economy, whereas growth accelerations may be more associated with particular sectors, and may not involve the most intensive transportation sectors. Alternatively, risks associated with inventory buildup in advance of anticipated economic growth may deter supply chain actions associated with transportation.

Next, how to measure turning points is discussed, in both the economic variables and in the TSI.

Identification of Turning Points

In 1946 Arthur Burns and Wesley Mitchell wrote the first major paper on business cycle turning points in the American economy. Turning points signal a shift from recession to expansion or expansion to recession, and are found at the trough or the peak of a cycle. Using hundreds of historic data series, Burns and Mitchell identified clusters of turning points in the overall business cycle. (Burns and Mitchell, 1946)

The fundamental components of the business cycle described by Burns and Mitchell are still used today. However, because it is often not clear which observation is the "true" low or high point of a cycle, methodologies for recognizing turning points have been refined many times during the past sixty years.

<u>Finding an Exact Method for Measuring Turning Points</u>

Recession Defined By NBER

The Business Cycle Dating Committee of the National Bureau of Economic Research (NBER) is regarded as the authority on identifying the turning points in business cycles. A recession is often considered a period of two consecutive quarters of decline in Gross Domestic Product (GDP). The Committee thought this definition was inadequate and too simple-minded. The Committee defines a recession as "a significant decline in economic activity spread across the economy, lasting more than a few months, normally visible in real GDP, real income, employment, industrial production, and wholesale-retail sales," and determines peaks and troughs based on multiple sources, but requires no set methodology.

During the period from 1980 to the present, the Committee found four recessions. However, these shifts in the business cycle were not identified by NBER in real time; each of these recessions was identified several months, or years, after its conclusion. As a result of this time delay, as well its lack of a formal methodology for duplication, the NBER process cannot be used to make real-time declarations about the economic conditions of the country. However, NBER definitions of recessions later became the standard by which our work is measured against. A more exact and timely measurement of business cycles is therefore needed.

Growth-Cycles Determined

The problem is much more complicated than identifying the business cycles. Economists have noted the existence of growth cycles *within* a business cycle and these too have turning points.

Turning points may signal the end points of expansions and recessions, or they may signal the endpoints of growth cycles. A growth cycle is a general slowdown in growth around a trend that continues to grow. As noted by Zarnowitz and Ozyildirim (2001), two prominent business cycle analysts, "growth cycles are generally shorter, more frequent, and much more nearly symmetrical than business cycles." Unlike business cycles, growth cycles are not declared by NBER. The end points of growth cycles are available in academic literature. For this analysis, the TSI team used the growth cycles as identified by Zarnowitz and Ozyildirim.

Academics have developed procedures that formalize the identification of turning points for business cycles. One technique used as a starting point for many methodologies is an algorithm developed by Bry and Boschan (1971). Application of the algorithm developed by Bry and Boschan (B&B, for short) is also the first step in many growth cycle analyses. Two of the most widely used and academically vetted methodologies, the Phase-Average Trend and the Hodrick-Prescott filter, use Bry and Boschan to prepare the cycle for more in-depth analysis.

Calculations of Turning Points for the TSI

The previous sections described the procedures that can be employed to measure turning points in the cycles of time series. We now utilize some of these approaches to calculate the turning points in the freight and passenger TSI.

<u>Validating TSI against Formally Declared Recessions by NBER</u>

12-month moving average with 15-point Spencer curve

Utilizing the B&B procedure, we first take a 12-month moving average of the TSI data, and then apply the 15 month Spencer curve to all three series. The 12-month centered moving average will allow us to identify the general location of the turns, whereas the Spencer curve helps to pinpoint the date. Then, by referring back to the original data, we select the peaks and troughs indicated by the moving average and Spencer curve.

To see the impact of the moving average, we illustrate the freight and passenger indexes against their 12-month moving averages, in Figures 3 and 4.

After identifying the general dates of the peaks and troughs, we then applied the following rules to eliminate inappropriate turns (as specified in the previous section). The peaks and troughs in the two indexes are then compared to the turning points in the recessions, as identified by the NBER. The results are displayed in Table 2, along with the dates of the recessions, which are also shown graphically in Figure 5.

The freight index tends to signal well the NBER declared recessions, but there were many twists and turns between the recessions that raise questions about the freight index. Though made-up of many components, it is, nevertheless, too sensitive a measure. The passenger index shows little consistency regarding the lead / lag relationship. The passenger index does not seem to be sensitive enough to relate to turns in the economy. But the freight index definitely has potential.

The question from the graph to ask is, why the over-signaling of the freight index? With such few data points, can we trust that this anticipation of change is something real?

We will attempt to validate what was found between freight TSI and recessions by studying growth cycles next.

<u>Validating TSI against Growth Cycles</u>
As noted in Zarnowitz and Ozyildirim (2001), recession turning points are not the only changes of interest in economic time series. As the original TSOI researchers studied, the turning points affiliated with growth cycles also are of interest.

Hodrick-Prescott filters
In order to specify the growth curve turns, the data need to be detrended – and, in our research, we chose to use the HP filters, with an alpha of 108,000 (as suggested by Zarnowitz & Ozyildirim (2001) and by Lahiri et al. (2003)).

The resultant time series are specified in the following graph, along with the turning points of the coincident index (which indicate the turns in the growth cycle of the economy (Zarnowitz and Ozyildirim, 2001).[4] This information is provided in the Figure 6.

This time the turns in the freight component begin to track better with the turns in the growth cycle. The passenger cycles are still not clear; this result could be attributed to the index construction of the "for hire" passenger mode, which is lacking a rather large component – automotive VMT. Consequently, we chose to pursue only the relationship of the freight index to the turns in the growth cycle.

Employing the same rules of thumb to eliminate spurious turns and then referring back to the original to pinpoint actual months in which the turns occurred, we compare the dates of the peaks and troughs against the turns in the growth cycle in the Table 3.

The TSI freight tends to lead the coincident index turns at the peaks as well as at the troughs. To quantify the degree of lead, the final column in the table provides the degree of lead or lag. On average, the TSI freight leads by 4 ½ months for the troughs and 3 months for the peaks. Only one false cycle occurred in the TSI freight – with a peak at July 1992 and a trough at July 1993.

Final conclusions

<u>Historical TSI Index Data Results</u>
The historical freight index anticipated rather well the NBER declared recessions, but the results were not wholly convincing. There were many turns that didn't result into full-blown recessions or expansions. The passenger index showed little consistency regarding the lead / lag relationship with recessions, but appears to be a coincident indicator, as it is presently defined as a "for hire" only passenger services.

The final comparison of the turning points in the freight TSI against the turning points in the growth cycles, however, proved to be a strong relationship: <u>*the freight TSI tends to lead the growth cycle, both at the peaks as well as at the troughs*</u>. Economic theory provides justification of this leading characteristic. So, with theory supported by empirical findings, we can rely that

[4] The turning points for the growth curves, as specified by Zarnowitz and Ozyildirim (2001) only go up to June 2000. To supplement the more recent turns, we applied the B&B turning point procedure to the recent Coincident Index data. It should be noted that one of the recent phases may actually be too short to be a true cycle, according to B&B, but we include it to show its relationship to the TSI data.

the lead characteristic of TSI freight will continue into the future.

Future Research

While we can assert the above conclusion regarding the history of the TSI measures, it is difficult to use this information to predict changes in real time in the economy through the turns in the TSI. Because the above procedures utilize moving averages, by default six month's worth of recent data are lost in the analysis. Perfecting our forecasting and possibly working with asymmetrical filters may provide the edge we need to anticipate changes in the economy 3 to 4 months ahead of time.

The passenger TSI did not prove to be as interesting. But, again, this may be due to the fact that personal automotive VMT was not included in this index. By creating a passenger TSI with automotive VMT in the future, we should be able to create a more complete picture of passenger travel.

We may also want to use the time series relationships in other ways, by looking at more than just the turning points. Both work in Granger Causality and in cointegration look promising as ways to expand the analysis of the data series to test the relationships.

References

Boschan, C. and W. W. Ebanks. 1978. The Phase-Average Trend: A New Way of Measuring Growth. *1978 Proceedings of the Business and Economics Statistics Section*. Washington, DC: American Statistical Association.

Burns A. and W. Mitchell. 1946. *Measuring Business Cycles*. New York, NY: National Bureau of Economic Research.

Bry, G. and C. Boshan. 1971. *Cyclical Analysis of Time Series: Selected Procedures and Computer Programs*, NBER Technical Paper 20. Cambridge, MA: National Bureau of Economic Research.

Kendall, M. and K. Ord. 1990. *Time Series*, 3rd ed. London, England: Edward Arnold.

Lahiri, K and H. Stekler. 2002. *The Theoretical Development, Selection, and Testing of Economic Indicators for the Transportation Industry*, BTS Research Grant final report. Washington, DC: Bureau of Transportation Statistics.

Lahiri, K., H. Stekler, W. Yao and P. Young. 2003. Monthly Output for the U.S. Transportation Sector. *Journal of Transportation and Statistics* 6(2/3), 1-28.

Lahiri, K., W. Yao and P. Young. 2004. Transportation and the Economy: Linkages at Business-Cycle Frequencies. *Transportation Research Record: Journal of the Transportation Research Board*, No. 1864, 103-111.

Ladiray, D. and B. Quenneville. 2001. *Seasonal Adjustment with X-11 Method*. New York, NY: Springer.

Layton, A. and G. Moore. 1989. Leading Indicators for the Service Sector. *Journal of Business & Economic Statistics* 7(3), 379-386.

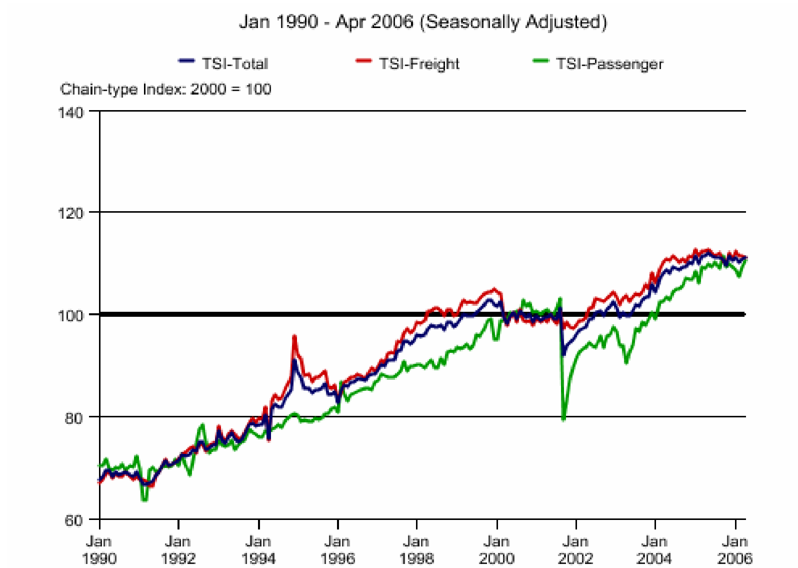
Page, D. and R. Wirtz. 2003. Wrong Side of the Tracks. *Fedgazette*, Federal Reserve Bank of Minneapolis, November 2003.

Wilson, G. 1980. *Economic Analysis of Intercity Freight Transportation*. Bloomington, Indiana: Indiana University Press.

Yao, V. and B. Sloboda. 2005. Forecasting Cycles in the Transportation Sector. *Journal of the Transportation Research Forum* 44(2), 45-60.

Zarnowitz, V. and A. Ozyildirim. 2001. *Time Series Decomposition and Measurement of Business Cycles, Trends and Growth Cycles*, Economics Program Working Paper #01-04. New York, NY: The Conference Board.

Figure 1. The Transportation Services Index



Source: U.S. Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics, http://www.bts.gov

Figure 2.

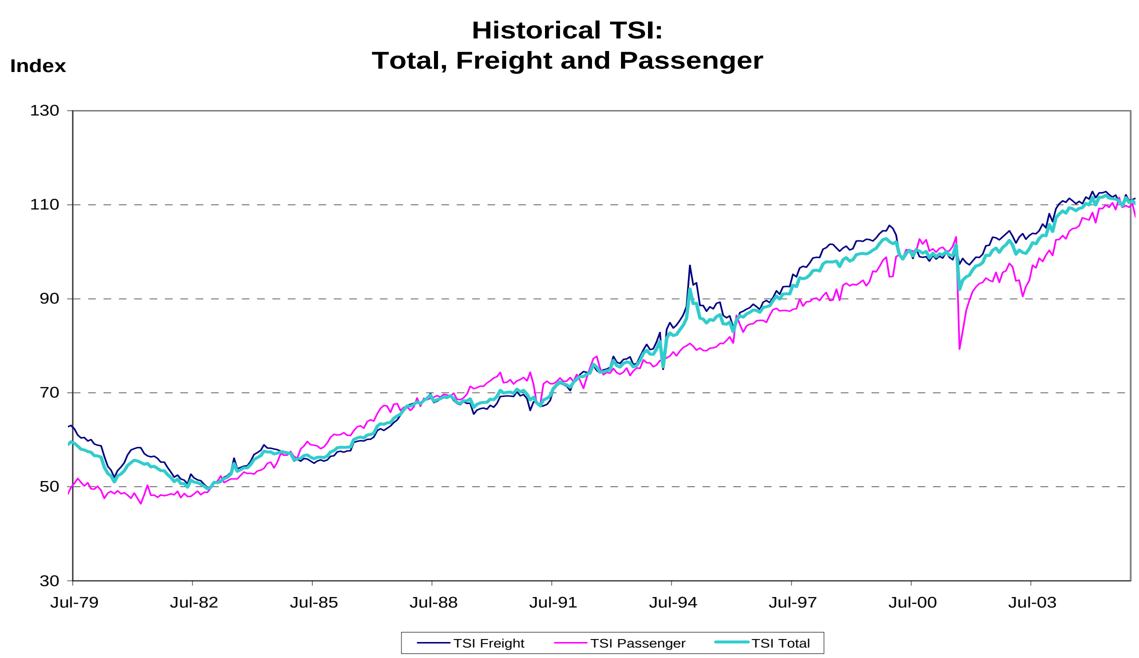


Figure 3.

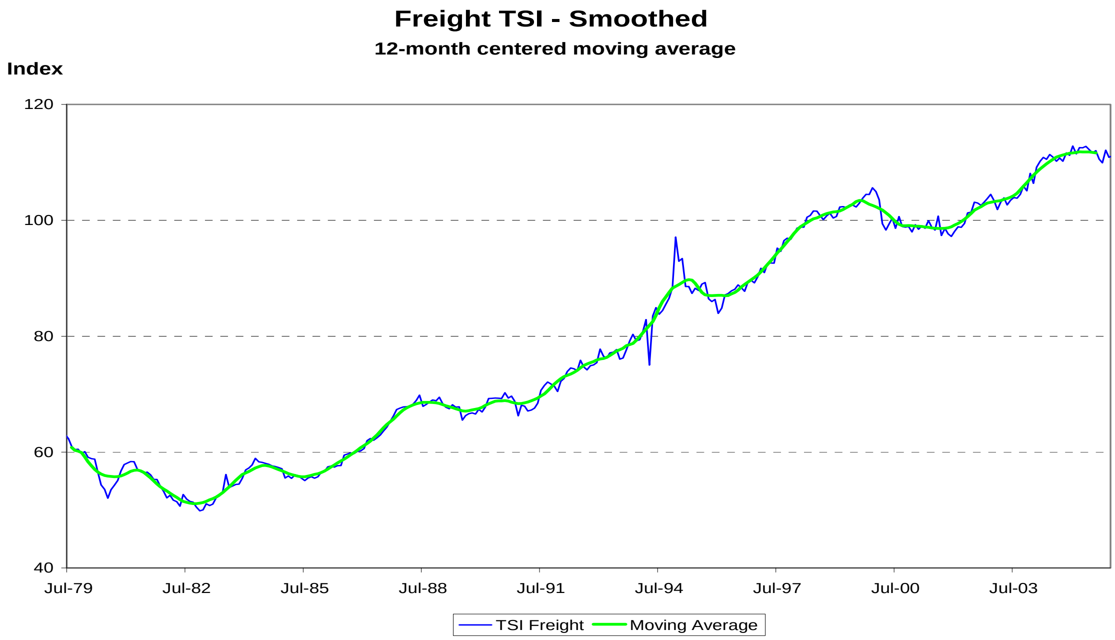


Figure 4.

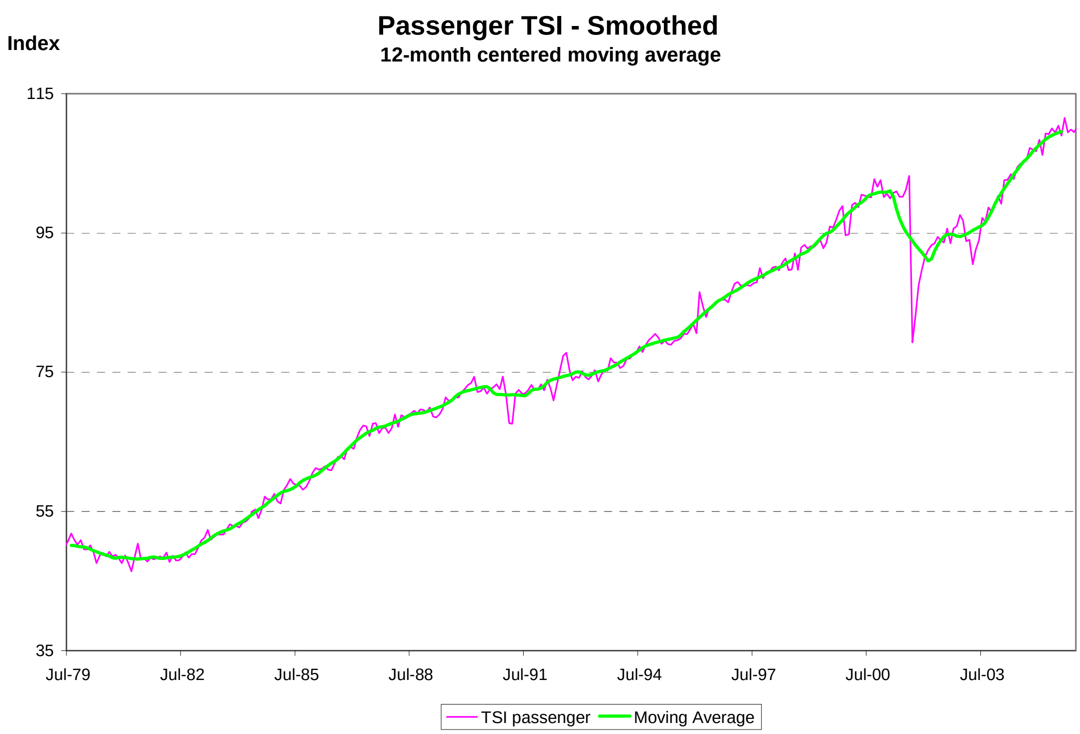


Figure 5.

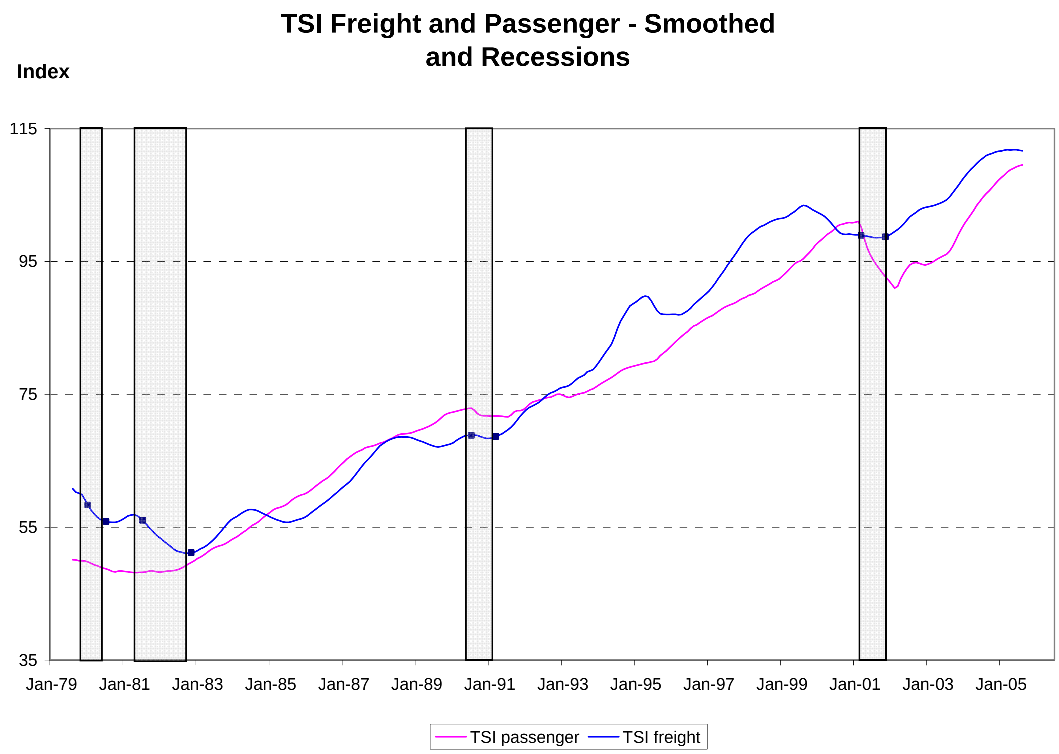


Figure 6.

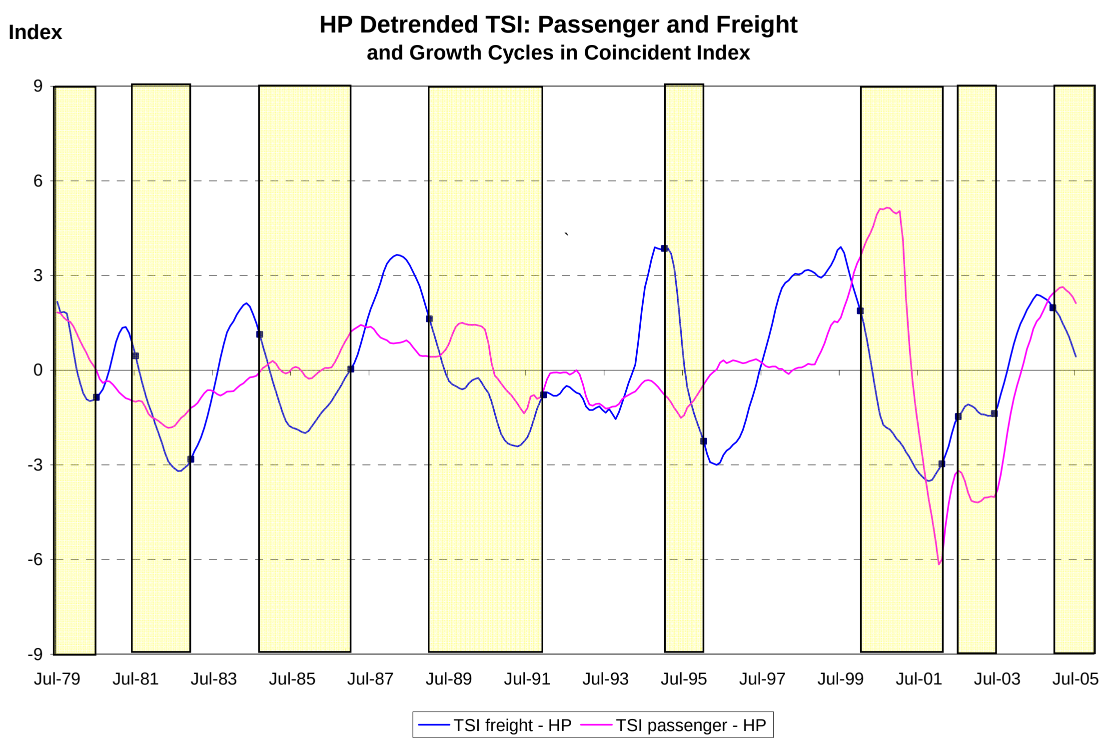


Table 1. Data Sources for the Transportation Services Index (TSI)

Mode		Source	Measure
Passenger	Air	BTS and carrier websites	Revenue passenger-miles
	Rail	FRA	Revenue passenger-miles
	Transit	APTA	Unlinked trips
Freight	Trucking	ATA	Index of tonnage
	Air	BTS and carrier websites	Freight ton-miles
	Rail	AAR	Carloads & Intermodal units, and
		FRA	Quarterly ton-miles
	Water	USACE	Tons
	Pipeline	EIA	Thousands of barrels

Table 2. Dates of turning points of TSI freight and passenger against the recessions.

Turning Points in the Economy, TSI freight, and TSI passenger

	Economy	**TSI freight**	**TSI Passenger**
Peak	Jan-80	NA	NA
Trough	Jul-80	Jul-80	Mar-81
Peak	Jul-81	Feb-81	
Trough	Nov-82	Nov-82	
Peak		Apr-84	
Trough		Jul-85	
Peak		Dec-88	
Trough		Jul-89	
Peak	Jul-90	Aug-90	Oct-90
Trough	Mar-91	Mar-91	Mar-91
Peak		Dec-94	
Trough		Jan-96	
Peak	Mar-01	Dec-99	Sep-00
Trough	Nov-01	Oct-01	Sep-01

Table 3. HP-filtered TSI turning points against the growth cycles in the Coincident Index

Growth Cycle Turning Points in the Coincident Index and TSI freight

	Economy	**TSI freight - HP filtered**	**Lead / Lag of TSI**
Peak	Mar-79		
Trough	Jul-80	Jul-80	0
Peak	Jul-81	Jan-81	+6
Trough	Dec-82	Nov-82	+1
Peak	Sep-84	Apr-84	+6
Trough	Jan-87	Oct-85	+13
Peak	Jan-89	Jun-88	+7
Trough		Jul-89	NA
Peak		Mar-90	NA
Trough	Dec-91	Mar-91	+9
Peak		Jul-92	NA
Trough		Jul-93	NA
Peak	Jan-95	Dec-94	+1
Trough	Jan-96	Jan-96	0
Peak	Jun-00	Nov-99	+2
Trough	Feb-02	Sep-01	+5
Peak	Jul-02	Dec-02	-4
Trough	Jun-03	May-03	-1
Peak	Dec-04	Jun-04	+6
Trough	Aug-05		

	Peak	Trough
Average lead	+3.4	+3.9
Median lead	+6	+1

The Recessions of 1990 and 2007(?)

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1. Business Cycles and Recessions

What is the cause of recessions? The amplitude of cyclical variations in real GDP (gross domestic product) is large enough that it sometimes exceeds the average growth, thereby producing an actual decline in economic activity. This reduces sales for businesses and often brings a decline in profits. Unemployment rises. Government operations are challenged by a decline in tax revenues and a rise in expenses from various welfare and entitlement programs.

Why are the cyclical variations in GDP so large as to be troublesome? Supply and demand do not come into equilibrium instantaneously, as naïve economic theory assumes; in fact they never come into equilibrium at all. Economics is an endless pursuit problem, with supply chasing demand, but never catching up with it. So various macroeconomic indices, such as GDP, do not follow the smooth curves one gets from either simple algebraic formulæ or the solutions of differential equations. However, the trend of the GDP has been closely following an exponential function of time since 1962 (see Figure 1) and undoubtedly longer than that. That the trend is indeed exponential is best demonstrated by a logarithmic plot (see Figure 2).

Often a macroeconomic (or microeconomic) variable will exhibit basic exponential growth (a straight line on a logarithmic plot). In some cases what appears to be a damped oscillation occurs. But in all cases there is lots of "noise." A part of this "noise" may be due to measurement errors, but most of it is "high frequency" variations. The viability of macroeconomic data comes from the apparent fact that measurement errors are not random, but highly correlated and hence, low frequency or even constant.

Aggregation is one method of filtering "high frequency noise." A weighted average of several variables will be smoother than any one of them if the "noise" is uncorrelated. A casual examination of the S&P 500 or Dow Jones stock market indices reveals that there still is a lot of post-aggregation "noise," despite the use of many share prices.

In the case of business cycle analysis, the "noise" is the data. As noted above, the trend is close to constant rate (exponential) growth. This has been the case since the end of World War II, when the US Department of Commerce began collecting macroeconomic data in greater quantities and greater detail. The trend actually declined during the Great Depression, which is dynamic behavior qualitatively different from that of the usual business cycle.

In theory, a detailed macroeconomic model could be constructed for every market so that precise forecasts could be made. What is wrong with this theory? The number of variables and the complexity of their interactions is such that the resulting mathematical model is unstable. The initial conditions cannot be measured with sufficient precision, and even if they could, the accuracy of the floating-point arithmetic used by a computer would have to be too high to be feasible. These are the same problems that plague climatology, weather forecasting, and many other scientific and engineering disciplines.

Highly aggregated econometric models have been constructed by some academics and consulting firms. Most forecasters in business and government, however, use different approaches. The more scientific one is a dynamical model based on noise-driven linear difference equations. (Many engineering and scientific disciplines also use this approach or noise-driven differential equations.) This methodology is widely known as time series analysis. Many forecasters, however, use various *ad hoc* curve-fitting approaches and, more often than not, they work as well as mathematically sophisticated approaches.

2. The Trend

For most dynamic systems there is no unique definition of the trend. Orbits of artificial satellites, natural satellites, major planets, and some asteroids can be closely approximated by rotating, precessing ellipses. The geometric parameters for these ellipses, as well as their rates of rotation and precession, can be obtained rather precisely by any of a number of perturbation theories.

But this precision is limited because different perturbation theories give slightly different results and nonlinear resonances limit the applicability of the theories. Those attempting to model and forecast econometric data are forced to use *ad hoc* curve-fitting, such as polynomial regression.

Polynomials of degree higher than one (a straight line) or two (a parabola) are usually too unstable to be useful for forecasts. For some data series these trend models suffice, especially if one works with the logarithms of the values.

Differencing the data is another approach, based on the fact that derivatives are polynomials of one degree lower than the polynomial which is the function. So if a cubic (third-degree) polynomial seems to be the best trend model, first differences should be able to use a parabola and second differences a straight line. The disadvantage of differencing is that it amplifies high frequency components of the data and hence decreases the signal-to-noise ratio. The analogy here is the derivatives of cosines and sines.

Smoothing without amplifying noise can be achieved by using a low-pass filter as the trend model. We developed the ramp filter a number of years ago (Morrison & Morrison, 1997); the name derives from the fact that the filter coefficients decrease by a constant amount. The one disadvantage is that points at the beginning of the data series cannot be used in the time series forecast for the deviations from the trend, but if necessary, a polynomial trend model could be used to obtain values for those points.

3. The GDP, Recessions, and the Indices of Leading, Coincident and Lagging Indicators

Real Gross Domestic Product does not grow at a constant rate, but in the post-WWII era its trend has approximated exponential growth. (See Figures 1 and 2.) Nevertheless, there have been periods of declining GDP long enough to constitute recessions. Economists in business, government and academe all would like to know when recessions are coming, but GDP numbers are not available in "real time," since collecting and processing the data is labor intensive and time consuming.

Neither GDP nor its growth rate can be forecast with sufficient precision to satisfy the needs of economists or the users of econometric data. For example, our own forecast for third-quarter GDP made in August 2006 was 11502.8 ± 84.4 billion "chained" 2000 dollars. The precision is 0.7%, which might seem good, but the quarter-to-quarter change predicted was 105.2, or 0.9%.

The growth rate in the second quarter had been 2.90%/year and the forecast for the third quarter was 3.22 ± 2.97%/year. Clearly such low precision does not allow recessions to be predicted. These forecasts were made using time series methods, which are based on the same dynamical model (a noise-driven linear system) as things like Box-Jenkins, but utilizes linear filtering rather than difference equations (Morrison, 1991; Makridakis, *& al*., 1998). Multivariate or econometric models might be able to do a little better, but not a lot better.

Filtered noise dynamics often produces "cycles," but ones of variable frequency. Signals of constant frequency (or containing small numbers of constant frequencies) are highly predictable, but filtered noise is just the opposite. The exchange economy is not a "clockwork universe"; the proper analogy is an overly complex device with belts and pulleys that bind and slip at random. More elaborate models cannot significantly improve forecasts, because the observations are too low in precision and some things that should be known are not observable. These principles apply to all quantitative analyses and therefore the number of dynamic systems that can be forecast with high precision is small.

An alternative approach is to seek data series that are correlated with future values of what one wants to predict. Along the way, those that correlate with current and past values also may be found. All three types can be useful. When a number of such data series are found, they can be aggregated into indices of leading, lagging and coincident indicators. This process was started at the US Department of Commerce not long after WWII and more recently was spun off to The Conference Board, based in New York City (*Handbook of Cyclical Indicators*, 1984).

4. Phase Plane Models

Time series plots (values vs. time) of indices may not be easy to interpret. In the case of GDP, the change (or growth rate) is of much more interest than the absolute value, which surely has biases due to errors of omission. Such errors are reduced in GDP estimates by revisions made every few years. But since these errors of omission are usually fairly constant, the current GDP growth rates are meaningful and useful. The analysis done by macroeconomists agrees fairly well with the experiences of businesses.

In some disciplines analysis may be facilitated by using phase plane plots. This technique plots one time series against another rather than both against time. The results might be a random oscillation, a random walk, or a "cycle." This is especially useful for cycles of variable period, since they are transformed into other cycles of constant period in terms of the *phase angle*. The other polar coördinate, the *radius*, may be a measure of amplitude. (See Figure 3.)

The phase plane model of the business cycle is constructed from the indices of leading, lagging, and coincident indicators. First, all three time series are detrended with a 60-point low-pass ramp filter. The output of this process is a distribution of points in 3-space. A plane fixed to the *y*-axis (detrended coincident index) is then fit by least squares to the constellation of points. The points are projected orthogonally onto the plane to produce the phase plane plot (Morrison & Morrison, 2001).

This projection approach creates an alternative index of leading indicators by using a linear combination of the indices of leading and lagging indicators. This is simply an optimal alternative to using the leading index alone or the lagging index inverted. Incorporating the lagging index this way has produced plots that vary less in shape from cycle to cycle.

5. The Recession of 1990-91

Revisions of the indices made over the past decade and longer have demonstrated that the phase angles are rather stable. The radii have varied in size, but the shapes of the cycles have been stable in the case of both the 2-index model and the 3-index model. However, to test the usefulness of the phase plane plots as a forecasting tool, the best approach is to look at how the plots developed during the onset of a recession and through to the end of it. So we recreated a plot from the era of the 1990-91 recession using the data available at that time, but with the 3-index methodology. The behavior of the 2-index methodology in use during that time frame was substantially the same. A natural extension would be to do the same thing using indices from even earlier periods that predate our development of this phase plane analysis.

Figure 5 is a phase plane plot made with the data available as of July 1991, whose latest value was for May. The implied end of the recession is in the March-April 1991 time frame, because March shows the plot turning up and by April the phase angle had passed 270°. The official (NBER, National Bureau of Economic Research) announcement of the end of the recession did not come until 21 months after the fact (Hershey, 1992), so in this case the phase plane plot did much better.

Figure 6 is an enlargement of the phase plane plot that includes only the data from the time near the beginning of the recession. The start is indicated by "B." The time of the start is not as clearly indicated as the end, and in a different way. During the period 1984-90 the GDP ran more or less parallel, and slightly above, its trend. (See Figure 4.) The phase plane model drifted aimlessly about the origin. With the onset of the recession, the phase plane plot dropped nearly parallel with the *y*-axis, which represents a decline in the detrended coincident indicator. In January 1991, the baton, so to speak, was passed to the leading indicator.

The lesson here is that a lot of the information in the model is in the radial coördinate. When it is "small," not much is happening; growth is average and fairly steady.

6. The Recession of 2007 or Later

Currently the business cycle model is in the second quadrant, but heading for the third, if one can believe the forecast. (See Figure 7.) The forecast was created using a linear filtering algorithm and the polar coördinates. Since the transformations between polar and Cartesian coördinates are nonlinear, the dynamics of the forecast are different. A forecast using Cartesian coördinates asymptotically spirals into the origin, whereas one using polar coördinates asymptotically approaches uniform circular motion (Morrison & Morrison, 2002).

The business cycle model is now entering a period in which a recession is to be expected, but the beginning cannot be predicted with much reliability. In most cases the drop of the *y*-coördinate to about –2 coincided with the beginning of the recession, but in the period 1972-76 the recession started with *y* being about +3 (*Critical Factors*, Special Report No. 11, Oct. 20, 2005). Every recession is different. Nevertheless, the phase plane model presents a clearer picture of what is going on with the exchange economy than the GDP and the time series graphs of the indices.

Another factor entering into the effort to anticipate the next recession is the fact that The Conference Board has revised the indices to improve the prediction of the beginnings of recessions. Our tests done by looking at the variability of phase angles at the starts of recessions indicated that this was the case, but also that the phase angles at the ends increased in variability (*Critical Factors*, Special Report No. 11, Oct. 20, 2005).

The definitions of the indices used immediately before the revisions had the recessions ending at phase angles that averaged 269° ±30°, close to the theoretical value of 270°. The new methodology changed this to 253° ±39°, a full 17° away from 270° and with an uncertainty 30% larger. The average of phase angles for beginnings was changed from 223° ±53° to 199° ±34°, which moved it closer to the theoretical 180° and decreased the uncertainty by 36%.

7. The Phenomenology of the Trend

The theme of this 15th Federal Forecasters Conference is the challenges created by the increasing average age of the US population. This is a different sort of problem than what is usually addressed by "forecasting," which looks only a few time steps (data sampling intervals) ahead. The size of age cohorts can be predicted rather well, since birth rates and death rates are known to sufficient precision and do not, themselves, change rapidly.

Falling birth rates are presenting challenges throughout the so-called developed world, not just the USA. Welfare and entitlement programs had been designed under the assumptions of an ever growing population. With a stagnant or even shrinking population, there will not be a large enough tax revenue base to sustain these programs. The private sector faces problems too, since almost all business models assume an ever growing number of consumers. Companies (such as Ford and GM) that are losing market share face grave challenges in maintaining defined benefit retirement programs.

Compound interest formulas have been taught in schools as early as grade 8 (and maybe earlier in some school districts). It is certainly worth knowing that if one's saving account pays interest quarterly, the total yield is higher than what would be received from a single annual payment at the same rate. One earns a tiny bit of interest on the interest paid. What has not been emphasized enough is that compound interest will double one's money in fixed time intervals. For every dollar you start with, after the first doubling time you will have $2.00. After the same period passes again it's $4.00, then $8.00, $16.00, $32.00, *ad infinitum*. There is no amount of money so large that it will not be reached in a finite time.

Why aren't we all rich? The answer is inflation and taxes. Over a period of years, the net yield on fixed-income investments is zero or even negative. Astute investors buy common stocks, real estate and other things that they hope will rise in value at least as fast as the dollar drops in value. All such investments, however, involve more risk than fixed-income investments.

In the case of population and supporting infrastructure, the size of the units does not decrease to compensate for the growth. (Although in recent decades in the USA, people have been getting taller and heavier, and houses larger, while trucks and SUVs have gained market share.) So growth has created various problems, including environmental degradation and traffic congestion.

Rapidly developing countries, most notably China and India, have both prospered and suffered because of the growth.

As observed in the "limits to growth" debate back in the 1960s, growth causes "feedbacks" that tend to control it, which can lead to a steady state or collapse. One such feedback is the depletion of nonrenewable resources. The long anticipated peaking of the production of high quality, light petroleum may already have occurred (Ruppert, 2004).

Another feedback is the destruction of renewable resources. A forest can grow new trees, but not if it is paved. The fact that the world is using resources faster than they can be produced by the biosphere has been established (Wackernager, *& al*., 2002).

A trend totally unanticipated in the 1960s is global warming (Lovelock, 2006). A minority of scientists is still arguing that the effects are natural and not caused by the burning of fossil fuels and the release of other gases from industrial processes. Even if this were true, that would not make the possible consequences less threatening. The rapid depletion of light petroleum is already causing the development of heavy oil (including heavy petroleum, tar sands and oil shale), with the production of massive amounts of toxic chemicals as well as greenhouse gases.

The ultimate consequences of growth and industrialization during the twentieth century are not yet known. All that can be said with certainty is that growth must eventually cease and it probably will well before the end of the twenty-first century. Some sort of steady state will be achieved. And if there is any such thing as an economy, cyclical variation will still occur and recessions will be as long as expansions.

8. References

Critical Factors, Special Report No. 11, Oct. 20, 2005.

Handbook of Cyclical Indicators: a Supplement to the Business Conditions Digest, *1984*, US Dept. of Commerce, Bureau of Economic Analysis, Washington, DC.

Hershey, R.D., Jr., "This Just In: Recession Ended 21 Months Ago," *The New York Times*, Dec. 23, 1992.

Lovelock, J., *The Revenge of Gaia: Earth's Climate Crisis and the Fate of Humanity*, Basic Books, 2006.

Makridakis, S., S.C. Wheelwright and R.J. Hyndman, *Forecasting: Methods and Applications*, third edition, John Wiley & Sons, Inc., New York, 1998.

Morrison, F., *The Art of Modeling Dynamic Systems: Forecasting for Chaos, Randomness, and Determinism*, Wiley-Interscience, New York, 1991.

Morrison, F. & N.L. Morrison, A phase plane model of the business cycle, *The 8th Federal Forecasters Conf. 1996 and The 7th Federal Forecasters Conf. - 1994: Combined Papers and Proceedings*, US Dept. of Education, NCES 97-341, pp. 93-112, Debra E. Gerald, editor, Washington, DC, 1997.

Morrison, F. & N.L. Morrison, An improved phase plane model of the business cycle, *The 11th Federal Forecasters Conf. - 2000*, US Dept. of Education, NCES 2001-036, pp. 183-191, Debra E. Gerald, editor, Washington, DC, 2001.

Morrison, F. & N.L. Morrison, Forecasting the business cycle with polar coördinates, *The 12th Federal Forecasters Conf. - 2002*, pp. 185-191, Debra E. Gerald, editor, Washington, DC, 2002.

Ruppert, Michael C., *Crossing the Rubicon: the Decline of the American Empire at the End of the Age of Oil*, New Society Publishers, PO Box 189, Gabriola Island, BC V0R 1X0, Canada, 2004.

Wackernagel, M., *& al*., Tracking the ecological overshoot of the human economy, *PNAS*, **99**, 14, pp. 9266-9271 (2002 July 9).

FIGURES

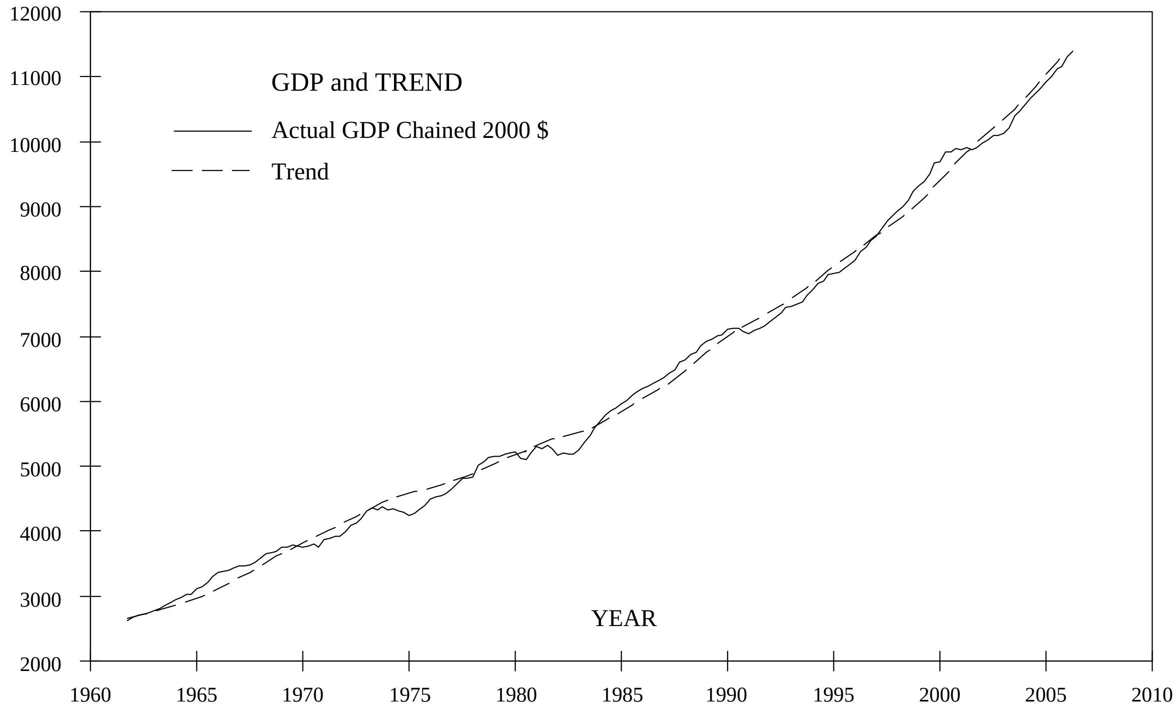


Figure 1. GDP and Trend (60-point low-pass ramp filter)

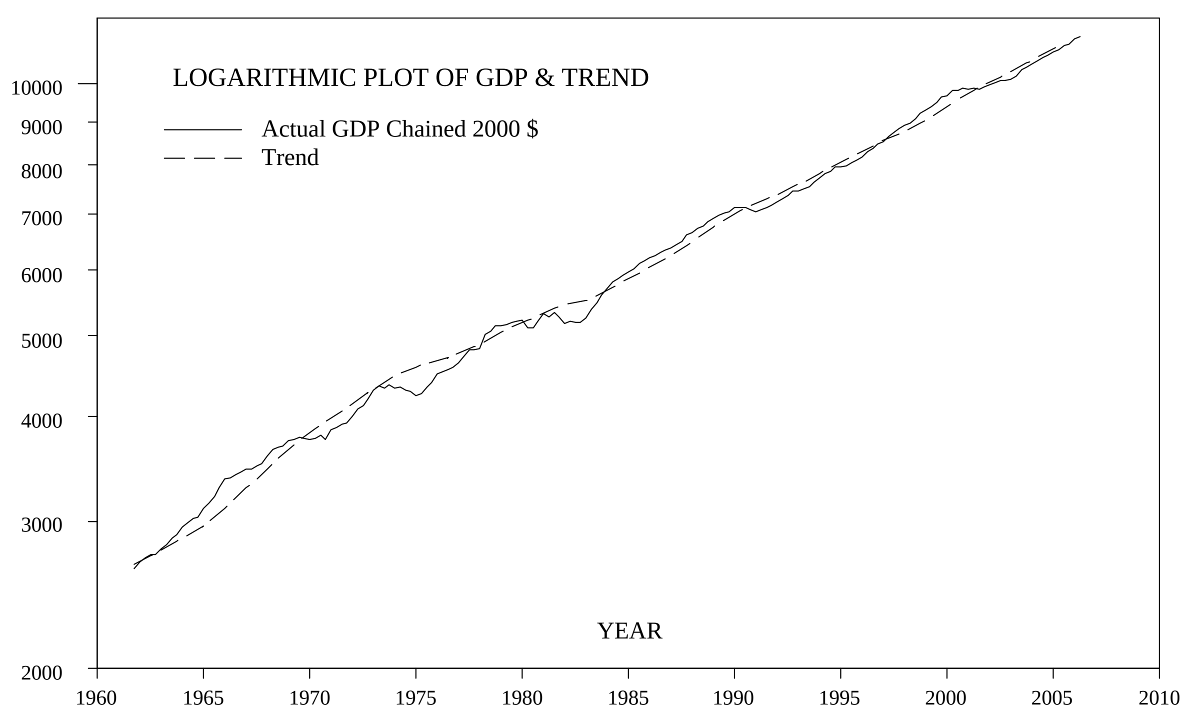


Figure 2. Logarithmic Plot of GDP & Trend

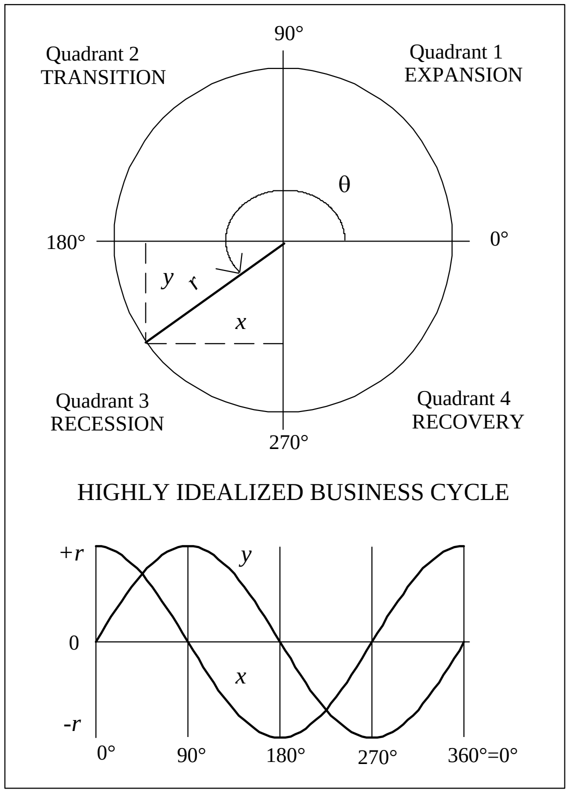


Figure 3. Idealized Business Cycle

When there are two (or more) data series, a technique called phase plane analysis may be used. Instead of plotting each data series against a (horizontal) time scale, use one series as the horizontal (x) coordinate and the other as the vertical (y) coordinate. Time sequence information may be discarded entirely or retained by connecting the sequence of points with lines. Connecting the points in time sequence is a way to look for dynamic effects. For simple problems in the physical sciences the phase plane plot may be a closed loop or spiral into one. Complex systems usually produce more elaborate patterns.

What would a "perfect" leading indicator and a "perfect" coincident indicator look like in a phase plane analysis? Look at the lower part of the above figure. Against a horizontal time scale the perfect leading indicator would be $+r$ at 0°, 0 at 90° $-r$ at 180°, 0 again at 270°, and $+r$ again at 360° = 0°. The perfect coincident indicator would be 0 at 0°, $+r$ at 90°, 0 again at 180°, $-r$ at 270°, and 0 again at 360° = 0°. In other words the leading indicator "leads" the coincident indicator by 90°. Those who may remember some trigonometry recognize the leading indicator as a cosine function and the coincident indicator as a sine function.

Now get rid of the horizontal time scale. If we plot the leading indicator as the horizontal (x) coordinate and the coincident (y) indicator as the vertical coordinate, we get a circle, the "perfect" business cycle. By convention, the motion is counterclockwise, with the zero angle being along the positive x-axis (3 o'clock). Ninety degrees is along the positive y-axis (12 o'clock); 180°, the negative x-axis (9 o'clock); 270°, the negative y-axis (6 o'clock).

In the first quadrant (between angles 0° and 90°), the leading and coincident indicators are both positive. This is the expansion period. In the second quadrant (between 90° and 180°), the leading indicator is negative, but the coincident indicator, although declining, is still positive. This is a period of transition. In the third quadrant (between 180° and 270°), both the leading and coincident indicators are negative. This is the recession-prone period. In the fourth quadrant (between 270° and 360°=0°), the leading indicator is positive and the coincident indicator, although negative, is increasing. This is the period of recovery.

Keep in mind that the *x*- and *y*-coordinates are PERCENT DEVIATIONS from the trends. This, as well as the specifics of the detrending process, allows for distortions due to net growth and inflation. A scale error would create an ellipse rather than a circular pattern for a perfect cycle. If the indicators were not precisely 90° out of step, the ellipse might be tilted. Every deviation from a perfect, uniform circle produces its own characteristic distortion in the picture. This is why phase plane analysis is so powerful, even though it is not always a precise, mathematical technique.

Changes in the period (time to complete one cycle) show up only in the spacing of the points along the circle (or ellipse). Since the length of the business cycle varies between 4 and 10 years, in most cases, and the percent deviations from the trend peak (and trough) at levels running from under 3% to more than 10%, the phase plane plots are rather ragged ellipses, but still recognizable.

Phase plane plots provide a much more refined analysis of the state of the economy than the simple dichotomy, growth vs. recession. Converting from an *x-y* coordinate system to a polar coordinate system, the phase plane model has two variables: *r*, the radius and θ, the phase angle. The phase angle and its progression tells us where we are in the cycle. The radius [r = square root of $(x^2 + y^2)$] gives a numerical measure of how robust the cycle is.

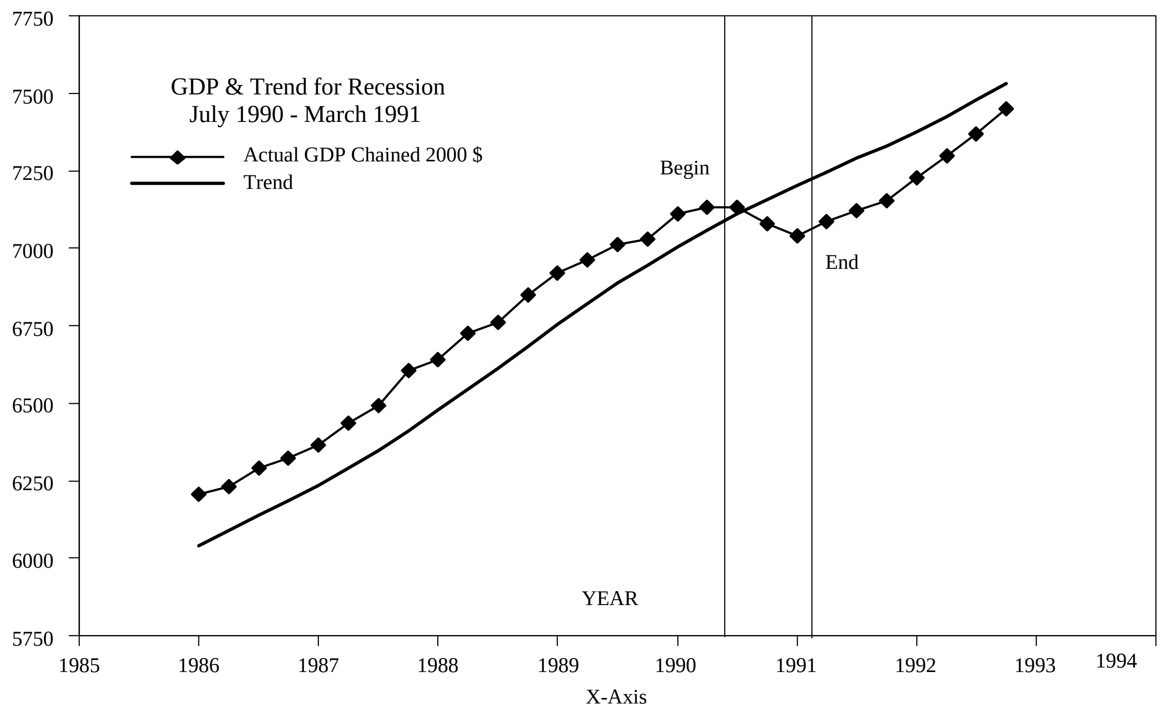
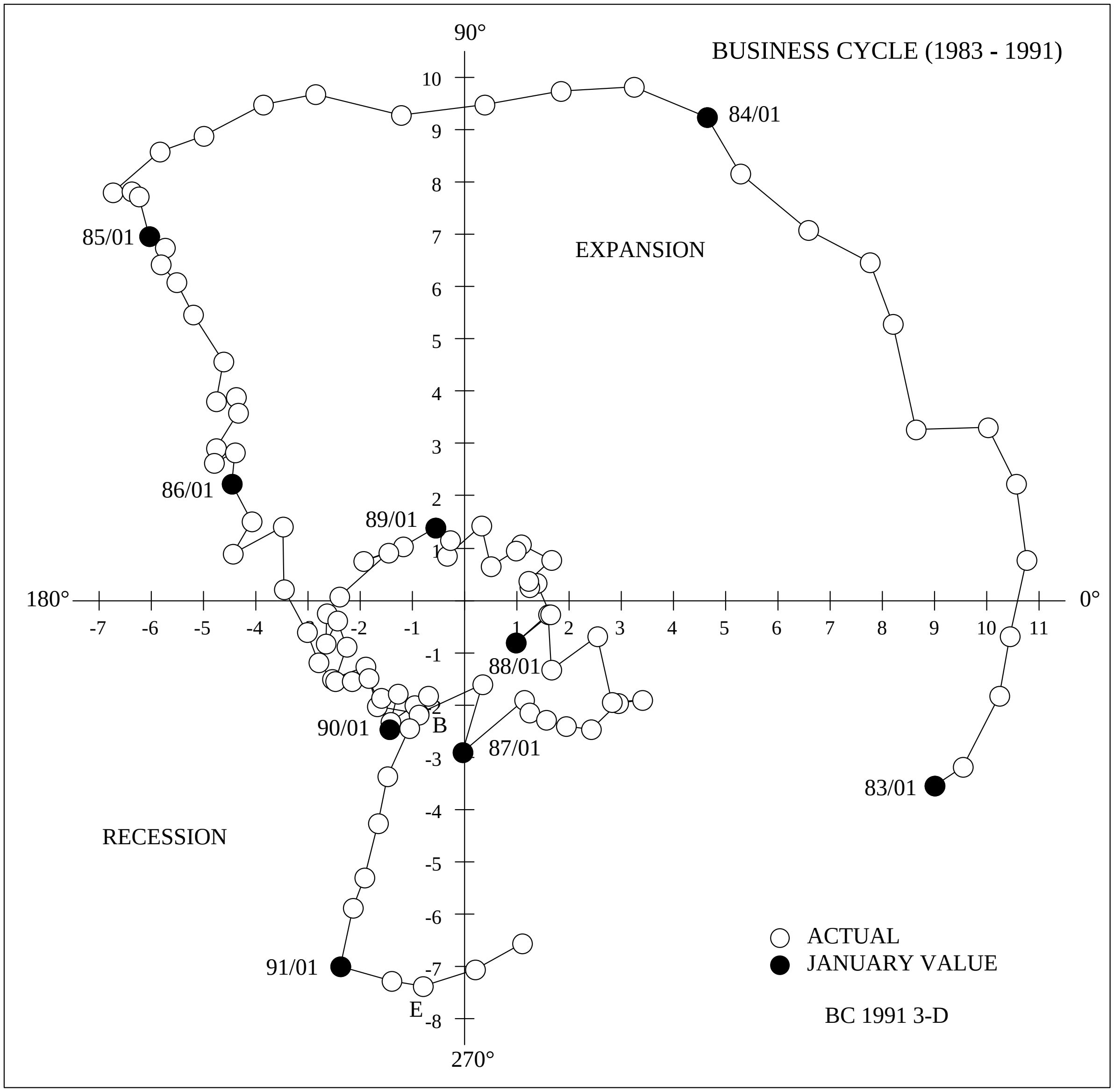


Figure 4. Detail of GDP & Trend for Recession



The business cycle model is a phase plane plot of a weighted mean of the detrended leading and detrended lagging indicators as *x*-coordinate and detrended coincident indicator as *y*-coordinate. Normal cycles follow a counter-clockwise roughly circular path with occasional stalls and reversals. Time is indicated along the cycle path. The data have a 2-month lag. Expansions occur between 0° and 90° and recessions between 180° and 270°. Other angles denote transition (90°-180°) and recovery (270°-360°=0°) periods. An "official" (NBER) beginning of a recession is indicated by a label "B" and an end by "E".

Figure 5. The Recession 1990-91

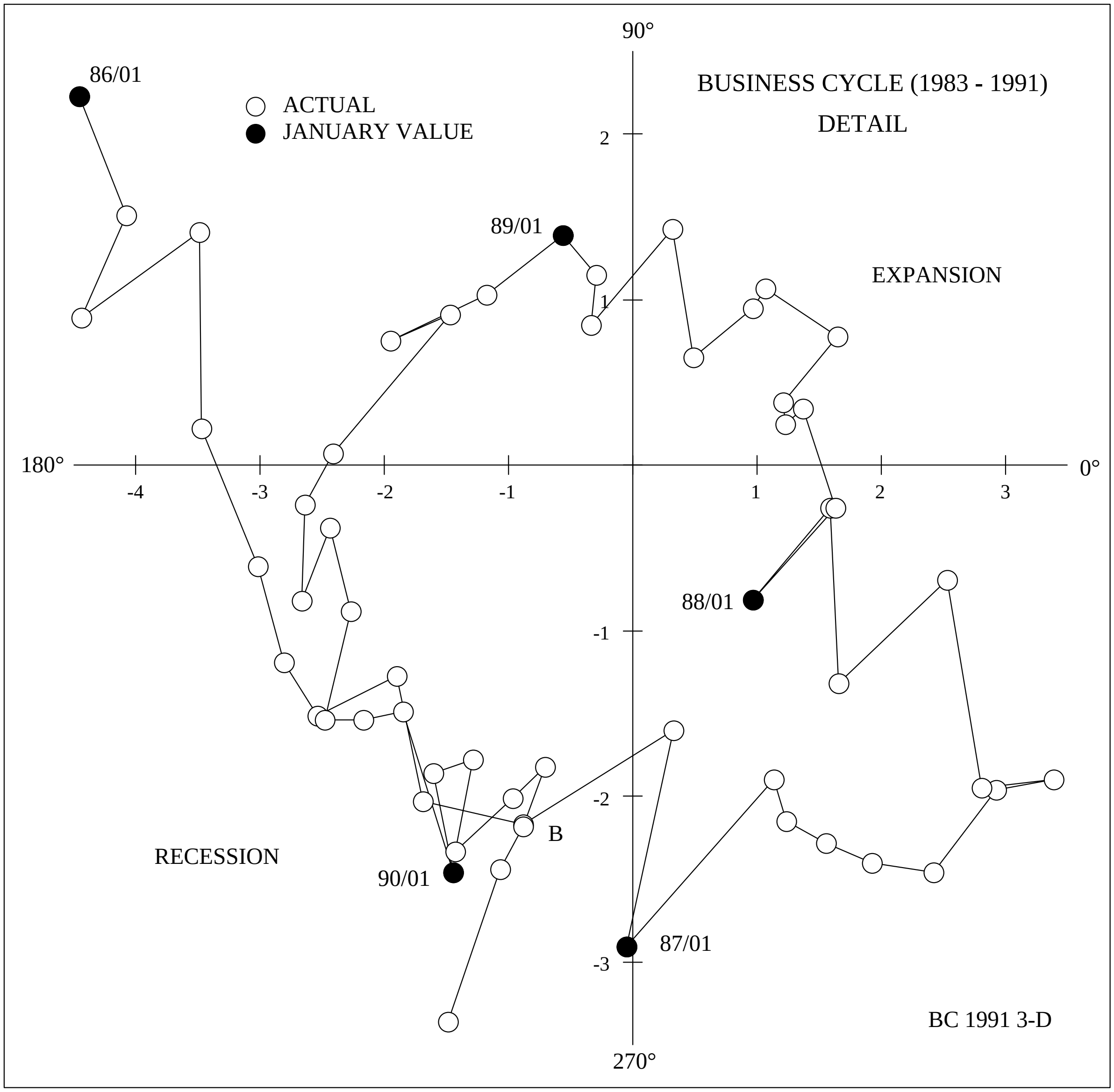


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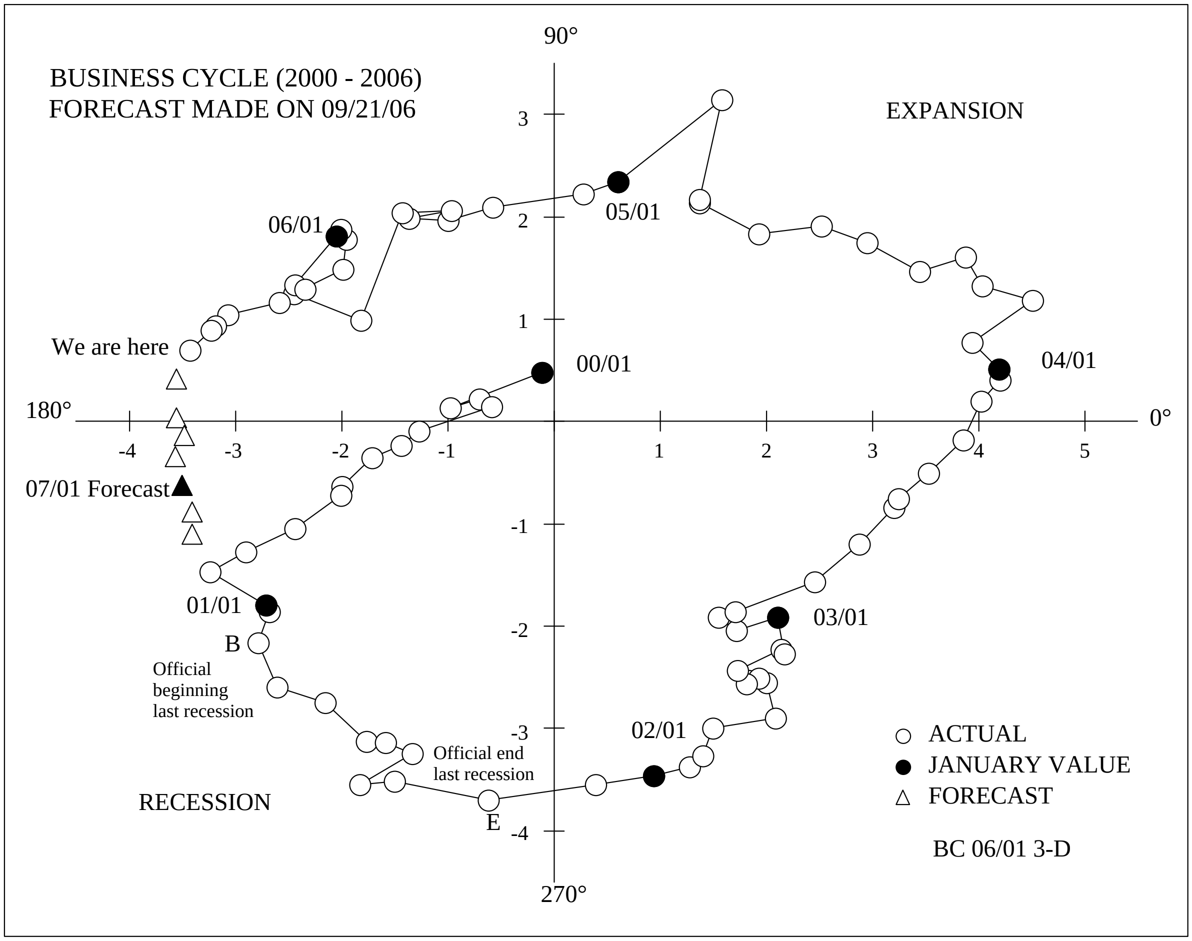
Figure 6. Detail of the Beginning of the 1990-91 Recession



The business cycle model is a phase plane plot of a weighted mean of the detrended leading and detrended lagging indicators as *x*-coordinate and detrended coincident indicator as *y*-coordinate. Normal cycles follow a counter-clockwise roughly circular path with occasional stalls and reversals. Time is indicated along the cycle path. The data have a 2-month lag. Expansions occur between 0° and 90° and recessions between 180° and 270°. Other angles denote transition (90°-180°) and recovery (270°-360°=0°) periods. An "official" (NBER) beginning of a recession is indicated by a label "B" and an end by "E".

Figure 7. The Current Business Cycle and Forecast 2006-07

Concurrent Sessions II

Trade Impacts on Employment and Prices; Defense-Related Employment

Session Chair: Kimberly Dawson, U.S. Postal Service

Cotton Price Forecasting and Structural Change

Stephen MacDonald, Economic Research Service

Reduced form cotton price models are generally specified with world ending stocks and China's trade as key independent variables. Changes in world cotton markets have altered the relationship between these variables and prices. The global adoption of Bt cotton has reduced the cost of production, and changes in the timing of cotton harvesting have added to estimated ending stocks. Finally, China's imports have surged to 16 percent of world consumption, from about 2 percent in earlier years. This paper will explore how information from periods preceding structural change can be subsequently used in forecasting.

Estimating Defense-Related Output and Employment

Eric Figueroa, U.S. Department of Labor, Bureau of Labor Statistics

In 2003, the Bureau of Economic Analysis (BEA) issued a comprehensive revision to the National Income and Product Accounts (NIPAs) explicitly recognizing services produced by government. This recognition has implications for the projection of defense-related employment prepared by the Bureau of Labor Statistics (BLS). This paper will describe the impact of the BEA revisions on the input-output methods used by BLS for its projections. Plans by BLS to accommodate the revision as well as projected employment data will be presented.

The Effects of Foreign Trade on Employment

Mirko Novakovic and Betty W. Su, U.S. Department of Labor, Bureau of Labor Statistics

We are in the age of globalization. Over the past two decades, the growing economic interdependence of countries worldwide through increasing volume and variety of cross-border transactions in goods and services, free international capital flows, and more rapid and widespread diffusion of technology have become increasingly important in U.S. economic activity. This study focuses on relationships between shifting trade flows and changing employment levels among industries in the U.S. economy. Using the available historical data and the most recent U.S. economic and employment projections developed by the Bureau of Labor Statistics, the trade-related jobs by industry are compared for the 1998-2004 and the 2004-2014 periods, and conclusions are drawn regarding the impacts of accelerating globalization on the U.S. economy.

Cotton Price Forecasting and Structural Change

Stephen MacDonald, Economic Research Service, USDA

Abstract

Agricultural prices have long been forecast with reduced-form models including ending stocks as an independent variable. In recent years, cotton prices have been persistently low compared with the other agricultural products that compete with cotton for land and other inputs. Furthermore, the cotton price forecasting models used by a number of entities have chronically realized positive errors—persistently forecasting prices too high. This paper reviews some general principles behind short-term agricultural price forecasting, discusses some of the issues specific to specifying cotton price forecasting models, and compares the forecasting performance of an number of alternative specifications. The discussion and results are intended to lay the basis for developing new models that account for structural changes in world cotton markets.

Introduction

Agricultural prices are notoriously difficult to forecast due to shocks from weather events around the world, the important role of government policy in the market place, and changing tastes and technology. Forecasts of agricultural prices are important to both private and public policy-makers, as well producers and consumers of agricultural products, and certain models have come into widespread use in government, academia, industry, and international agencies. Cotton prices are an important concern for cotton farmers, textile mills, and shippers, but there are several factors peculiar to cotton. One is that USDA is legally prohibited from forecasting cotton prices. Another is the long-standing lack of reliable economic information available from China, the country that has come to dominate world consumption and trade in cotton in recent years. Finally, cotton prices have distinctly diverged from relatively long-standing relative price relationships in recent years.

While corn, wheat, soybean, and rice prices have all returned to, or surpassed, the nominal levels they achieved during the 1990's, cotton prices during 2005/06 were about 20 percent below these earlier levels. Furthermore, the economic models developed by USDA and other entities to forecast cotton prices have persistently failed to anticipate the degree to which cotton prices have been below past levels and the levels of competing crops. As first step to revising these models, a careful examination of alternative model specifications is appropriate.

Agricultural Price Forecasting

The world economy is increasingly integrated, and unprocessed agricultural commodities have long been at the forefront of this integration. This suggests that the relationship between U.S. and world prices for cotton might be described by the "Law of One Price" (LOP). At its simplest, the LOP states that the price of a good in various countries is exactly the same after adjusting for the different currencies in these countries. The weak form of the LOP acknowledges that even when two countries have and integrated market for a good, transportation costs and policy differences mean that the good's price in the two countries can be constantly different. The result is that the currency-adjusted prices in the two countries are not necessarily at equal levels, but do adjust to market conditions together. If this were true for cotton prices, it would arguably be an arbitrary choice whether to forecast the price of cotton within the United States or a foreign or world price stated in U.S. dollars.

The price transmission elasticity between world cotton prices (Cotlook's A-Index) and U.S. cotton prices (the National Agricultural Statistical Service's season-average farm price) during 1996/97-2005/06 was not significantly different from 1 at the 5 percent level, so it is appropriate to consider the U.S. cotton market integrated with the world cotton market. However, this relationship did not hold in every year. In 1998/99 U.S. and world prices differed by 19 percent, compared with an average absolute difference in the other years of 3 percent (with a maximum difference of 7 percent). Under certain circumstances, U.S. and world prices can respond differently to developments in cotton supply and demand. Furthermore, the U.S. Step 2 program created a wedge between U.S. and world prices in some years. This program has been terminated by the United States to reach compliance with the findings of a World Trade Organization (WTO) Dispute Settlement Panel. Given this information it is clear there is a need to forecast world and U.S. prices separately. This analysis will concentrate of forecasting world prices (see Meyer, 1998, for discussion of forecasting U.S. cotton prices).

The U.S. cotton market's integration with world cotton markets is effected through trade. This would suggest that prices could be forecast on the basis of either expected U.S. supply and demand or world supply and demand. Trade between the U.S. and the rest of the world would be part of the market equilibrium that determines prices in a given year, so production and consumption shocks outside the United States would be reflected in U.S. stocks as U.S. exports adjusted to these shocks. Strictly speaking however, this equilibrium can be achieved through either actual trade or potential trade. At various times, it has been appropriate that cotton ultimately destined for consumption outside the Untied States be stored either within the United States or in other countries for relatively extended periods to take advantage certain market conditions or government policies. These conditions have changed from year to year, so U.S. and foreign stocks have fluctuated with respect to each other due to circumstances that may not have had significant impact on the level of world prices in these years. This analysis will use world supply and demand to forecast prices, given that the price in question is also a world price.

While the forecasted price is a world price, and the independent variables are also at the global level, the structure of the models examined here is analogous to the structure used by USDA to forecast U.S. domestic prices (e.g. Meyer, Westcott and Hoffman, Plato and Chambers, and Chambers). One difference from these earlier models is the inclusion of an exchange rate variable. While the A-Index is widely quoted in U.S. dollar terms, cotton and cotton-based products are bought and sold throughout the world with prices stated in other currencies. Therefore, the model is specified with supply and demand a function of the A-Index in U.S. dollar terms times an exchange rate index:

$P = \text{A} - \text{Index}$ (Northern Europe cotton price in U.S. dollars)

$e = \text{U.S. exchange rate index}$ (foreign currency units per U.S. dollar)

$P_W = Pe$

$D_W = f(P_W, P_{W,t-1}, Z_D)$ demand function

$S_W = g(P_{W,t-1}, Z_S)$ supply function

$K_W = h(P_W, Z_K)$ stocks function

$0 = S_W - D_W - K_W$ equilibrium condition

$\text{P} = \text{h}^{-1}(K_W, e, Z_K)$ implicit price function

Stocks as a share of use is a variant of this model that is typically applied to forecasting, and is the variant used in this analysis.

Short-term price forecasting can also be accomplished by extending estimated trends and more sophisticated univariate analysis. Alternatively, published futures prices can be used to derive forecasts of future farm and spot prices by forecasting future basis levels to adjust futures prices. While these approaches have their merits, variations of the reduced-form structural approach illustrated above have been preferred by many forecasters. Price forecasting often occurs in the context of expected weather, policy, and demand stocks which may cause prices to diverge from past trends and that may not have been reflected in current futures prices.

Issues Specific to World Cotton Markets

Commodities are differentiated by their physical characteristics, but also by the structure of their markets and role of different institutions in these markets. Two recent developments in world cotton markets suggest technical change may have altered the relationship between cotton prices and the supply and demand for cotton.

One is the widespread adoption of genetically modified (GM) cotton varieties around the world. Starting with the United States late in the 1990's, GM cotton spread quickly to Australia and China. After being adopted in Mexico, South Africa, and to some extent in Argentina, GM cotton has in recent years come to account for 50 to 60 percent of cotton planted in India. With GM cotton now widely adopted in the third largest cotton producing country (China and the United States are the first and second largest), GM cotton came to account of 28 percent of world cotton area, according to the International Service for the Acquisition of Agri-Biotech Applications. Interestingly, soybeans surpass cotton in the global area share attributable to GM varieties (59 percent), but in another important respect cotton has surpassed soybeans, as well as other crops.

GM-cotton adoption is a yield-enhancing development in developing countries due to improved pest management. In the United States, developments like the continued spread of the boll-weevil eradication program and the development of new management techniques has also led to significant yield growth. As a result, a weighted average of the yield indices of the 10 largest cotton producers in the world has realized 31 percent growth since 1997. By comparison, a similar measure of soybean and corn yields grew only 13 percent (Table 1).

It is plausible that the widespread adoption of GM cotton in developing countries, and further technical change in the United States, has lowered the cost of cotton production. This would be consistent with both the behavior of cotton prices and with the persistent over-estimates produced by price forecasting models. It is also consistent with economic theory which indicates that in the absence of market power the price of goods reach equilibrium at their marginal cost of production. Note that this is just a statement of a hypothesis and this study does not address the testing of this hypothesis. In March 2006, the International Cotton Advisory Committee (ICAC) published a review of their forecasting model's performance, and offered other reasons for its over-estimates. The purpose of this study is to explore the best way to devise new cotton price forecasting models in the face of recent changes rather than to determine why older models are no longer adequate.

The ICAC cited changes in China's stockholding behavior as a potential reason for the persistent price forecasting errors. China's role in world cotton markets differs from its role in other commodity markets. While both cotton and soybeans stand out among the major U.S. field crops for the large role international trade plays in consumption, cotton differs from soybeans in the proportion of world consumption accounted for by China. Trade is extremely important to world cotton markets, with 36 percent of world cotton traded across international borders before being consumed. This compares with 13 percent for beef and 21 percent for wheat, but only 8 percent for rice. Soybeans also have about 35 percent of all consumption first crossing international borders.

Interestingly, cotton and soybeans are also similar in that about 15 percent of total world consumption is accounted for by China's imports. However, there are two important differences between these two commodities. One is that China's trade regime is more liberal for soybeans than for cotton, and the other is that China's share of world consumption is much larger for cotton than for soybeans. In 2005/06, about 40 percent of the world's cotton was consumed in China, about twice China's share of world soybean consumption.

Specifying Cotton Price Models

The model $P = h^{-1}(K_W, e, Z_K)$ includes Z_K, exogenous variables affecting demand for stocks. One variable included in a number of cotton price forecasting models is China's net cotton imports. China was until recently a relatively closed economy. An economy's openness is typically equated to the proportion of its economic activity linked to the rest of the world. The ratio of trade to economic activity is a typical metric of these links. Through the 1980's and early 1990's, China's economy was closed in this respect, but was also closed with respect to the transmission of information.

Economic data that was widely disseminated in other countries was officially treated as a state secret in China. This secrecy, combined with other factors, made China's demand for foreign cotton a key variable in the determination of world cotton prices for a number of years. One factor was China's centrally planned economy, which reacted slowly to trends in China's agricultural production. Another factor was China's large population, and the role of textile exports in China's economy during the 1980's. This demand for domestic and exported clothing kept China's demand for cotton relatively stable, while fluctuating production resulted in periodic surpluses and shortages. The secrecy surrounding China's economy meant that world cotton markets had limited information about the likely magnitude or duration of the resulting large swings between net exports and net imports.

Between 1980 and 2000, there was a 74 percent correlation between China's net cotton trade and the A-Index. However, in recent years, China has come to dominate world cotton markets to such an extent that it is difficult to regard any aspect of its behavior as exogenous. China is expected to be a large net importer for the foreseeable future, and the surge in China's imports has coincided with weakness in world cotton prices in recent years. The impact of including or excluding China's net trade in the specification of cotton forecasting models will be examined below.

Another important model specification variation in world cotton price forecasting models concerns the measurement of world stocks. As noted earlier, limitations on information available from China are an issue in world price determination. For many years, the magnitude of China's cotton stocks was regarded by the government there as a a state secret. In recent years, the official desire for secrecy has diminished, and government agencies in China participate in the publication of estimates of China's cotton stocks. However, much uncertainty remains to this date about the supply and demand for cotton in China, and an estimate of historical relationships probably will rely on data from years when China's government suppressed information about its domestic cotton stocks. There, one alternative to a measure of world cotton stocks for K_W in $P = h^{-1} (K_W, e, Z_K)$ is world stocks only outside of China.

Stocks variables in price forecasting models are typically expressed ass a share of consumption. If China's stocks are excluded from the measurement of world stocks, then it seems appropriate that China's consumption be excluded from the world consumption estimate used in the stocks/use ratio. Given the absence of official estimates from China of cotton consumption there, the reasonableness of this approach seems even greater. However, China's cotton consumption is now estimated to account for 40 percent of world consumption. Therefore, excluding China's consumption from a global estimate overlooks some of the most important developments in world cotton markets. The impact of including China's consumption from the world consumption estimates used in ratios of stocks-to-use and use-to-stocks will be examined below.

Another model specification variation that will be examined is the effect of measuring stocks directly or in inverse form. Price levels and ending stock levels are inversely related, which is a non-linear relationship. While it is not widely utilized (MacDonald is one example), use-to-stocks is an alternative expression of K_W that will be examined below.

Finally, trends are often included in models to account for unobservable variables with trends, like technical change. Inflation-adjusted cotton prices have a downward trend, as is the case for most unprocessed commodities, presumably reflecting long-run changes that have reduced the cost of cotton production. Given that cotton prices are hypothesized to have fallen in both the long run and the short run due to technical change, it seems reasonable that a cotton price forecasting model might include a trend among its exogenous variables.

Results

A range of alternative cotton price forecasting models were specified, estimated, and compared for recent forecast accuracy. Models were specified with six alternative measures of ending stocks, K_W:

SUW,	World stocks-to-use
SUWxC,	World minus China stocks divided by world minus China consumption
SUWCC,	World minus China stocks divided by world consumption
USW,	World use-to-stocks
USWxC,	World minus China consumption divided by world minus China stocks
SUWCC,	World consumption divided by world minus China stocks

Models with each alternative K_W was also specified with and without two exogenous variables, Z_K:

NIM,	China's net cotton imports
TREND,	a linear trend.

A cotton-specific exchange rate was included as an exogenous variable in all the models examined (RXR). With all possible exogenous variables the full model examined here was,

$$P = h^{-1} (K_W, RXR, NIM, TREND).$$

After examining the time series properties of the variables, the models were estimated with ordinary least squares (OLS) with 1986-2002 data. Forecasts were generated for 2003-05, and the mean absolute percent errors (MAPE) of the various models compared. Two additional versions of each model were also estimated: one version with 1986-1993 data, and another with 1993-2002 data. The MAPE's of these model's forecasts were compared with each other and the models estimated over the full sample to assess the variation in accuracy over time.

Examination of the time series properties of the A-Index and the independent variables used to forecast it indicates that most of these variables are non-stationary (the null hypothesis of non-stationarity cannot be rejected in the Augmented Dickey-Fuller test), but are stationary in first differences (the data generating processes are generally I(1)). (Table 2) The A-Index is trend stationary at the 10 percent significance level, and USWCC is trend stationary at the 5 percent level. The remaining variants of K_W are not trend stationary.

The only variant of K_W among the variables that are not I(1) are SUW and USW. Interestingly neither RXR nor NIM were I(1), but were I(2). Neither SUW nor USW were I(2). The heterogeneity of the data generating process of these variables could become an issue when developing models based on estimates of the cointegrating vectors and dynamic adjustment parameters between the exogenous variables, prices, and stocks.

The variants of K_W producing the least accurate forecasts were SUW and USW (based on average accuracy across the full set of possible exogenous variables and sample time periods) (Tables 3-6). The most accurate over the full sample (1986-2002) were USWxC and SUWxC, but the most accurate over the recent sample (1993-2002) were USWCC and SUWCC. With respect to the exogenous variables, the least accurate specification estimated over the full sample was to include both NIM and TREND. Generally speaking, accuracy was improved by excluding exogenous variables.

The most accurate specification over the entire sample was

$P = h^{-1}$ (USWCC, RXR).

And the least accurate was

$P = h^{-1}$ (SUW, RXR, NIM, TREND).

The most accurate estimates of all the models were those estimated with 1993-2002 data where K_W equals either USWxC or SUWxC and NIM is excluded. The inclusion of TREND has little impact on the accuracy of these models. During the earlier time period, the greatest accuracy was achieved by excluding TREND, including NIM, and using any variant of world minus China stocks/use or use/stocks. Interestingly, over the full sample, including TREND and excluding NIM reverses the relative accuracy of USWxC and USW: USW and SUW are the most accurate while USWxC and SUWxC are the least accurate..

Conclusions

A comparison of the forecast accuracy of a wide variety of cotton price forecasting models indicates that the preferred world stock variable includes an adjustment to exclude China to some degree. It is difficult to rank the different ways of treating China's consumption in the estimate of K_W based on these results. Given the dynamic nature of world cotton markets, it might seem preferable to emphasize accuracy using more data from a more recent sample, which would suggest the preferred model is $P = h^{-1}$ (USWxC, RXR). However, the difference in accuracy between models with WxC and WCC is not great.. Similarly, this analysis indicates that neither US nor SU are particularly superior to one another. Further testing of more sophisticated models with stocks estimates with or without China's consumption and in either SU or US form seems appropriate. Models with unadjusted stocks estimates should probably not be pursued, and the usefulness of including China's trade or a trend in price forecasting models seems questionable under current circumstances. China's trade was a useful explanatory variable during the 1990's, but this no longer seems to be the case.

References

Chambers, William (2004), *Forecasting Feed Grain Prices in a Changing Environment*, FDS-04F-01, Economic Research Service, U.S. Department of Agriculture.

MacDonald, Stephen (1997), "Forecasting World Cotton Prices," *The Ninth Federal Forecasters Conference—Papers and Proceedings*, National Center for Educational Statistics, U.S. Department of Education.

Meyer, Leslie (1998), "Factors Affecting the U.S. Farm Price of Upland Cotton," *Cotton and Wool Situation and Outlook Yearbook*, CWS-1998, Economic Research Service, U.S. Department of Agriculture.

Plato, G., and W. Chambers, (2004). *How Does Structural Change in the Global Soybean Market Affect the U.S. Price?* OCS-04D-01, Economic Research Service, U.S. Department of Agriculture.

Secretariat of the ICAC, (2006), "Update on the ICAC Price Model," *Cotton: Review of the World Situation*, 59(4): 6-8.

Westcott, P., and L. Hoffman, (1999). *Price Determination for Corn and Wheat: The Role of Market Factors and Government Programs*, TB-1878, Economic Research Service, U.S. Department of Agriculture.

Table 1--Trends in world field crop exporter yields[1]: cotton strongest

	Wheat	Corn	Soybeans	Rice	Cotton
		Index: 1990s average = 100			
Average, 2004-06	109	119	114	113	135

Source: *World Agricultural Supply and Demand Estimates* .
[1]Production-weighted averages of yield indices for top three 2006 exporters.

Table 2--Rejection of H_0 of non-stationarity (1985-2005 sample)

Variable	ADF Test statistic	Prob. value	Constant	Trend	Lags
Real A-Index	3.316	0.09	Yes	Yes	0
Real A-Index	1.351	0.58	Yes	No	0
USW	1.448	0.81	Yes	Yes	2
USWCC	3.688	0.05	Yes	Yes	2
USWCC	1.230	0.64	Yes	No	2
SUW	1.214	0.88	Yes	Yes	2
SUWCC	4.064	0.03	Yes	Yes	2
SUWCC	1.170	0.66	Yes	No	2
NIM	1.509	0.79	Yes	Yes	2
RXR	1.645	0.73	Yes	Yes	2
dNIM	1.306	0.85	Yes	Yes	1
dRXR	3.076	0.14	Yes	Yes	0
ddRXR	3.833	0.05	Yes	Yes	4

Source: Estimated with Eviews 5.0

Table 3--Forecast errors by stocks variable and China trade assumption

Stocks variable	China trade	Error by sample (MAPE): Complete	1990's	2000's
		Percent	Percent	Percent
SUW	No	56	27	35
SUW	Yes	51	23	81
SUWxC	No	61	15	8
SUWxC	Yes	50	11	59
SUWCC	No	22	17	12
SUWCC	Yes	25	11	67
USW	No	51	21	35
USW	Yes	47	18	88
USWxC	No	37	15	6
USWxC	Yes	35	11	60
USWCC	No	15	17	12
USWCC	Yes	22	12	66

Source: Forecast errors in 2003-5 or 1993-5.

Table 4--Forecast errors by stocks variable and China trade assumption (trend included)

Stocks variable	China trade	Error by sample (MAPE): Complete	1990's	2000's
		Percent	Percent	Percent
SUW	No	13	40	57
SUW	Yes	88	38	67
SUWxC	No	48	37	7
SUWxC	Yes	54	42	56
SUWCC	No	21	39	12
SUWCC	Yes	64	43	64
USW	No	16	40	52
USW	Yes	87	39	60
USWxC	No	38	37	6
USWxC	Yes	49	41	60
USWCC	No	18	39	20
USWCC	Yes	63	43	65

Source: Forecast errors in 2003-5 or 1993-5.

Table 5--Average MAPE by stocks variable

Stocks variable	Error by sample (MAPE): Complete	1990's	2000's
	Percent	Percent	Percent
SUW	52	32	60
SUWxC	53	26	32
SUWCC	33	28	39
USW	50	30	58
USWxC	40	26	33
USWCC	30	28	41

Table 6--Average MAPE for models by trade and trend

Variable	Error by sample (MAPE): Complete	1990's	2000's
	Percent	Percent	Percent
China trade	53	28	66
No trade	33	29	22
Trend	47	40	44
No trend	39	17	44
Both	67	41	62
Neither	40	19	18

Estimating Defense-Related Output and Employment

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Introduction

The BLS Office of Occupational Statistics and Employment Projections (OOSEP) prepares biennial projections of the aggregate economy, labor force, and industry and occupational employment. As part of this process, a system of input-output (IO) tables is developed relating industry consumption and production across all sectors. These relationships are projected ten years into the future and used to derive projections of industry output and employment. The most recent projections for 2014 were published in November 2004.

OOSEP's IO system is also used to estimate output and employment related to specific components[1] of final demand[2], such as the Federal Defense component. To do so, requirements tables are derived relating demand for final commodity purchases to the industrial output and employment necessary to satisfy this demand. Using such tables, one can calculate the amount of output and employment generated by a given component of final commodity demand. Estimates of defense-related employment, for example, show the industry employment generated by Federal government spending on defense.

The underlying data for OOSEP's IO system come from the Bureau of Economic Analysis (BEA) of the U.S. Department of Commerce. Every five years, BEA publishes extensively detailed input-output tables that serve as benchmarks for OOSEP's IO system[3]. BEA periodically revises its tables to reflect changes in how it measures the economy. Two recent revisions dealt with the government sector:

1. First, in its 2003 comprehensive revision, BEA explicitly recognized services produced by general government as part of gross domestic product (GDP), thus increasing industry output. Within GDP the addition of these services is offset by the reclassification of general government purchases as intermediate demand[4]. As a result of the offset, GDP does not change.
2. Secondly, in preparation for its 2002 benchmark IO table, BEA announced that it would split the sector Federal general government into Defense and Nondefense sectors[5].

The purpose of this paper is to assess the impact of these BEA revisions on OOSEP's estimates of defense-related output and employment. The paper consists of four parts. First, OOSEP's IO system will be briefly described. Secondly, the analysis methods will be explained. These consist of comparing estimates generated by three IO systems, each reflecting different treatment of government. Third, the impact of BEA's revisions on the underlying IO tables will be identified for each of the three systems. Finally, defense-related output and employment generated for each system will be compared to assess the impacts of BEA's revisions.

OOSEP's IO System

The framework of OOSEP's IO system mirrors that of BEA's, and consists of three base tables. These, in turn, are used to estimate two requirements tables. Here are brief descriptions:

Base tables:

1. Use table: the columns show industry purchases of intermediate inputs by commodity.
2. Final demand table: the columns show commodity purchases by final demand component.
3. Make table: the columns show commodity output by industry.

To estimate employment generated by a final demand component, domestic versions of the use and final demand table are created by removing imports[6]. If

[1] The components of final demand presented in this paper's tables are Personal Consumption Expenditures (PCE), Gross Private Domestic Investment (GPDI), Exports, Imports, Federal Defense, Federal Nondefense, and State & Local.
[2] The terms final demand and gross domestic product both refer to the total market value of all final goods and services produced annually within the United States.
[3] For a description of OOSEP's projections methods, see the BLS website: www.bls.gov

[4] Moulton, Brent R. and Eugene P. Seskin, "Preview of the 2003 Comprehensive Revision of the National Income and Product Accounts", *Survey of Current Business*, June 2003, pages 17-34.
[5] Stanley-Allen, Karla L., Nicholas R. Empey, Douglas S. Meade, Stanislaw J. Rzeznik, Mary L. Streitwieser, and Monica S. Strople, "Preview of the Benchmark Input-Output Accounts for 2002", *Survey of Current Business*, September 2005, pages 66-77.
[6] To create domestic versions of the use and final demand tables, the value of imports for each commodity row is proportionally removed

imports are not removed, the results may overstate estimates of component-related employment by allowing purchases of imports to generate domestic employment.

Once domestic use and final demand tables have been created, two additional tables are derived from the IO system:

4. Total requirements table: relates final commodity purchases to industry output
5. Employment requirements table: relates final commodity purchases to industry employment

Examples of the requirement tables are discussed below.

OOSEP develops its own sectoring plan for each round of projections. These determine the number of final demand components as well as the number of industry and commodity sectors.

Analysis Methods

This paper will examine the impact of two recent BEA revisions on OOSEP's estimates of defense-related output and employment. The first is the explicit recognition of general government services, offset by the reclassification of general government purchases as intermediate demand. The second is the planned split of the existing sector for Federal General Government, into more detailed Federal Defense and Federal Nondefense sectors.

Methods

To assess the impact of the revisions, estimates of defense-related output and employment will be derived from three IO systems. Each incorporates the BEA revisions to varying degrees, and is unique in its treatment of government. Data for all three systems are based on chained 2000 dollars. The three systems are derived under the following conditions:

1) Pre-Revision (1997): This IO system incorporates none of BEA's revisions. These 1997 data were obtained from OOSEP's 2012 projection, published by BLS prior to incorporating any of the revisions.
2) Partial-Revision (1998): This IO system incorporates the first of the two revisions described above: the recognition of general government services, offset by the reclassification of general government purchases as intermediate demand. It does not incorporate the sector change. These 1998 data were obtained from OOSEP's 2014 projections which incorporate the first revision.
3) Full-Revision (1998): This IO system incorporates the first revision, described above, and adjusts the data to approximate the second. Data are for 1998 and were obtained from OOSEP's 2014 projections. These were adjusted to approximate the BEA's anticipated split of the Federal General Government sector into Federal Defense and Federal nondefense sectors.

Limitations

Two major limitations are present. First, the three IO systems are based on different years due to data availability: The 2012 projections, on which the Pre-Revision data are based, are available for 1997, 2001, 2002 and 2012. The 2014 projections, on which the other IO systems were based, are available for 1998 to 2004, and for 2014. An analysis period as close as possible to 1997 was desirable, so that the data reflect the underlying benchmark tables on which they were based. For this reason, 1997 data from the 2012 projections were chosen for the Pre-Revision IO system. For the other two IO systems, 1998 data from the 2014 projections were chosen as these were the closest to 1997 available.

Secondly, the data are based on two different benchmark IOs. The Pre-Revision data are based on a benchmark IO incorporating neither of BEA's revisions. The Partial- and Full-Revision data are based on a benchmark IO which incorporates the first of the two revisions. The use of two benchmark IO systems is critical to understanding this revision; however, other differences between benchmarks may impact the results.

Impact of the Revisions: IO Tables

To illustrate the impact of the BEA's revisions on Federal sectors[7] in the three IO systems, highly aggregated versions of the tables have been prepared. Within each, relevant Federal sectors have been shaded.

Use and Final Demand Tables

The impact of BEA's revisions can be seen in the use and final demand tables for each IO system (table 1).

from all sectors of the use table and all components of final demand, except exports which are assumed to contain no imports.

[7] The Federal sectors are the FGG sector in the Pre- and Partial Revision IO systems; and the sum of Federal Defense and Nondefense in the Full-Revision IO system.

Each final demand table has a Federal Defense and Federal Nondefense column. Within the Federal Defense column, the Federal General Government (hereafter, FGG) row values are lower in Pre-Revision data than in Partial Revision data. This is because the latter reflect BEA's recognition of government services as part of final demand, and consequently have a higher value.

Within the same final demand column, row values other than FGG are higher in Pre-Revision data than in Partial Revision data. This is because the Partial Revision reflects BEA's transfer of government consumption from final demand to the use table. The impact on the use tables can be seen in the shaded FGG industry columns. All column cells outside the FGG row are higher in the Partial-Revision's use table than in Pre-Revision's.

Full-Revision tables also incorporate these revisions. They differ from the Partial-Revision only in the Federal sectors. Full-Revision data are a split between Federal Defense and Federal Nondefense sectors[8], reflecting the second BEA revision described in the introduction.

Domestic versions of the use and final demand tables were used in estimating defense-related employment and output (table 2). The impacts of BEA's revisions are the same for these tables as for those in the previous discussion. For completeness' sake, aggregated make tables are also provided (table 3).

Total Requirements Tables

For each of the three IO systems, total requirements tables were generated. Highly aggregated versions are presented for explanatory purposes (table 4)[9]. These tables relate industry output to final commodity demand. Individual cell values represent the amount of industry output required from the row sector to satisfy a dollars' worth of final commodity demand for the column sector. For example, the Partial-Revision's FGG column has a cell value of 0.250 in the goods-producing row. Given a dollar of defense final demand for FGG, goods-producing industries must produce about 25 cents of output. Column sums are greater than one, because industries produce not only the dollar's worth of output to satisfy final demand, but also the required intermediate inputs.

Impacts of BEA's revisions on the three tables are seen in their Federal columns. The FGG column sum of 1.017 in the Pre-Revision table is less than 60% of the corresponding 1.765 value in the Partial-Revision table. This reflects BEA's shift of consumption from final to intermediate demand: Larger off-diagonal-cells in the Partial-Revision's FGG column spur relatively large production of intermediate inputs in industries other than FGG. The same is true of the off-diagonal cells in the Full-Revision table's Federal Defense column.

Partial- and Full-Revision tables only differ in their Federal sectors. Full Revision data are split between Federal Defense and Federal Nondefense sectors, reflecting the second BEA revision described in the introduction.

Employment Requirements table

The employment requirements table relates final commodity demand to industry employment. It is created by scaling each row of the total requirements table by the ratio of that sector's employment to its output. Highly aggregated employment requirements tables are presented for explanatory purposes (table 5)[10].

Individual cell values in these tables represent the amount of industry employment, in thousands, required by the row sector to satisfy a million dollars' worth of final commodity demand by the column sector. For example, the Partial-Revision's FGG column has a cell value of 1.376 in the goods-producing row. Given a million dollars worth of defense final demand for FGG, goods-producing industries must generate 1,376 jobs in order to satisfy demand. Column sums are greater than one because enough employment must be created to satisfy final demand as well as to produce required intermediate inputs.

The impact of BEA's revisions on the three IO systems is seen in their Federal columns. The FGG column sum of 8.854 in the Pre-Revision table is less than the corresponding 10.635 value in the Partial-Revision table. This reflects BEA's shift of consumption from final to intermediate demand: Larger off-diagonal-cells in the Partial-Revision's FGG column represent the creation of jobs to produce intermediate inputs in industries other than FGG. The same is true of the off-

[8] To obtain the values for the use table's Federal Defense and Federal Nondefense columns, the pattern of corresponding final demand purchases from the Pre-Revision data were applied by row to the corresponding levels of FGG intermediate demand in the Partial-Revision data.

[9] Aggregated versions of total and employment requirements tables will not yield the same results as presented in table 6. These results were created at the full sector order for each of the three IO systems.

[10] See footnote 9.

diagonal cells in the Full-Revision's Federal Defense column.

The Partial- and Full-Revision tables are identical except for their Federal column sectors: the former has a single FGG column, whereas the latter has Federal Defense and Federal Nondefense columns. The Partial-Revision's FGG column sum is higher than the corresponding value in the Full-Revision's table. This is mostly due to the difference in the diagonal coefficients: 4.286 in the former, and 2.088 in the latter.

The smaller Full Revision coefficient results from BEA's sector change. Figure A shows federal employment and output data used to create the employment requirements table. Due to greater sector detail, the Full-Revision IO system splits FGG employment and output between the Federal Defense and Federal Nondefense sectors. This yields a smaller employment-to-output ratio for Federal Defense than that obtained for FGG in the other IO systems. The smaller ratio, in turn, yields the smaller diagonal coefficient. The greater precision of the data used to obtain the Full-Revision's Federal Defense diagonal coefficient should yield more precise estimates of defense-related employment for this industry sector.

Figure A. Industry Employment-Output Ratio

IO SYSTEM	Industry Sector	Emp.	Output	Employment-Output Ratio
Pre-Revision, 1997	Fed. General Gov't	1.8	208.7	0.009
Partial-Revision, 1998	Fed. General Gov't	1.8	414.5	0.004
Full-Revision, 1998	Fed. Defense	0.6	263.7	0.002
	Fed. Nondefense	1.2	150.9	0.008

Impact of the Revisions: Defense-Related Output and Employment

Estimates of defense-related output and employment are presented for each of the three IO systems (table 6). For each system, Federal Defense final demand is also reproduced.

Defense-Related Output

Compared to the Pre-Revision estimate, aggregate defense-related industry output increases by nearly a third in the Partial- and the Full-Revision estimates. The change occurs in the Federal sectors and is attributable to BEA's recognition of government services as output. The Partial- and Full-Revision estimates include this additional output in the Federal sectors, whereas the Pre-Revision value does not.

For industries outside the Federal sectors, there is less difference between Pre- and Full-Revision estimates than between Pre- and Partial-Revision estimates. Across the three IO systems, the differences between these non-Federal sectors are largely definitional: they mostly result from the reclassification and the sector change. Hence, one would expect results for the non-Federal sectors from the Partial- and Full-Revision IO systems to resemble those of the Pre-Revision system. Because the Full-Revision results are closer to the Pre-Revision's, they appear more reasonable.

The Full-Revision results are closer because this system's use table has a greater level of sector detail than does the Partial-Revision's. The Partial-Revision has only a single federal column in its use table, the FGG column. When federal consumption data were moved from final demand to this column, per BEA's reclassification, the distinction between Federal Defense and Federal Nondefense values was lost. As a result, the Partial-Revision total requirements table distorts estimates of defense-related output. It is not until the Full-Revision splits the use table's FGG sector into Federal Defense and Federal Nondefense sectors that the sector detail is restored.

Defense-Related Employment

The Partial-Revision's estimate of aggregate defense-related employment is nearly identical to that generated by the Pre-Revision IO. However, the Full-Revision IO yields an aggregate defense-related employment figure that is about one-fifth lower than the Pre-Revision estimate. Most of the decline is in Federal employment, calculated as the sum of Federal Defense and Federal Nondefense employment. This lower level of Federal employment appears to be a more reasonable estimate than the higher FGG results in the other two IO systems.

The employment estimate for the Federal sectors appears more reasonable because its calculation was carried out with more precise data. The splitting out of the Federal Defense sector in the Full-Revision IO system allows use of more precise employment and output data when creating the employment requirements tables. This increased precision prevents the relatively larger Federal Nondefense employment from inflating the estimates of defense-related employment. The Pre- and Partial-Revision IO systems lack this sector detail, and hence, also lack the data precision. As a result, their estimates overstate defense-related employment in the FGG industry.

Employment estimates for industries outside the Federal sector also appear more reasonable in the Full-Revision results. Across the three IO systems, the differences between these non-Federal sectors are largely definitional: they mostly result from the reclassification and the sector change. Hence, one would expect results for these sectors from the Partial- and Full-Revision IO systems to resemble those of the Pre-Revision system. Because these Full-Revision results are closer to the Pre-Revision's, they appear more reasonable. As with estimates of defense-related output, this improvement results from the greater level of sector detail in the Full Revision's IO system.

Conclusions:

The impact of two BEA revisions on OOSEP estimates of defense-related output and employment have been assessed in this paper. These two revisions are:

1. The recognition of services produced by general government as part of final demand, offset by the reclassification of general government purchases as intermediate demand.
2. Splitting the sector covering Federal general government into Defense and Nondefense sectors.

The first revision has two major impacts on Partial-Revision estimates of defense-related output. First, the recognition of government services increases the aggregate estimate due to increased output in FGG. Second, the reclassification of consumption expenditures as intermediate demand distorts the estimates for industries outside the Federal sectors. This results from a loss of sector detail: in the transfer of consumption expenditures from the final demand table to the use table, the distinction between Federal Defense consumption and Federal Nondefense consumption disappears. In terms of defense-related employment, the Partial-Revision's results are similarly distorted for industries outside the Federal sector. This is also due to a loss of sector detail when the consumption expenditures are reclassified as intermediate demand and consequently transferred to the use table.

The revisions have two major impacts on Full-Revision estimates. The first is the increase in defense-related output, due to increased output in FGG. Secondly, defense-related employment in the Federal sector decreases. This result appears reasonable. Analysis shows that the lack of sector detail in the Partial-Revision IO system leads to an overestimation of Federal employment in the FGG sector.

Full-Revision estimates of defense-related output and employment for industries outside the Federal sector appear more reasonable than Partial-Revision estimates. The increased sector detail of the Full-Revision IO system produces results which are closer to those produced prior to the BEA revision's than are the estimates produced in the Partial-Revision system. As the major factors impacting estimates for these sectors are definitional, one would expect the results to resemble those produced prior to the BEA's revisions.

Table 1. Use and Final Demand Tables
Billions of chain-weighted 2000 dollars

INDUSTRIES | SPENDING CATEGORIES

Pre-Revision, 1997

	USE TABLE: Intermediate Demand	Goods-Producing	Trade & Trans.	Service-producing, exc. Gov't	Federal General Gov't	Other
COMMODITIES	Goods-producing	2,015.6	175.1	459.7	0.7	89.8
	Trade & transportation	434.1	149.6	162.4	0.2	24.5
	Service-producing, exc. Gov't	706.0	529.4	1,507.3	1.3	79.5
	Fed. General Gov't	0.0	0.0	0.0	0.0	0.0
	Other	43.7	33.6	64.1	0.0	3.1

FINAL DEMAND TABLE	PCE	GPDI	Exports	Imports	Federal Defense	Federal Nondefense	State & Local
Goods-producing	1,015.1	1,126.5	627.1	-963.0	86.3	31.7	256.1
Trade & transportation	944.8	129.5	138.1	9.4	10.5	3.9	28.7
Service-producing, exc. Gov't	2,866.8	187.4	121.1	-17.0	50.8	50.1	13.7
Fed. General Gov't	0.0	0.0	0.0	0.0	128.3	75.9	0.0
Other	599.9	-47.7	95.8	-125.0	71.8	20.2	627.5

Partial-Revision, 1998

	USE TABLE: Intermediate Demand	Goods-Producing	Trade & Trans.	Service-producing, exc. Gov't	Federal General Gov't	Other
COMMODITIES	Goods-producing	2,073.6	176.2	542.7	68.7	223.3
	Trade & transportation	485.5	153.1	194.1	11.0	62.3
	Service-producing, exc. Gov't	739.8	483.9	1,870.8	99.6	319.4
	Fed. General Gov't	0.0	0.0	0.0	0.0	0.0
	Other	39.7	32.9	69.9	14.8	9.9

FINAL DEMAND TABLE	PCE	GPDI	Exports	Imports	Federal Defense	Federal Nondefense	State & Local
Goods-producing	1,126.6	1,260.9	522.0	-946.6	36.4	21.3	181.8
Trade & transportation	1,054.2	127.0	129.2	7.4	2.3	0.9	5.1
Service-producing, exc. Gov't	3,239.1	221.5	133.5	-20.2	6.8	9.2	8.1
Fed. General Gov't	0.0	0.0	0.0	0.0	258.5	147.4	0.0
Other	726.9	-72.9	113.8	-146.3	61.4	17.1	868.1

Full-Revision, 1998

	USE TABLE: Intermediate Demand	Goods-Producing	Trade & Trans.	Service-producing, exc. Gov't	Federal Defense	Federal Nondefense	Other
COMMODITIES	Goods-producing	2,073.6	176.2	542.7	54.6	14.1	223.3
	Trade & transportation	485.5	153.1	194.1	8.1	3.0	62.3
	Service-producing, exc. Gov't	739.8	483.9	1,870.8	55.4	44.2	319.4
	Federal Defense	0.0	0.0	0.0	0.0	0.0	0.0
	Federal Nondefense	0.0	0.0	0.0	0.0	0.0	0.0
	Other	39.7	32.9	69.9	11.2	3.5	9.9

FINAL DEMAND TABLE	PCE	GPDI	Exports	Imports	Federal Defense	Federal Nondefense	State & Local
Goods-producing	1,126.6	1,260.9	522.0	-946.6	36.4	21.3	181.8
Trade & transportation	1,054.2	127.0	129.2	7.4	2.3	0.9	5.1
Service-producing, exc. Gov't	3,239.1	221.5	133.5	-20.2	6.8	9.2	8.1
Federal Defense	0.0	0.0	0.0	0.0	258.5	0.0	0.0
Federal Nondefense	0.0	0.0	0.0	0.0	0.0	147.4	0.0
Other	726.9	-72.9	113.8	-146.3	61.4	17.1	868.1

Table 2. Domestic Use and Final Demand Tables
Billions of chain-weighted 2000 dollars

INDUSTRIES — SPENDING CATEGORIES

Pre-Revision, 1997

	USE TABLE: Intermediate Demand	Goods-Producing	Trade & Trans.	Service-producing, exc. Gov't	Federal General Gov't	Other
COMMODITIES	Goods-producing	1,629.5	147.5	385.8	0.6	78.7
	Trade & transportation	431.2	148.2	159.7	0.2	24.2
	Service-producing, exc. Gov't	704.1	527.7	1,502.0	1.3	79.0
	Fed. General Gov't	0.0	0.0	0.0	0.0	0.0
	Other	43.7	33.6	64.1	0.0	3.1

FINAL DEMAND TABLE	PCE	GPDI	Exports	Imports	Federal Defense	Federal Nondefense	State & Local
Goods-producing	809.9	984.0	535.9	2.4	76.2	28.9	241.4
Trade & transportation	941.1	129.2	136.0	23.2	10.3	3.9	28.5
Service-producing, exc. Gov't	2,861.1	186.7	120.7	0.0	50.6	49.9	13.2
Fed. General Gov't	0.0	0.0	0.0	0.0	128.3	75.9	0.0
Other	599.9	-47.7	95.8	-125.0	71.8	20.2	627.5

Partial-Revision, 1998

	USE TABLE: Intermediate Demand	Goods-Producing	Trade & Trans.	Service-producing, exc. Gov't	Federal General Gov't	Other
COMMODITIES	Goods-producing	1,693.2	148.2	453.2	56.1	193.9
	Trade & transportation	484.4	152.7	193.9	11.0	62.1
	Service-producing, exc. Gov't	738.0	482.6	1,865.8	99.3	318.4
	Fed. General Gov't	0.0	0.0	0.0	0.0	0.0
	Other	39.7	32.9	69.9	14.8	9.9

FINAL DEMAND TABLE	PCE	GPDI	Exports	Imports	Federal Defense	Federal Nondefense	State & Local
Goods-producing	894.2	1,101.7	522.0	1.0	30.3	19.1	174.2
Trade & transportation	1,053.6	126.9	129.2	9.9	2.3	0.9	5.1
Service-producing, exc. Gov't	3,235.4	220.5	133.5	-5.9	6.8	9.2	8.0
Fed. General Gov't	0.0	0.0	0.0	0.0	258.5	147.4	0.0
Other	726.9	-72.9	113.8	-146.3	61.4	17.1	868.1

Full-Revision, 1998

	USE TABLE: Intermediate Demand	Goods-Producing	Trade & Trans.	Service-producing, exc. Gov't	Federal Defense	Federal Nondefense	Other
COMMODITIES	Goods-producing	1,693.2	148.2	453.2	44.2	11.9	193.9
	Trade & transportation	484.4	152.7	193.9	8.0	3.0	62.1
	Service-producing, exc. Gov't	738.0	482.6	1,865.8	55.2	44.1	318.4
	Federal Defense	0.0	0.0	0.0	0.0	0.0	0.0
	Federal Nondefense	0.0	0.0	0.0	0.0	0.0	0.0
	Other	39.7	32.9	69.9	11.2	3.5	9.9

FINAL DEMAND TABLE	PCE	GPDI	Exports	Imports	Federal Defense	Federal Nondefense	State & Local
Goods-producing	894.2	1,101.7	522.0	1.0	30.3	19.1	174.2
Trade & transportation	1,053.6	126.9	129.2	9.9	2.3	0.9	5.1
Service-producing, exc. Gov't	3,235.4	220.5	133.5	-5.9	6.8	9.2	8.0
Federal Defense	0.0	0.0	0.0	0.0	258.5	0.0	0.0
Federal Nondefense	0.0	0.0	0.0	0.0	0.0	147.4	0.0
Other	726.9	-72.9	113.8	-146.3	61.4	17.1	868.1

Table 3. MakeTables
Billions of chain-weighted 2000 dollars

Pre-Revision, 1997

	MAKE	COMMODITIES Goods-Producing	Trade & Trans.	Service-producing, exc. Gov't	Federal Gov't	Other
INDUSTRIES	Goods-producing	4,822	41	38	0	4
	Trade & transportation	22	1,946	144	0	0
	Service-producing, exc	28	33	5,829	0	2
	General Fed. Gov't	0	0	4	204	0
	Other	47	16	81	0	1,381
	VALUE ADDED	0	0	0	0	0

Partial-Revision, 1998

	MAKE	COMMODITIES Goods-Producing	Trade & Trans.	Service-producing, exc. Gov't	Federal Gov't	Other
INDUSTRIES	Goods-producing	5,164	44	40	0	4
	Trade & transportation	24	2,133	162	0	0
	Service-producing, exc	33	38	6,606	0	3
	General Fed. Gov't	2	0	7	406	0
	Other	65	18	296	0	1,729
	VALUE ADDED	0	0	0	0	0

Full-Revision, 1998

	MAKE	COMMODITIES Goods-Producing	Trade & Trans.	Service-producing, exc. Gov't	Federal Defense	Federal Nondefense	Other
INDUSTRIES	Goods-producing	5,164	44	40	0	0	4
	Trade & transportation	24	2,133	162	0	0	0
	Service-producing, exc	33	38	6,606	0	0	3
	Federal Defense	1	0	4	258	0	0
	Federal Nondefense	1	0	3	0	147	0
	Other	65	18	296	0	0	1,726
	Value Added	0	0	0	0	0	0

Table 4. Domestic Total Requirements Table

Relates industry output to final commodity demand

Pre-Revision, 1997

		FINAL COMMODITY DEMAND				
		Goods-Producing	Trade & Trans.	Service-producing, exc. Gov't	Federal General Gov't	Other
RELATED INDUSTRY OUTPUT	Goods-producing	1.515	0.185	0.152	0.005	0.089
	Trade & transportation	0.163	1.064	0.087	0.002	0.030
	Service-producing, exc. Gov't	0.344	0.397	1.325	0.010	0.093
	Fed. General Gov't	0.000	0.000	0.001	1.000	0.000
	Other, exc scrap	0.036	0.038	0.037	0.000	1.006
	Column sums	2.057	1.676	1.604	1.017	1.215

Partial-Revision, 1998

		Goods-Producing	Trade & Trans.	Service-producing, exc. Gov't	Federal General Gov't	Other
RELATED INDUSTRY OUTPUT	Goods-producing	1.488	0.169	0.161	0.250	0.167
	Trade & transportation	0.167	1.056	0.092	0.075	0.061
	Service-producing, exc. Gov't	0.332	0.340	1.325	0.379	0.243
	Fed. General Gov't	0.001	0.000	0.001	1.000	0.000
	Other, exc scrap	0.048	0.044	0.078	0.061	1.023
	Column sums	2.035	1.611	1.658	1.765	1.493

Full-Revision, 1998

		Goods-Producing	Trade & Trans.	Service-producing, exc. Gov't	Federal Defense	Federal Nondefense	Other
RELATED INDUSTRY OUTPUT	Goods-producing	1.488	0.169	0.161	0.295	0.172	0.167
	Trade & transportation	0.167	1.056	0.092	0.082	0.062	0.061
	Service-producing, exc. Gov't	0.332	0.340	1.325	0.353	0.426	0.243
	Federal Defense	0.000	0.000	0.001	1.000	0.000	0.000
	Federal Nondefense	0.000	0.000	0.001	0.000	1.000	0.000
	Other, exc scrap	0.048	0.044	0.078	0.067	0.051	1.023
	Column sums	2.035	1.611	1.658	1.797	1.710	1.493

Table 5. DomesticEmployment Requirements Table
Relates industry employment to final commodity demand

Pre-Revision, 1997

		FINAL COMMODITY DEMAND				
		Goods-Producing	Trade & Trans.	Service-producing, exc. Gov't	Federal Gov't	Other
RELATED INDUSTRY EMPLOYMENT	Goods-producing	8.824	1.077	0.887	0.031	0.519
	Trade & transportation	1.987	12.983	1.061	0.024	0.364
	Service-producing, exc. Gov't	3.589	4.142	13.830	0.099	0.976
	Fed. General Gov't	0.003	0.002	0.008	8.694	0.001
	Other, exc scrap	0.418	0.443	0.430	0.005	11.770
	Column sums	14.822	18.647	16.215	8.854	13.631

Partial-Revision, 1998

		FINAL COMMODITY DEMAND				
		Goods-Producing	Trade & Trans.	Service-producing, exc. Gov't	Federal Gov't	Other
RELATED INDUSTRY EMPLOYMENT	Goods-producing	8.192	0.933	0.885	1.376	0.920
	Trade & transportation	1.886	11.933	1.041	0.844	0.686
	Service-producing, exc. Gov't	3.152	3.236	12.595	3.606	2.306
	Fed. General Gov't	0.004	0.002	0.006	4.286	0.001
	Other, exc scrap	0.410	0.382	0.671	0.524	8.798
	Column sums	13.644	16.485	15.198	10.635	12.712

Full-Revision, 1998

		FINAL COMMODITY DEMAND					
		Goods-Producing	Trade & Trans.	Service-producing, exc. Gov't	Federal Defense	Federal Nondefense	Other
RELATED INDUSTRY EMPLOYMENT	Goods-producing	8.192	0.933	0.885	1.622	0.945	0.920
	Trade & transportation	1.886	11.933	1.041	0.925	0.702	0.686
	Service-producing, exc. Gov't	3.152	3.236	12.595	3.355	4.044	2.306
	Federal Defense	0.001	0.000	0.002	2.088	0.001	0.000
	Federal Nondefense	0.003	0.001	0.005	0.001	8.126	0.001
	Other, exc scrap	0.410	0.382	0.671	0.574	0.436	8.798
	Column sums	13.644	16.485	15.198	8.565	14.253	12.712

Table 6. Federal Defense Final Demand and Related Output and Employment

	Pre-Revision, 1997	Partial-Revision, 1998	Full-Revision, 1998
Federal Defense Final Demand, domestic			
Billions of chain-weighted 2000 dollars			
COMMODITIES			
Goods-producing	76.2	30.3	30.3
Trade & transportation	10.3	2.3	2.3
Service-producing, exc. Gov't	50.6	6.8	6.8
Federal General Gov't	128.3	258.5	na
Defense	na	na	258.5
Nondefense	na	na	0.0
Other	71.8	61.4	61.4
Aggregate	337.2	359.2	359.2
Defense-related industry ouput			
Billions of chain-weighted 2000 dollars			
INDUSTRIES			
Goods-producing	123.4	109.4	121.9
Trade & transportation	28.4	25.1	27.1
Service-producing, exc. Gov't	90.9	111.9	103.9
Federal General Gov't	128.6	259.0	na
Defense	na	na	258.8
Nondefense	na	na	0.2
Other	66.9	68.4	66.8
Aggregate	438.2	573.8	578.6
Defense-related industry employment			
Thousands of jobs			
INDUSTRIES			
Goods-producing	695.4	578.4	632.0
Trade & transportation	223.1	212.4	225.3
Service-producing, exc. Gov't	845.5	916.4	887.1
Federal General Gov't	1,118.3	1,109.4	na
Defense	na	na	540.1
Nondefense	na	na	1.5
Other	45.3	125.0	99.6
Aggregate	2,927.7	2,941.6	2,385.6

The Effects of Foreign Trade on Employment

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We are in the age of globalization—markets have become globalized, customer bases have been expanded around the world, and corporate entities have transcended geographic and political boundaries. Over the past two decades, this growing economic interdependence of countries, companies, and customers, has resulted in an increasing volume and variety of cross-border transactions in goods and services, less restricted international capital flows, and the more rapid and widespread diffusion of technology. This phenomenon has become increasingly more important for U.S. economic activity. As a plus for American workers, an increasingly larger share of goods and services produced in the U.S. is now exported. As a plus for American consumers, on the other hand, there are a greater variety of imported goods and services to buy. (The integration of the U.S. can also be viewed from the perspective of outsourcing, as production processes are accomplished abroad and then combined with domestic production activity.)

To examine the effects of expanding foreign trade on the U.S. economy, this article focuses on shifting trade flows and related changes in employment levels in all industries of the U.S. economy. Using the historical data and the most recent U.S. economic and employment projections to 2014 developed by the Bureau of Labor Statistics,[1] trade-related jobs by industry are compared for the 1998-2004 and the 2004-2014 periods, and conclusions are drawn regarding the impacts of accelerating globalization on the U.S. economy. The number and types of jobs dependent on foreign trade are estimated in the context of an input-output system that enables one to trace the purchases of goods or services through the entire production chain.

Factors affecting trade-related demand on employment

Changes in the level of foreign trade and productivity changes. Changes in employment attributable to exports result from the interaction of several influences. As the volume of exports expands, export employment will increase if all other factors remain unchanged. However, gains in labor productivity in export industries will offset increases in export-related employment as labor requirements per unit of output decrease.

Over the 1998-2004 period, U.S. productivity grew dramatically. Continuous gains in productivity have been a major element in maintaining or reducing costs and permitting an improvement in the U.S. competitive position in foreign trade growth. Between 1998 and 2004, the value of exports in real terms rose 2.5 percent per year, however, the employment generated by exports dropped from 8.7 million in 1998 to 7.5 million in 2004. In addition, export related employment accounted for 6.3 percent of total domestic employment in the economy in 1998, but dropped to 5.2 percent in 2004. During the same period, productivity growth was 4.9 percent. Over the next 10 years, the recent surge in productivity growth is projected by BLS to settle into a more sustainable rate of 2.5 percent each year between 2004 and 2014. Exports are estimated to grow by 6.7 percent annually over the same period. By 2014, export-related employment is expected to reach 11.3 million, representing a 7.0-percent share of total domestic employment and an increase of 3.8 million jobs over this 10-year period.

Changing industry composition and commodity mix. Another key factor affecting the export-employment estimates is the change in industry distribution of exports, because the estimates include both the direct (primary) and indirect employment effects. Due to technology changes, the changes in the exports of one industry may have a significant effect on several other industries for materials and services. For example, the automobile industry substitutes the use of plastics for steel, indirect steel employment generated by automobile exports may be decreased while that for plastics may be increased. An equally important factor is the change in commodity distribution of exports that will also affect export related employment.

High import penetration rate. Import penetration, the import share of an industry's total output, shows to what degree domestic demand for goods and services is satisfied by imports. Since 1990s, a strong demand for competitive imported goods reflect the higher wage rates in the U.S. and their effect on U.S. companies' ability to compete in the world market. Because purchases of imports do not generate jobs at home, the result of intense import competition is expected to continue to play a negative role in determining an individual industry's employment. It is also unknown whether outsourcing abroad, particularly of activities previously considered immune to foreign competition, is playing a positive role in this overall reorganization of work, but globalization will continue to be a force of economic change.

Data

This analysis is based on industry-level data for both exports and imports of goods and services, labor productivity, and employment. Historical data were developed for the years 1998 to 2004 and projections were carried out to 2014. Annual export and import merchandise data were initially obtained from the Commerce Department's Trade Policy Information System (TPIS). The trade data are classified by using the North American Industry Classification System (NAICS) codes and also on the basis of the descriptions of the items in question. At times, both the lack of a NAICS specification and an inadequate description of the product occur, in which case judgmental analysis must be relied upon to classify the product to the correct industry. For services, the main set of data is provided by the Bureau of Economic Analysis (BEA) of the Department of Commerce. The trade data were then distributed across 200 industries based on the historical input-output table prepared by BEA.

Methods

Estimates of employment related to foreign trade are developed within an input-output framework. The input-output table traces the flows of goods and services throughout the U.S. economy, among industries and as sales to final users, primarily as a function of the input-output matrix of technical coefficients and the level and distribution of GDP. By tracing the purchase of a good or service through the entire chain of production, the employment required in each industry to produce that good or service can be measured.

The transition from production in the input-output tables to employment is accomplished by deriving a total requirements table from the use and the make tables. The total requirements table shows the total production requirements necessary to support a dollar of final demand, or as in this case, exports. The measure of a total requirements table includes both direct and indirect input requirements to production. For example, automobiles are produced in the automobile industry, but through the entire production chain, inputs such as steel and plastics are produced in the steel industry and plastics industry to support that producing industry.

After the total requirements table is generated, it is scaled by the employment-output ratio and transformed to show the employment required per dollar of demand. This result, known as an employment requirements table—the heart of this analysis, demonstrates how industry interrelationships in the economy affect employment. It should be noted that this study focuses on domestic employment generated by exports, therefore, the total requirements table is adjusted by excluding the import vector among final users and industries.[2] Also, the analysis in this article focuses specifically on foreign trade during the selected years—1998, 2004, and 2014. The employment resulting from foreign trade activities has been calculated by multiplying the annual employment requirements table by the foreign trade column of the appropriate year.

U.S. exports and imports projections, 2004-2014

The Bureau's projections of exports and imports are displayed in table 1. From 2004 to 2014, both exports and imports are projected to increase their individual shares of total GDP. The export share of total GDP is expected to increase from 10.0 percent in 2004 to 13.7 percent in 2014, while the import share of total GDP is expected to rise at a somewhat lower rate from 15.2 percent in 2004 to 17.9 percent in 2014. However, even though exports are expected to grow faster than imports, the trade deficit in 2014, although somewhat smaller than in 2004, is expected to remain. Behind these expectations lie expectations of a growth of GDP, that from 1998 to 2004 was supported by a solid growth of average industry productivity. These high rates of industry productivity growth, however, may not continue through 2014. Over the next decade, imports are projected to be contained by an expected adjustment of the presently overvalued US dollar. These assumptions thus, will allow the exports to grow at a slightly faster rate than imports, which would yield a lower trade deficit than the one currently prevailing.

Individual industries with the fastest growth rates of exports and imports

Individual industries with the fastest growth rates of exports are given in table 2. Most of the exported items are from industries considered to be 'modern', indicating from the traditional trade perspective that the U.S has a comparative advantage in producing them. The fastest and most impressive was the growth rate of exports of the computers and peripheral equipment industry, which averaged 19.6 percent annually over the 1998-2004 period. Possibly the exception regarding more traditional industries may rest with the fabric mills industry which showed a high annual average growth rate of exports of 8.1 percent over the 1998-2004 period.

Likewise, in the case of imports given in table 3, as expected by the traditional economic theory, the coal mining industry, another 'traditional' industry, had a high rate of annual growth of imports of 20.9 percent for the 1998-2004 period. Over the same period, however, imports from industries, such as computers and peripheral equipment grew annually by 21.5 percent, pharmaceuticals and medicine by 17.2 percent, and communications equipment by 16.7 percent, respectively. In economics literature, these 'newest developments in foreign trade' appear to be related to the issue of multinational corporations and how their presence affects U.S. foreign trade. For instance, U.S. investment in China supports the creation of U.S. affiliates, which then sell in China and to other countries, including the United States. In fact, the value of U.S. affiliate sales in China has exceeded the value of U.S. exports to China since 2002.[3]

Export related employment by major sector and by industry

A more complete picture of foreign trade is given in tables 4 and 5 in which we view the issue of export related employment as a share of total industry employment. (See the methodology section for a more detailed discussion). From table 4, a slight decline in export related employment can be observed in all the sectors during the 1998-2004 period, possibly due to rapid productivity growth and the exchange rate overvaluation.[4] The rapid gains in productivity have begun to slow since the third quarter of 2004, as the U.S. economy shifted into a new phase of steady expansion. This indicates that productivity gains maybe settling into more sustainable rates and will be less robust in the future. As noted earlier, all industrial sectors' export related employment is expected to rise by 2014.

In table 5, we examine the export related employment by industry given as a percent of total industry employment. The last four industries shown in the table, especially those of computers and peripheral equipment, and pharmaceutical and medicine manufacturing, have a very low export employment ratio to overall industry employment when compared with the first four industries. Thus, the audio and video equipment industry, one of the first four industries in table 5, is showing a high share of 70.8 percent of it's export employment to total industry employment ratio in 2004, indicating a much higher sensitivity to foreign trade than the computers and peripheral equipment industry which in 2004 had a low export employment ratio to overall industry employment of 18.8 percent.

The BLS 2004-2014 projections do not foresee any dramatic rise in the share of exports in total final demand either for the computers and peripheral equipment or for the pharmaceutical and medicine industries. In fact, for the computers and peripheral equipment industry, an even lower ratio is projected for 2014. The opposite is seen as likely for the audio and video equipment industry, for which the share of export employment over total industry employment is expected to be 96.4 percent in 2014, which is likely to make the industry even more foreign trade sensitive.

Industry's import penetration rate—import sensitivity

Using BLS data, one may calculate an industry's foreign trade sensitivity more precisely by calculating each industry's import penetration rate that is defined at BLS as the ratio between industry imports and total domestic supply.[5] If this ratio is relatively high for certain industries, those industries could be labeled as 'overpowered by foreign competition'. In table 6 one can observe the relatively 'modern' industry of computers and peripheral equipment as having a relatively low import penetration rate of 42 percent in 2004. Conversely, another 'modern' industry of audio and video equipment, due to fierce foreign competition, displayed a high import penetration rate of 83.0 percent in 2004.

Particularly the 'traditional' industries in the U.S.--like footwear, apparel, and leather products show how vulnerable they may be from imports. Thus, the footwear industry's import penetration ratio amounted to 89.2 percent in 2004 and is projected to reach 92.9 percent in 2014. Likewise, another 'traditional' industry of cut and sew apparel showed a slightly lower import penetration rate of 64.8 percent in 2004, and is projected, due to international trade expectations, to reach 81.5 percent in 2014.

Growth of productivity by industry

Growth of productivity is a must for both modern industries oriented towards exports almost by definition as well as for those traditional ones, not favored by the comparative advantage principle but which need to survive. In principle, productivity changes allow firms to be more competitive, by keeping the growth of prices in check. Table 7 presents U.S. industries' annual productivity growth data, where productivity is defined as output over hours worked.

A number of traditional industries are experiencing productivity growth higher than average. Thus, from 1998 to 2004, industries like apparel knitting mills, cut and sew apparel, footwear, and other leather and allied products experienced high annual productivity growth rates of 11.3 percent, 12.1 percent, 11.4 percent, and 8.4 percent, respectively. On the other hand, computers and peripheral equipment, a more modern industry also experienced a high annual productivity growth rate of 21.5 percent from 1998 to 2004, and is expected to grow at an annual rate of over 25 percent between 2004 and 2014.

However, the productivity growth rates for the above mentioned traditional industries like cut and sew apparel and footwear are expected to grow much slower over the next 10 years-at annual average rates of 5.2 percent and 1.9 percent, respectively. It suggests in a way that the U.S. does not have a comparative advantage in exporting these goods and it is hard to keep the high rates of productivity growth as prevailed during 1998-2004.

New advances in foreign trade

What we have offered so far is a glimpse of issues in foreign trade considered in the process of industry projections at BLS. Advances in foreign trade have markedly raised the productivity in the world economy by lowering the costs of production for many firms. These changes have affected the overall market structure and have also brought about a rise in market sensitivity that has been exemplified in the following issues: a) direct (primary) and indirect employment, b) multinational corporations, and c) outsourcing. It appears that on all three issues there is going to be a lot of work and speculation in the coming years due to the issues' significance.

Measuring Direct (primary) and indirect export employment at BLS. By using an input-output table expressed in terms of employment requirements, one can obtain a demand distribution translated into direct and indirect employment requirements at the industry level**.** Direct employment relates to the employment generated by the exporting industry, while indirect export employment may be defined as the number of jobs in a given industry necessary to produce the goods and services incorporated in the exports of all other industries.

The estimate of the share of direct export employment in total export employment has roughly remained the same over the years. In 2004, about 42 percent of all export jobs were considered direct export jobs, while 58 percent were indirect jobs. In 2014, we expect that direct export jobs will decline slightly to 39 percent. Table 8 gives a view of direct employment on an industry basis. The highest ratios of direct to total industry export employment for 2004 were calculated for aerospace, medical equipment, and pharmaceutical and medicine industries, representing 95.7 percent, 93.7 percent, and 94.4 percent, respectively. The high direct employment ratios for these industries may indicate that these industries may not be in a position to change the way they produce their products, and that they will probably escape a possible industry tendency toward vertical integration—an important benefit in reducing cost by bringing the mode of production closer to the production of scale. Thus, a possible decline in the ratio of direct to total employment in a certain industry is an important indicator of viewing the organizational changes of industries.

*Multinational corporations***.** Multinational corporations also raise a set of interesting questions regarding export and import projections. It is claimed in literature that U.S. exports and imports of goods in 2003 associated with U.S. parent companies, their foreign affiliates, and U.S. affiliates of foreign companies totaled nearly $1.2 trillion and accounted for more than half of U.S. imports and over two-thirds of U.S. exports. Nevertheless, it is not clear what the impact of overseas investment by multinationals on total U.S. trade or the U.S. trade balance is.[6] Also, several studies have concluded that the bulk of multinationals' investment is horizontal in nature and is also the strongest force driving foreign direct investment.[7] On the other hand, recent studies have also suggested that vertical integration and access to low cost foreign labor may be gaining in importance.[8]

Lastly, the issues regarding technology transfers are very hard to define and measure in the case of multinationals. A technology transfer may occur simply by an employee traveling to an overseas affiliate and discussing technology or through a series of E-mails rather than through an explicit royalty or licensing payment that would show up in companies' financial accounting statements or foreign direct investment operations reports.[9] Studies also suggest that output in both the home and host countries is positively correlated with new direct investments, and that foreign direct investment may lead to knowledge 'spillovers' with other firms in the host economy. Hence, the impact on host and home country employment from new direct investments is unclear.[10]

Outsourcing. The role of outsourcing is seen as a way to increase the productivity of the firm by raising its competitiveness, which is accomplished by throwing away the repetitive tasks of the production process and giving them to the foreign firms. In literature, this process has been seen as a phenomenon of vertical specialization, where the vertical trading chains stretch across many countries, with each country specializing in a particular stage of production, rather than manufacturing final goods from start to finish.[11] What this means is that foreign country sales may not necessarily reflect some changing framework of world trade where the 'old' economic law of comparative advantage does not function any more. While it is acknowledged that outsourcing may have some 'natural' limit, one can argue from some more traditional standpoint. Dan Griswold, for example, writes that "the jobs that have been lost in the IT sector tend to be the lower skilled and lower paid jobs in the industry—just as trade theory would predict. Thus, from 1999 through 2002, total employment in the IT industry did drop by more than a quarter of a million, from 6.24 million to 5.95 million. But declining employment was concentrated in those occupations requiring relatively low or moderate levels of training and education."[12]

However, many authors do believe that there are indications that the 'lower skilled' jobs mentioned above are constantly redefined and are possibly not the only types of U.S. jobs that are affected by foreign trade. "U.S. workers suddenly face a grave new threat, with even highly educated tech and service professionals having to compete against legions of hungry college grads in India, China, and the Philippines willing to work twice as hard for one-fifth the pay…"[13] As rising global salaries dissipate the easy cost gains from offshore outsourcing, the challenge will be even greater for BLS in the future regarding employment projections.[14]

It may be an interesting question for BLS to consider in its projections how some IT occupations have been and are affected by foreign trade, given that IT industries may be considered to be the 'modern' industries of our time? For example, the computer related service occupations dropped modestly from 1999 to 2003, yet important shifts did take place in the mix of employment between programmers and computer support personnel. It indicates that trade and offshoring were not the primary reason for weak post-2000 US employment performance.[15] Nevertheless, although the entire impact of foreign outsourcing on the U.S. economy is not entirely known, the domestic households do and in the future will get foreign goods at lower prices. Similarly, domestic businesses will most likely continue to obtain their foreign-produced inputs at a lower price, reducing production costs and increasing profitability.[16]

Possible future research

As discussed earlier, changes in the level of export-related employment can be linked to changes of the level of exports, changes in productivity, changes in the input structure, and changes in the commodity mix of exports. Thus, the interaction among factors affects the changes in employment required to produce U.S. exports. Using the factor analysis (multiple regression) technique, the effects of any given factor on export employment are determined by varying that factor while holding the others constant. The resulting employment figures indicate the effect that each factor has upon export-related employment over time. To determine the interactive effects, it would be necessary to vary two, and then three factors at a time in differing combination while holding the remainder constant. The factor analysis procedures would thus enable us to view the contributions of various factors to the changes in employment relative to exports.

Conclusions

- Globalization and international competition have exerted a positive effect on U.S. foreign trade. Exports are projected to generate 7.0 percent of total employment in the economy in 2014, which is an increase from 5.2 percent prevailing in 2004. This adjustment is assumed to result from a stabilized rise in productivity as well as a projected decline in the U.S. exchange rate over the 2004-14 projection span. The productivity growth played a significant role in the U.S. economy during the 1998-2004 period, affecting both exporting and the traditionally 'importing' industries.
- The levels of export related employment presented key indicators of the significance of exports in the final demand structure among industries. The high import penetration rates related mostly (as expected) to those 'traditionally' importing industries in the U.S., such as footwear and apparel, supporting the BLS industry data and upholding the principal of comparative advantage.
- The issue of outsourcing (relating both to goods and to services) should be looked more carefully from the issue of overall structure of international

trade. While the simplest aspect of outsourcing—where 'repetitive tasks' in the production process are yielded to foreigners—may hold, the number of U.S. jobs lost due to outsourcing remains unclear, also due to the number of jobs created in the U.S. by foreign affiliates through in-sourcing. The issue has been complicated further by the ongoing process of horizontal and vertical specialization in international trade.

- The heightened level of competition makes it more difficult to project the future industrial organization around the world and therefore the employment projection process becomes even more demanding.

Appendix: How to measure the employment related to imports

To measure the effects of foreign trade on industry employment, it is necessary to estimate the changes for both exports and imports. However, it is far more difficult to estimate the level of employment related to imports than that related to exports. In relating employment to exports, the task is to measure those jobs involved in producing the exported goods and services. Imports, on the other hand, are not demands upon the U.S. economy and thus there are no domestic jobs involved in producing the goods and services. How to measure the employment related to imports? the preliminary studies of imports were done where imports were treated as if they constituted demands on the U.S. economy in the same manner as exports.[17] Under this hypothesis, the hypothetical number of jobs in the U.S. is estimated which would be required to produce a given value of imports as though they were domestically produced.

In the National Income and Product Accounts system, the value of imports is treated as a negative entity, in order to calculate the "employment related imports", the total requirements table which including a negative entity for imports, is used to calculate the total employment requirements table. When the total employment requirements table is multiplied by final demand, the result of the vector of imports is then treated as a positive entity and added by industry to the total domestic production to obtain the total supply of goods and services. The import penetration, which is the ratio of import employment to total employment, represents the percentage increase or decrease in the level of each industry's employment that would be required in order to produce competitive imports domestically.

A further complicating factor in measuring the employment impact of imports is that not all imported goods and services are of the same character. There is the fact that some imported products are not produced in the U.S., such as coffee and industrial diamond. Conceivably, with a sufficient expenditure of effect and resources, it might be possible to produce some of them domestically, but the amount of employment created is a speculative matter of no practical interest. The focus of this study is export related employment. For this reason, the hypothetical results of import related employment will not be shown or discussed in the analysis.

Table 1. Exports and imports of goods and services

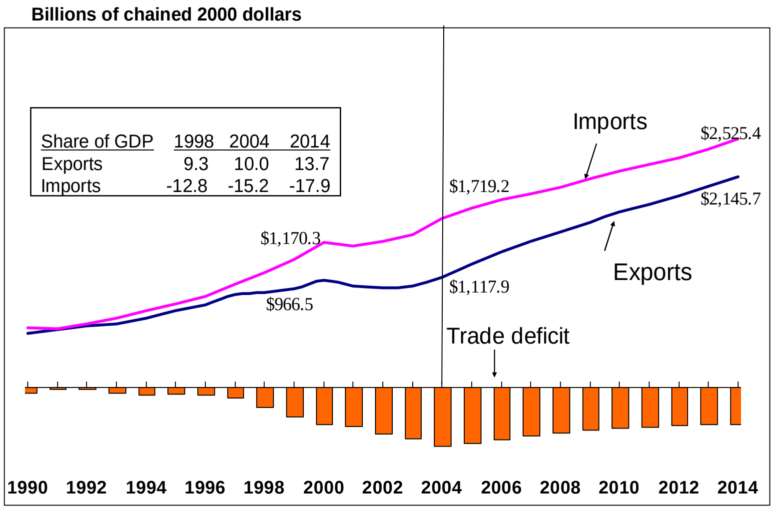

Table 2. Growth of exports in selected industries		
Industry	Average annual rate Of change	
	1998-2004	2004-2014
Computers and peripheral equipment	19.6	17.9
Semiconductor and other electronic components	7.2	8.3
Pharmaceuticals and medicine	11.2	6.2
Communications equipment	1.2	4.7
Motor vehicles	3.0	7.0
Basic chemicals	2.5	2.9
Crop production	1.8	6.7
Fabric mills	8.1	0.8
Air transportation	1.4	9.3

Table 3. Growth of imports in selected industries		
Industry	Average annual rate of change	
	1998-2004	2004-2014
Computers and peripheral equipment	21.5	2.1
Coal mining	20.9	1.4
Pharmaceuticals and medicine	17.2	8.5
Communications equipment	16.7	1.5
Forging and stamping	16.1	2.3
Medical equipment and supply	16.1	0.9
Air transportation	6.0	1.6

Table 4. Export related employment by major industry sector

Industry	Export related employment (thousands)			Export related employment as a percent of total employment		
	1998	2004	2014	1998	2004	2014
All sector	8,724	7,536	11,342	6.3	5.2	7.0
Agriculture	394	288	402	15.6	13.5	21.0
Mining	88	73	91	7.4	6.6	8.6
Construction	46	37	69	0.6	0.4	0.7
Manufacturing	3,465	2,645	3,244	19.4	18.1	23.4
Wholesale, retail, & transportation	1,827	1,648	2,414	7.0	6.2	8.3
Information	310	269	460	9.3	8.2	12.6
Finance, insurance, & real estate	433	444	771	5.3	5.0	7.9
Professional and management	1,488	1,497	2,664	8.7	8.1	11.5
Education and Health	29	27	68	0.2	0.1	0.3
Other services	331	289	599	1.8	1.4	2.6
Government and special industry	314	319	560	1.6	1.5	2.4

Table 5. Export-related employment as a share of total employment, selected Industries

Industry	2004	2014
Audio and video equipment	70.8	96.4
Fishing, hunting, and trapping	51.2	77.4
Semiconductor and other electronic	48.2	58.6
Aerospace product and parts	45.2	57.4
Metal ore mining	28.3	43.4
Computers and peripheral equipment	18.8	12.2
Pharmaceutical and medicine	16.5	22.6
Medical equipment and supplies	17.1	21.5

Table 6. Industries with high import penetration rate

Industry	Percent	
	2004	2014
Footwear	89.2	92.9
Audio and video equipment	83.0	90.0
Other leather and allied products	72.3	75.6
Cut and sew apparel	64.8	81.5
Fishing, hunting, and trapping	62.1	71.3
Oil and gas extraction	52.0	56.0
Apparel	51.1	66.4
Computer equipment	42.0	10.0

Table 7. Labor productivity growth in selected industries		
Industry	Average annual rate of change	
	1998-2004	2004-2014
Computer and peripheral equipment	21.5	25.1
Cut and sew apparel	12.1	5.2
Semiconductors and electronic components	11.7	5.7
Footwear	11.4	1.9
Apparel knitting mills	11.3	3.7
Communications equipment	11.3	14.8
Other leather and allied products	8.4	6.9
Pulp, paper, and paperboard mills	8.1	1.8

Table 8. Export-related employment as a share of total employment, selected industries			
Industry	Percent of total direct employment directly related to exports		
	1998	2004	2014
Aerospace product and parts	96.6	95.7	95.3
Pharmaceutical and medicine	90.0	94.4	93.2
Medical equipment and supplies	91.5	93.7	93.6
Computers and peripheral equipment	64.0	86.0	94.5
Computer equipment	86.4	85.1	73.9
Crop production	71.7	73.5	73.7
Motor vehicle parts	72.5	71.4	75.4

Note: All tables are available on a 200-industry detail.

Footnotes

[1]A series of five articles discussing the employment outlook, 2004-14, were published in the Monthly Labor Review, November 2005.

[2] See Eric B. Figueroa, "2004 Defense-related employment: analysis of BLS estimation methods," FFC 2006 Paper and Proceedings.

[3] China Trade, GAO-06-162, December 2005, p. 41.

[4] Martin Neil Baily and Robert Z. Lawrence, The McKinsey Quarterly, 2005, Number 1.

[5] Two measures of import penetration rate are most often used in economics literature. In the Department of Labor working paper 372 of June 2004, R. Jason Faberman defines the import penetration ratio as the ratio of imports to domestic consumption, where consumption is defined as shipments plus imports less exports. The same definition is used by William Testa: "Estimating U.S. metropolitan area export and import competition," Economic Perspectives, Federal Reserve Bank of Chicago, 2003, where exports are subtracted (in the denominator) because in both cases the idea is to divide imports by domestic consumption. Thus, an increase in import penetration over time may be seen as the reflection of industrial competition. At BLS, the import penetration ratio is defined as the ratio of imports to new supply, where domestic supply includes domestically produced goods that are exported for foreign consumption as well as those that are consumed domestically. See Robert W. Bednarzik: "An analysis of U.S. industries sensitive to foreign trade, 1982-87," Monthly Labor Review, February 1993.

[6] See J. Steven Landefeld and Ralph Kozlow, The U.S. Department of Commerce's Bureau of Economic Analysis for the June 2003 Conference of European Statisticians, Geneva.

[7] David L. Carr, James R. Markusen, and Keith E. Maskus, "Estimating the Knowledge-Capital Model of the Multinational Enterprise," American Economic Review, June 2001.

[8] Gordon H. Hanson, Raymond J. Mataloni, Jr., and Matthew J. Slaughter, "Expansion Strategies of U.S. Multinational Firm," The Brookings Institution, April 2001.

[9] Presenter: Ralph Kozlow, "Globalization, Offshoring, and Multinational Companies: What Are the Questions, and How Well Are We Doing in Answering Them?" The U.S. Bureau of Economic Analysis 2006 Annual Meeting, Boston, MA, January 6, 2006.

[10] Ibid.

[11] Valeria Gattai , "From the Theory of the Firm to FDI and Internalization: A Survey," NOTA DI LAVORO 51.2005.

[12] Daniel Griswold, "Why We Have Nothing to Fear from Foreign Outsourcing," The Center for Trade Policy Studies Free Trade Bulletin, No. 10, March 30, 2004.

[13] Pete Engardio, Michael Arndt and Dean Faust, "The Future of Outsourcing," BusinessWeek, January 30, 2006.

[14] Ibid.

[15] Martin Neil Bailey and Robert Z. Lawrence, "Don't blame trade for US job losses," The McKinsey Quarterly, 2005, No. 1.

[16] Craig K. Elwell, "Foreign Outsourcing: Economic Implications and Policy Responses," CRS Report for Congress, Updated June 21, 2005. Also, Charles L. Schultze, "Offshoring, Import Competition, and the Jobless Recovery," The Brookings Institution, Policy Brief No.136, 2004.

[17] See Eva. E. Jacobs and Ronald E. Kutscher, "Employment in relation to U.S. imports, 1960," Monthly Labor Review, July 1962, pp. 771-773. Also see Donald P. Eldridge and Charles T. Bowman, "Employment and Foreign Trade," 1971, a working paper of the Division of Economic Growth, former Division of Industry Employment Projections, Office of Occupational Statistics and Employment Projections, Bureau of Labor Statistics.

Finance and Health Topics Related to Aging

Session Chair: Terry Manzi, Internal Revenue Service

Aging and Bankruptcy

John Golmant and Tom Ulrich, AO U.S. Courts

The purpose of this study is to examine the distribution of ages of bankruptcy filers over time. The degree to which bankruptcy, the legal means by which a debtor can establish a "fresh start" from burdensome debt, is a function of age has not previously been studied in a comprehensive manner. The study shows that the population of bankruptcy petitioners is getting older at a faster rate than that of the general population. Older individuals are increasingly likely to file for bankruptcy, and there could be an influx of new bankruptcy petitions as the baby boom generation continues to age.

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Mortality at Late Age for Major U.S. Race-Ethnic Groups

Ward Kingkade, Population Projections Branch, Bureau of Census

Ethnic differences in mortality at late age have attracted considerable discussion, most notably in terms of the Black/White crossover in age-specific death rates as well as the significantly lower death rates among the Hispanic population relative to others. The proposed paper presents an analysis of US mortality data in race-ethnic detail, by sex and single-year age, from age 60 to 100+, relying on a time series of mortality rates from 1984 to 1999 for three major race-ethnic categories (Hispanic, Black Non-Hispanic, and Non-Black Non-Hispanic). The dynamics of mortality rates by sex and single-year age for these categories are examined. The impact of alternative graduations, including those suggested by Thatcher and associates (1998) are investigated with special attention to how they impinge on the questions mentioned above.

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Aging and Bankruptcy

John Golmant and Tom Ulrich

Bankruptcy is the legal means by which a debtor can establish a Afresh start@ from burdensome debt. Until now, the degree to which bankruptcy is a function of age has not been studied in a comprehensive manner. This study[1] shows that the population of bankruptcy petitioners is getting older at a faster rate than that of the general population. Because older individuals are increasingly likely to file, the bankruptcy courts can anticipate an influx of new bankruptcy petitions as the baby boom generation continues to age.

Background

Until the implementation of the Bankruptcy Abuse Prevention and Consumer Protection Act of 2005 (BAPCPA) in October of 2005, personal bankruptcies had been growing at a significant rate for over a decade and reached record levels in recent years.[2, 3] The causes of the bankruptcy explosion have been debated, but debt, as a percentage of income, has reached record levels and appears to be a factor leading to the increase in filings.[4] While the relationship between age and debt has been documented,[5] the degree to which bankruptcy is a function of age is less well-studied.

The purpose of this study was to determine the proportion of bankruptcy petitioners that fall within particular age categories and whether these proportions have changed over time. This research was conducted for two main reasons. First, having a better sense of who will be filing petitions in the future will enhance the statistical projections performed by the Administrative Office of the U.S. Courts, which are used for short-term and long-term planning. Second, the study was conducted to evaluate the results of previous studies, which were based on less comprehensive data. In order to track changes over time, national aggregate measures were obtained for the years 1994 and 2002.

The paper is organized into five sections. Following this background section, a synopsis of previous studies is presented. Third, a data and methodology section documents what data were examined, how the data were collected, and some of the limitations of the data. The fourth section presents the findings, and the last section provides concluding remarks.

Previous Studies

A 2001 study by Sullivan, Thorne, and Warren found that, while the overall bankruptcy filing rate increased between 1991 and 2001, the bankruptcy filing rate for young petitioners actually declined.[6] Moreover, the greatest number of bankrupt debtors is consistently in the middle-age category.[7] And, finally, the authors reported an increase in the rate at which debtors aged 65 and over filed.[8] The study examined a survey sample of petitioners from five states; hence, any generalizations to the national population was questionable. A 2002 study of chapter 7 petitioners conducted by the Executive Office for United States Trustees (EOUST)

[1] The authors are employees of the Administrative Office of the U.S. Courts (AO). This paper reflects results of an ongoing research effort, and the views and opinions expressed within this paper are solely those of the authors and do not necessarily represent official policy of the AO.

[2] BAPCPA was signed into law, April 20, 2005, and the implementation date for the Act was October 17, 2005. Just prior to the implementation date, filings exploded; more than 600,000 petitions were filed in the month of October alone. Subsequent to the implementation date, filings plummeted. The count of petitions for November 2005 was approximately 14,000. While the number of petitions has been steadily rising since November, it remains unclear at this time whether filings will reach pre-BAPCPA levels.

[3] During the 12-month period ending September 30, 1990, nonbusiness (i.e., personal) filings reached 685,420 petitions. During 1995, nonbusiness filings had risen to 832,415 petitions. By September 30, 2000, filings had grown to 1,226,037 petitions, a 79 percent rise over the 1990 figure. And the September 30, 2005 figure, 1,748,421 petitions, was a 43 percent increase in just five years, and an all-time record (for this reporting period) for total filings.

[4] See, e.g., the bankruptcy statistics subsection of the online resources section of the American Bankruptcy Institute website, www.abiworld.org.

[5] See, e.g., Survey of Consumer Finance, Federal Reserve Board.

[6] Teresa A. Sullivan, Deborah Thorne, & Elizabeth Warren, *Young, Old, and In Between: Who Files for Bankruptcy?*, NORTON BANKRUPTCY LAW ADVISER, Issue 9, September 2001.

[7] *Id.*

[8] *Id.*

determined that its distribution of ages was consistent with the Sullivan, Warren, and Westbrook results.[9] However, the authors also acknowledged that only 20 percent of the available data contained age information.[10] A 2003 study, which examined publicly available bankruptcy records for debtors in Utah during 1997, concluded that the median age of filing was 33 years.[11] The study also stated that Utah had the lowest median age (irrespective of filing status) of any state population.[12] A 2005 study, whose purpose was to compare rural filers to urban filers, found that the average age of a rural filer was 41, whereas the average age of an urban filer was 40.[13] The study examined petitions from specific locations in Iowa and Tennessee.

More recently, the Institute for Financial Literacy conducted a national (voluntary) survey of petitioners who filed for bankruptcy following the implementation of the BAPCPA.[14] This study also presented results that were consistent with the Sullivan, Warren, and Westbrook paper and the EOUST paper.

To varying degrees, these studies lacked the methodological advantages of the current study. For example, they all relied on debtor-supplied information - either through responses to questionnaires or through voluntary submission. Such data can be misleading (in the case where inaccurate information is supplied) or incomplete (in the case where information is not supplied because it is not required). Secondly, there is the issue of item and survey non-response. Thirdly, with two exceptions, these studies were not national in scope. And, finally, with one exception, these studies were not longitudinal.

Unlike the previous studies, the current study uses data derived from information that is required of every petitioner when they file for bankruptcy, i.e., their social security number, rather than responses to questions about prior bankruptcy petitions, thereby avoiding the issues of non-disclosure and respondent bias. Respondent bias, while presumably small in the above studies, could provide distorted estimates. The current study also employs a database that is thousands of times larger, broader in extent, and covering a longer time period, which allows the results to be much more representative of the nation.

Data and Methodology

The data used in this study came from a database constructed for the paper, Bankruptcy Repeat Filings.[15] The dataset has over 13 million records and contains information on chapter 7 and chapter 13 consumer bankruptcy filers. The dataset covers 88 (of the 94) judicial districts for the years 1993 through 2002.[16] Each record has the petitioner=s name, as well as their social security number. Lastly, information was collected on both single petitioners and joint petitioners (for joint filings, the dataset captured separate records for each petitioner).

Unfortunately, the database (or any other bankruptcy database maintained by the judiciary) does not contain any age-specific data.[17] Therefore, age information for particular debtors needs to come from data sources outside the judiciary.

To accomplish this, we first selected samples of petitioners for the years 1994 and 2002. Six samples, three per year, were constructed using simple random sampling. The samples that examined chapter 7 cases only and chapter 13 only were comprised of 400 cases each, and the samples that examined all filings (irrespective of chapter) were comprised of 600 cases.[18]

Birthdates for each petitioner were obtained by matching the social security number to the public

[9] Ed Flynn & Gordon Bermant, *Bankruptcy by the Numbers, Chapter 7 Debtors B From 19 to 92*, AMERICAN BANKRUPTCY INSTITUTE JOURNAL, Vol XXI, No. 9, 2003.

[10] *Id.*

[11] Jean M. Lown & Barbara R. Rowe, *A Profile of Utah Consumer Bankruptcy Petitioners*, JOURNAL OF LAW AND FAMILY STUDIES, 5, 2003.

[12] *Id.*

[13] Katherine Porter, *Going Broke the Hard Way: The Economics of Rural Failure*, WISCONSIN LAW REVIEW, 2005, 969

[14] Institute for Financial Literacy, First Demographic Analysis of Post-BAPCPA Debtors, Institute for Financial Literacy, Inc., April 2006.

[15] See John Golmant & Tom Ulrich, *Bankruptcy Repeat Filings*, AMERICAN BANKRUPTCY JOURNAL LAW REVIEW, 14, Spring 2006. A detailed description of the dataset, including a discussion of how the dataset was created, can be found in the paper.

[16] At the time the Golmant and Ulrich study was conducted, data were unavailable for the Northern District of Alabama, the Southern District of Georgia, and the Districts of the Virgin Islands, Idaho, Guam, and the Northern Mariana Islands. See Golmant and Ulrich (2006), *op. cit.*, for additional details.

[17] A very small percentage of debtors provide their birthdates on Schedule I of the bankruptcy petition, although disclosure is completely voluntary, and there is no mechanism in place to ensure that the information is correct.

[18] The number of cases examined (sample size) for each sample was determined so that the confidence level could be at least 95 percent for the chapter 7 and chapter 13 samples and at least 99 percent for the total filings (chapter 7 plus chapter 13) samples.

records accessible through Lexis and Westlaw. The success rate for matching social security numbers with birthdates was very high; of the 2,800 records sampled for use in this study, we found a match to a birthdate on record for all but 13.[19] Age at filings (in months) was calculated by subtracting the birthdate from the filing date.

Two limitations should be noted. First, the survey samples can only be applied to the nation as a whole, i.e., the samples were not designed to provide viable estimates at the district or circuit levels. Second, the 13 million record dataset did not have any data for six of the 94 districts (as mentioned) and had incomplete data from the earlier years for a few of the others.[20]

Results

The results are presented in the following tables and graphs. Figure 1 shows that the median age increased, from 37.7 years in 1994 to 41.4 years in 2002.

Figure 1: Median Age at Filing

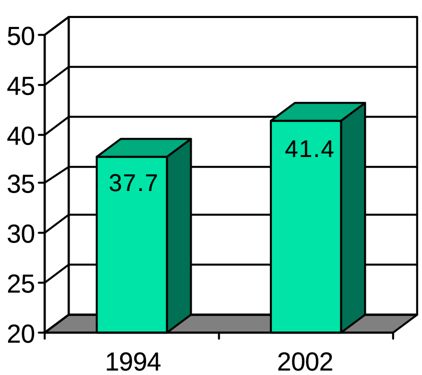
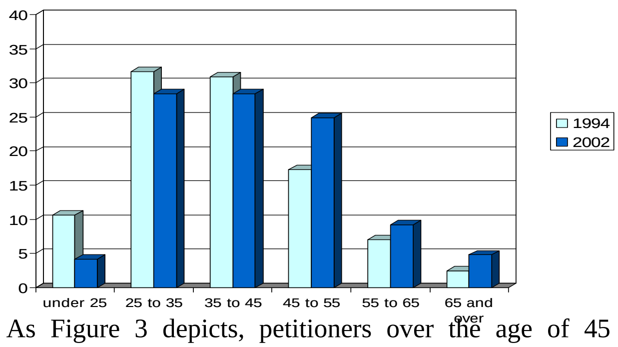


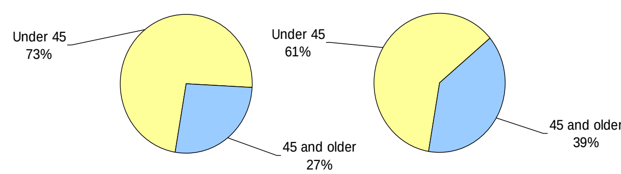
Figure 2 shows there was also a shift in the age profile; that is, older filers are accounting for a larger percentage of overall filers. The largest drop occurred for those filers under age 25. In 1994, these filers accounted for 11 percent of filers; in 2002, 4 percent.

Figure 2: Percent of Filers in Age Category



As Figure 3 depicts, petitioners over the age of 45 comprised 27 percent of filers in 1994, but 39 percent of filers in 2002.[21]

Figure 3
1994 Percentages 2002 Percentages



Both the general population and the bankruptcy population are getting older. However, it appears that the aging of the general population cannot, by itself, account for the aging of the bankruptcy population. As Table 1 suggests, the two groups are aging at different rates. Change in the proportion of bankruptcy petitioners by age group is much greater.

A related finding is that it appears that chapter 7 petitions are becoming more prevalent among older debtors. As Table 2 indicates, the fastest growth in chapter 7 petitions occurred in the over 55 age grouping. The fastest growth in chapter 13 petitions occurred in the over 55 age grouping as well, although the 45 to 54 age grouping also experienced significant growth.

Concluding Remarks

Our results are consistent with those of Sullivan, Thorne, and Warren; Bermant and Flynn; and the Institute for Financial Literacy. That is, the bulk of bankruptcy filings have been filed by the middle-aged. In addition, the pattern of change over time is consistent with the findings of Sullivan, Thorne, and Warren. The

[19] For less than 1 percent of the petitioners in our sample, the birthdate was listed as a year. For the purposes of this study, the month of January was assigned to those petitioners.

[20] A more thorough discussion of these limitations can be found in Golmant and Ulrich (2006), *op. cit.*

[21] Even though the *percentage* of filers under 45 fell, the absolute number likely increased. Between 1994 and 2002, overall filings increased 72 percent. Applying our percentages to the total bankruptcy filing count for each year suggests that the number of filings by this age grouping increased by nearly one third.

younger filers account for a smaller proportion, and the older filers account for a larger proportion. And the pattern of change exaggerates the pattern of change in the general population. In fact, if one were to compare the results of the Institute for Financial Literacy study with ours as in Table 3, it appears that the pattern of change over time is continuing.[22]

The fact that middle-age debtors account for the majority of bankruptcy petitioners suggests that the baby-boomers are disproportionately represented in bankruptcy proceedings. Sullivan, Warren, and Westbrook have hypothesized that the baby boomers were uniquely challenged during their peak earning years. They argue that the economy was particularly tumultuous during the 1980s and early 1990s, and real wages remained flat or declined while real estate prices rose.[23] And this occurred simultaneous to aggressive marketing strategies by the credit industry.[24] According to Flynn and Bermant, credit card debt levels among chapter 7 petitioners were the lowest for debtors under the age of 25, twice that (the lowest amount) for debtors in the mid-30s, three times that for debtors in their 50s, and five times that for debtors age 60 and older.[25] No explanation is given as to why the older debtors incurred the most credit card debt, but the high credit card debt among those aged 60 or older could explain why the percentage of chapter 7 filers who were aged 60 or older has grown at the fastest pace.

During the 1990s, indebtedness increased concurrently with wealth.[26] But personal savings actually declined substantially.[27] In the general population aged 50 and over, median debt levels nearly doubled at every income level.[28] The amount of credit card debt among seniors (aged 65 or older) rose 89 percent between 1992 and 2001.[29] In fact, recent data suggests that 14 percent of 64-year-olds are facing retirement with negative net worth.[30] Incomes derived from assets fell from 21 percent to 16 percent, and more than one-third of seniors depend on Social Security for over 90 percent of their income.[31] More seniors are borrowing against their homes; whereas 20.7 percent of seniors owed on their homes in 1990, 28.3 percent owed on their homes in 2000.[32]

Moreover, the amount of mortgage debt carried by older homeowners has been increasing, as more older homeowners tap into their home equity.[33] This trend is partially the result of the Tax Reform Act of 1986, which retained the tax deduction for mortgage interest but eliminated the deduction for consumer credit, and the removal of legal impediments in the late 1980s that discouraged lenders from offering home equity products.[34] But it is also partially the result of generational shifts in marriage, two-income families, labor market structures, life expectancies, retirement planning, levels of education and health care, and, more generally, a rising standard of living and housing consumption.[35] Of course, this trend also tends to make older homeowners financially vulnerable as, typically, household income declines after age 55.[36]

Health care costs seem to be major contributors to indebtedness among seniors. Medical expenses such as deductibles, co-pays, dental and vision care, and prescription drugs are now all payable by credit card. At the same time, the number of employer-sponsored supplemental insurance plans has steadily declined -- from 66 percent of employers in 1988 to 38 percent in 2003.[37] The result: credit card debt of middle- to low-income families without health insurance increased 169 percent, compared to a 37 percent rise for those families with health insurance.[38]

Certainly, senior citizens of the World War II generation faced reduced income in retirement and escalating health costs. But additional factors as outlined above have developed gradually over the past two decades, and have pushed increasing numbers in the more recent group of retirees toward financial insolvency. These trends likely will persist into the foreseeable future.

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22 This table was constructed for discussion purposes only. Methodological differences between the two studies make direct comparisons questionable.

23 Teresa A. Sullivan, Elizabeth Warren, & Jay Westbrook, THE FRAGILE MIDDLE CLASS, Yale University Press, (2000), p.39.

24 *Id.*

25 Flynn & Bermant (2003), *op.. cit.*

26 John Gist & Carlos Figuelredo, *Deeper in Debt: Trends Among Midlife and Older Americans*, AARP Public Policy Institute, April 2002.

27 *Id.*

28 *Id.*

29 Heather C. McGhee & Tamara Draut, *Retiring in the Red, The Growth of Debt Among Older Americans*, Demos Briefing Paper, 2nd Edition, February 26, 2004.

30 *Id.*

31 *Id.*

32 *Id.*

33 George S. Masnick, Zhu Xiao Di, & Eric S. Belsky, *Emerging Cohort Trends in Housing Debt and Home Equity*, Joint Center for Housing Studies, Harvard University, W05-1, January 2005.

34 *Id.*

35 *Id.*

36 *Id.*

37 McGhee & Draut, *op. cit*.

38 *Id.*

Table 1. Percentages of Age Grouping

General Population * | **Bankruptcy Population**

Percentages of Age Group in US Population				Percentages of Age Group in Total Filers			
Census Data	1994	2002	% change	AO Study	1994	2002	% change
under 25	9.9	9.8	**-1.0%**	under 25	10.6	4.2	**-60.4%**
25 - 34	22.2	19.2	**-13.5%**	25 - 34	31.6	28.4	**-10.1%**
35-44	22.5	21.7	**-3.6%**	35-44	30.9	28.4	**-8.1%**
45-54	16.1	19.3	**19.9%**	45-54	17.3	24.9	**43.9%**
over 55	29.2	30.1	**3.1%**	over 55	9.6	14	**45.8%**

* Source: U.S. Census Bureau Current Population Report, 2000, and Population Division, U.S. Bureau of the Census. Note: the percentages exclude data for persons who were less than 20 years old.

Table 2. Percentages of Age Grouping (by Chapter)

Chapter 7				**Chapter 13**			
Age Category	1994	2002	% change	Age Category	1994	2002	% change
under 25	9.0	8.1	**-10.0%**	under 25	7.3	5.3	**-27.4%**
25 - 34	35.6	25.0	**-29.8%**	25 - 34	32.0	19.6	**-38.8%**
35 - 44	30.1	29.8	**-0.1%**	35 - 44	31.3	32.7	**4.5%**
45 - 54	16.0	19.7	**23.1%**	45 - 54	20.8	27.0	**29.8%**
55 and over	9.3	17.4	**87.1%**	55 and over	8.8	15.4	**75.0%**

$p < .01$

$p < .05$

Table 3. Change in Age Group Representation Over Time

Percent of Bankruptcy Population by Age			
Age Category	1994	2002	2006*
under 25	10.6	4.2	3.6
25 - 34	31.6	28.4	22.7
35-44	30.9	28.4	28.6
45-54	17.3	24.9	22.4
over 55	9.6	14.0	22.7

* Source: Institute for Financial Literacy

Mortality at Late Age for Major U.S. Race-Ethnic Groups

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U.S. Census Bureau

Background

With the growth of the elderly population in modern industrialized societies, both in absolute numbers and as a share of the total population, oldage mortality has acquired increasing importance as a determinant of population change. As regards mortality trends, an analysis of data for 13 low-mortality countries with high quality historical data found no evidence of any reduction in the pace of mortality decline at late age (Thatcher et al., 1998). As to age patterns of oldage mortality, the same study found evidence that at late age mortality increases monotonically with age, but at a decreasing pace as age increases. This finding stands in contrast to the traditional Gompertz assumption under which the force of mortality is held to rise with age at a constant exponential rate[1].

The United States does not belong to the group of 13 low-mortality countries with long time series of high quality mortality statistics (ibid.). Of course, this is hardly a criticism, given that the country is little more than 200 years old and death registration did not extend to its entire territory until 1933[2]. The United States covers a large territory and hosts a heterogeneous population, across whose segments the completeness and accuracy of demographic statistics is uneven.

Considerable attention has been devoted to the "crossover" in the mortality schedules of certain U.S. race/ethnic categories. In particular, age-specific death rates are higher in the U.S. Black population than the remainder of the population beginning in infancy and over most of the age range. At a rather advanced age, the age schedules of death rates for Blacks of either sex cross under those for the rest of the population and remain lower thereafter. Some analysts have attributed this phenomenon to age misreporting (Coale and Kisker, 1986; Preston et al., 1996), while others have found it plausible (Kestenbaum, 1992) on ground such as heterogeneous unmeasured frailty in the population (Vaupel et al., 1979). With regard to the Hispanic population of the U.S., which is characterized by high immigration, Palloni and Arias (2004) advance a "salmon bias" explanation under which immigrants return to live out their retirement years in their native homelands, where their deaths take place; such a process could account for a crossover in the mortality of the U.S. Hispanic population.

The Task at Hand

In the present analysis we were charged with estimating mortality schedules in single- year detail to age 100 for three major race/ethnic subdivision of the U.S. population: Hispanics, Black Non-Hispanics, and Non-Black Non-Hispanics. This seriously constrained the time period covered in the analysis, since mortality data by Hispanic origin are available from the National Center for Health Statistics starting in 1984. By 1989 data in Hispanic detail are available from NCHS for the overwhelming majority of states and the District of Columbia (see Appendix Table A), but it was not until 1997 that data in Hispanic detail were available for all states.

The objective of this effort was to derive standard mortality schedules representative of the three race/ethnic categories as best as could be achieved with available data for use in imputing the race/ethnic distribution of deaths in nonreporting states by a methodology akin to indirect standardization[3]. The raw data employed in the present analysis include deaths by age, sex, and (where present) race/ethnic group for the U.S. resident population from the NCHS public-use mortality datasets from 1984 to 1999. The U.S. Census Bureau's intercensal population estimates for the years in question were employed as denominators of the annual death rates, with an adjustment to yield agreement with the results of Census 2000. In constructing the standard schedules it has been necessary to adjust irregularities in annual mortality schedules which rendered them awkward to use as standards, such as declines in mortality with advancing age. Fortunately, the models investigated by Thatcher and associates (ibid.) were available to use for this

[1] The Gompertz assumption represents a major improvement over the assumption that the force of mortality is constant at late age, which is entailed any time the life expectancy in the open interval is obtained as the reciprocal of the age-specific death rate.

[2] Australia, Canada, and New Zealand were not included either in the group of countries analyzed by Thatcher and associates (op. cit.).

[3] See Kingkade (2004 and 2005) for some results of this reconstitution.

purpose. The exercise of fitting the models to our data and selecting an appropriate standard is described below.

Dynamics of Mortality for the "Big Three" Race/Ethnic Categories, 1984-1999

In this section we investigate mortality patterns in terms of the force of mortality, or instantaneous death rate

$$\mu(a) = -\frac{dl(a)}{l(a)da} \quad ,$$

where *a* is exact age and *l(a)* represents the number of survivors at age *a* out of an original cohort of *l(0)* births (the "radix" of the life table). In practice, we estimated the average force of mortality in a single-year age interval using the life table relationship

$$\overline{\mu}_{a+0.5} = -\ln {}_1p_a \quad ,$$

where ${}_1p_a$ is the probability of survival from exact age a to a+1. The survival probabilities were computed from another life table formula

$${}_1p_a = \frac{1-(1-k_a)\cdot {}_1m_a}{1+k_a \cdot {}_1m_a} \quad ,$$

where ${}_1m_a$ is the central death rate for the age interval a to a+1 and k_a is the average duration lived in this age interval by persons who perish in the interval. Except in infancy, k_a is taken to be ½ by convention[4], yielding the simpler expression

$${}_1p_a = \frac{2-{}_1m_a}{2+{}_1m_a} \quad .$$

The Force of Mortality Across the Age Range

Figure 1 presents the force of mortality among Non-Black Non-Hispanic males for single-year intervals beginning at age 0 and continuing to age 99 for selected years from 1984 to 1999. Over most of the age range a decline over time in the force of mortality is discernable. At ages from 93 onwards, however, there is no obvious decline, and at age 99 it is even clear that the (apparent) force of mortality rises over the period of observation. The age pattern exhibited by the data is for the most part typical for a modern industrial or post-industrial society with low-mortality. There is some evidence of what might constitute an "accident heap" in death rates in the early 20s, followed by a slight decline in death rates through age 30. Thereafter a steady rise in death rates commences and continues into the oldest ages. At the latest ages Non-Black Non-Hispanic male mortality appears to level off or even decline at the earlier dates. As of 1999 the (apparent) mortality of this subpopulation continues to rise with age straight through to the oldest age presented (99).

Black Non-Hispanic males offer a decidedly different picture from their Non-Black Non-Hispanic counterparts (Figure 2). Starting in the early teen ages and continuing to around age 50, mortality in this subpopulation increased from 1984 to 1989 and remained elevated thru 1994 (at least). Subsequently the mortality of young and middle-aged Black Non-Hispanic men declined, leaving the force of mortality at ages 25 through 40 lower than had been observed for this subpopulation at these ages in 1984. At older ages, especially late age, trends in age-specific mortality are difficult to discern in Figure 2. It appears that mortality among Black Non-Hispanic males declined over the period of observations from ages around 60 to around 70 years of age. From age 70 to 80 no clear trend is evident, and over age 80 the mortality schedule appears to have increased. Some leveling off in the slope of mortality with respect to age also seems to insinuate itself at the oldest ages.

Among Black Non-Hispanic females (Figure 3) there is some indication of an increase in mortality in the younger portion of the age range from 1984 to 1999, as well as a decline thereafter. The relative magnitude of these shifts is less than that observed among Black Non-Hispanic males. At ages over 80 the mortality of Black Non-Hispanic women appears clearly to have increased through 1999. There is less evidence of leveling off in the slopes with respect to age in the mortality schedules of Black Non-Hispanic females than is the case among their male counterparts.

The mortality schedules of Hispanic males for selected years from 1984 to 1999 are presented in Figure 4. What emerges most vividly from this figure is the pronounced decline in Hispanic male mortality in youth and at ages up through the mid 40s. At ages over 40 there is little discernable trend in Hispanic male mortality. In terms of the age pattern of mortality, there may be some indication of the emergence of an accident hump around age 20 as of 1999. Leveling off of the mortality schedules at the oldest ages is more apparent.

Figures 5-8 focus on the portion of the mortality schedules of the various race/ethnic groups at ages 60 and over, affording a much more precise view of the dynamics of age and sex-specific mortality in these subpopulations. As Figure 5 illustrates, mortality has

[4] In their authoritative monograph on life table methodology, Namboodiri and Suchindran (1987) remark: "In the extreme old age, where mortality rates sharply increase with age, the use of 0.5 for k_a is not theoretically justifiable, but in practice one uses it" (op. cit., p. 21). The present analysis is no place to dispute this established practice.

clearly declined since 1984 among Non-Black Non-Hispanic males ages 60-90. Above age 90 the picture becomes muddled and noisy. At ages from 92 onwards the 1984 mortality schedule features the lowest mortality for Non-Black Non-Hispanic men. The accuracy of these values is called into question by the pronounced decline with advancing age starting at age 95. There is some suggestion of a tendency for the Non-Black Non-Hispanic male mortality schedules to evolve towards a pattern of monotonic increase with age after 1984.

Non-Black Non-Hispanic females in Figure 6 present the neatest picture of the evolution of oldage mortality schedules of all subpopulations considered in this analysis. A tendency for the mortality schedules of Non-Black Non-Hispanic women to "straighten out" from a pattern in which mortality levels off at late age to one in which mortality increases throughout is clearly evident in this figure. The disquieting feature of Figure 6 is the unambiguous and consistent increase in mortality at late age among these women. This runs precisely counter to the findings cited by Thatcher and associates (ibid.) to the effect that mortality continues to decline at all ages in low-mortality countries.
The mortality schedules of elderly Black Non-Hispanic males, according to Figure 7, exhibit a decline at ages under 80. From this age onwards, the mortality schedules begin to cross back and forth, one over another, in a tangle that becomes progressively more incoherent with advancing age. The alternating "sawtooth" pattern in Black Non-Hispanic male mortality at these ages is highly suggestive of age misstatement[5]. These data afford little opportunity to discern trends or patterns. It is clear, however, that Black Non-Hispanic male mortality increases from age 80 into the ages over 90. Careful scrutiny also reveals that from age 85 onward, mortality, as reflected in these data, was lower in 1984 than at later dates.

In terms of their mortality schedules, Hispanic males present less of a mess than their Black Non-Hispanic counterparts, as Figure 8 reveals. However, this does not signify that the data in Figure 8 offer a great deal of clarity. A decline over time in Hispanic male mortality at ages below 89 can be gleaned from inspection of the figure. At older ages the evidence of a decline in mortality is unclear. The validity of the data at the oldest ages, where the mortality values for 1984 are visibly higher than those for later dates, is called into question by the leveling off or decline in mortality with advancing age in these mortality schedules.

[5] Unfortunately, these data taken alone do not allow us to determine whether the source of the error lies in the death statistics, population estimates, or both.

Summary of Trends

Because of the noisiness in the oldage mortality data for the subpopulations under investigation, as well as the evident rise and fall of mortality among Black Non-Hispanic men and women over the period of observation, a means to statistically summarize the overall trends in age and sex-specific mortality for the various race/ethnic categories is desirable. In the present analysis regression lines were fit to the time series of observations on each age and sex-specific death rate in each race/ethnic category. The signs of the slopes of the respective lines provide a summary of the direction in the trend of the force of mortality for the age-sex-race/ethnic contingent in question over the period of observation. Our use of this measure is strictly descriptive and we are concerned only with the signs of the estimated parameters. These are assembled in Table 1, where positively signed parameters (indicative of an increase in the force of mortality) are highlighted in blue.

The most important regularity in Table 1 from the viewpoint of the present analysis is that above age 92 the regression slopes are positive nearly everywhere. This is an indication that the force of mortality as reflected in our data was rising on average for the sex and race/ethnic groups in question over the period of observation. There is one exception: among Hispanic males the number of positively signed regression slopes for ages 93 and over (4) is barely more than the number of negatively signed slopes (3), making the conclusion for this subpopulation rather ambiguous. But by the same token, there is even less support for the notion that mortality was decreasing among Hispanic males in this age range.

Parametric Models of Oldage Mortality by Sex and Race/Ethnic Category

Our examination of the mortality patterns described above has made it obvious that they stand in need of serious adjustment before they can be suitable as standards for imputing mortality. One can argue whether the force of mortality increases without bound or approaches some asymptote in extreme old age. It is quite another matter to try to defend the notion that mortality at a point in time declines with advancing age into the late 90s. Consequently, we sought a means to adjust the oldage mortality patterns of the sex and race/ethnic categories in the analysis. Fortunately, a variety of parametric actuarial models are available.

For the purpose of adjusting oldage mortality, we selected for comparison three of the actuarial models examined by Thatcher and associates (op. cit.), namely the Logistic ("Kannisto"), Gompertz, and Weibull models. The Gompertz model entails unabated increase in the force of mortality with advancing age, as follows:

$$\mu(a) = c \cdot e^{\gamma \cdot (a - a_0)} \qquad c, \gamma > 0,$$

where a_0 is the earliest exact age to which the model is taken to apply and c and γ are parameters to be estimated. The "Kannisto" model investigated by Thatcher and associates amounts to a logistic curve with asymptotes of 0 and 1:

$$\mu(a) = \frac{b \cdot e^{r \cdot (a - a_0)}}{1 + b \cdot e^{r \cdot (a - a_0)}} \qquad b, r > 0 \quad ,$$

where b and r are to be estimated. Finally, the Weibull model takes the form

$$\mu(a) = k \cdot (a - a_0)^x \qquad k>0, \quad x>-1 \quad ,$$

where k and x are parameters to be estimated. Each of the three oldage mortality models was fit to the untransformed values of the average force of mortality in single-year age intervals from 80 to 95 separately by sex for the three race/ethnic categories by nonlinear regression[6]. This approach has the advantage of keeping the residuals for each model under comparison in a common metric, so that goodness of fit can be readily compared in terms of sums of squared errors. The additivity property of the latter statistic permits the construction of overall goodness of fit summaries for aggregations of categories. Age 80 was chosen as the lower boundary of the age range within which the models were fit, in keeping with Thatcher and associates (ibid.). The upper boundary was set at age 95 because the observed data at older ages seemed highly erratic and untrustworthy.

Table 2 presents the sum of squared errors (SSE) statistics for each of the models in this analysis separately by sex for the three race/ethnic categories. The SSEs in this table are simply the sums of squared residuals over the age range in which the models were fit for the respective sex and race/ethnic category. The lower the value of the SSE, the better the fit of the model.

According to the grand total SSE for both sexes combined, the Gompertz model provides the best overall fit, slightly edging out the Logistic model. This is due to the performance of the Gompertz model among males; the Logistic model provides the best overall fit among females. Inspection of the results for race/ethnic categories indicates that the Logistic model actually yields the best fit among Hispanics and Non-Black Non-Hispanics of either sex. The superior performance of the Gompertz model in the Black Non-Hispanic population dominates the grand total. The differences in SSEs between the Gompertz and Logistic models are small in comparison to the differences between either of the former models and the Weibull model, which provides a distinctly poorer fit to the data.

Figure 9 illustrates the fit of the three oldage mortality models to the data for Non-Black Non-Hispanic males in 1999[7]. The Gompertz and Logistic models fit the data better around the endpoints of the age range to which they were fitted. Curiously enough, the Weibull model actually comes closest to the data points at a number of ages from the early 80s to the early 90s. The Weibull model starts out and ends up at distinctly lower values than the Gompertz and Logistic models. In general, it is difficult to tell the latter two models apart in the chart. At the latest ages the Gompertz model yields values that are slightly higher than those produced by the Logistic model.

A counterexample is offered in Figure 10, which portrays the case of Black Non-Hispanic males in 1996. In this instance the Weibull model fits the data best. The better fit provided by the Weibull model to the data at ages 80, 95, and several other ages in the middle of the range of data points outweighs the performance of the Gompertz and Logistic models elsewhere.

A question of some interest concerns the magnitude of the correction to the observed oldage mortality data entailed by the fitted models. In Table 3 we explore what happens when the residuals for ages above 95 are included in the calculation of the SSEs for the oldage mortality models[8]. Contrary to what might be expected from the analysis above, the Logistic model turns out to have the smallest grand total SSE among the three models considered. This is due to the superior fit of the Logistic model among Non-Black Non-Hispanic as well as Black Non-Hispanic females. The Weibull model exhibits the lowest SSE of the models considered among Non-Black Non-Hispanic males and Hispanics of either sex.

To depict the performance of the respective mortality models over the age range 80-99, Figure 11 presents the instance of Non-Black Non-Hispanic females in 1999. This chart reveals that the better goodness of fit

[6] SAS PROC NLIN was used to fit the models.

[7] In this figure and those which follow the data points are aligned with the midpoints of the respective single-year age intervals. In other words, the average force of mortality in the single-year interval beginning at age a is aligned with the point a+0.5 on the horizontal axis.

[8] The parameters estimated for ages 80-95 were retained. The differences between the observed force of mortality estimates and those extrapolated to ages above 95 were included in the calculation of the SSEs in Table 4.

exhibited by the Weibull model is fundamentally the result of the model's proximity to the empirical force of mortality values at ages over 95. In addition, it is this portion of the age range that mainly accounts for the poorer fit of the Gompertz relative to the Logistic model in this subpopulation as of 1999.

Figure 12 illustrates a case where the Logistic model best fits the data for ages 80-99: Black Non-Hispanic females in 1990. Here the Weibull model does an especially poor job of fitting the empirical data anywhere except at age 99. As has often been seen above, the Gompertz and Logistic models resemble each other closely in this instance. The superior fit of the Logistic model relative to the Gompertz model for Black Non-Hispanic females as of 1990 is evidently due to the slightly lower values extrapolated from the Logistic model at ages over 96.

Conclusion

The above analysis makes it evident that no one of the models considered is ideally suited to represent oldage mortality in each contingent of the U.S. population distinguished here. If one had to choose a single model, the Logistic seems to possess a slight advantage over the Gompertz model in most instances. This advantage does not pertain exclusively to the performance of the Logistic model over the age range 80-95, in which it provides a better fit in the majority of cases. The fact that the Logistic model offers a slightly more conservative adjustment than the Gompertz model to the data at ages near 100, where the observed data invite skepticism, is also a consideration. Clearly the data at these ages need to be adjusted: we cannot accept a standard featuring a declining force of mortality with advancing age, and we are uncomfortable with the Weibull model because it comes too close to the observed values at these ages. In choosing between the Gompertz and Logistic models, it seems preferable to err on the side of caution and select the model that yields the more conservative adjustment.

References

Coale, A.J. and E.E. Kisker, "Mortality Crossovers: Reality or Bad Data ?", Population Studies, 40, 1986, pp. 389-401.

Kestenbaum, Bert, "A Description of the Extreme Aged Population Based on Improved Medicare Enrollment Data", Demography, 29(4), 1992, pp. 565-580.

Kingkade, W.W., Alternative Time Series Approaches to Mortality Projection, presented at the annual meetings of the Population Association of America, Philadelphia, March 31-April 12, 2005.

Kingkade, W.W., Mortality Dynamics of the U.S. Population by Race and Hispanic Origin: 1984-1999, documentation for poster presentation at the annual meetings of the Population Association of America, Boston, April 1-3, 2004.

Namboodiri, K. and C.M. Suchindran, Life Table Techniques and Their Applications. New York, Academic Press, 1987.

Palloni, A. and E. Arias, "Explaining the Hispanic Adult Mortality Advantage", Demography, 41(3), 2004, pp. 385-415.

Preston, S.H., I.T. Elo, I. Rosenwake, and M. Hill, "African American Mortality at Old Age: Results of a Matching Study," Demography 33, 1996, pp. 193-209.

Shryock, H.S., J.S. Siegel and associates, The Methods and Materials of Demography, Volume 2. Washington, DC, U.S. Government Printing Office. 1975.

Thatcher, A.R., V. Kannisto, and J.W. Vaupel, The Force of Mortality at Ages 80 to 120. Monographs on Population Aging, 5. Odense University Press. 1998.

Vaupel, J.W., K.G. Manton, and E. Stallard, "The Impact of Heterogeneity in Individual Frailty on the Dynamics of Mortality," Demography, 16(3), 1979, pp. 439-454.

Vaupel, J.W. and A.I. Yashin, The deviant dynamics of death in heterogeneous populations. IIASA Research Report, No. RR-83-1. Laxenburg, Austria. International Institute for Applied Systems Analysis. 1983.

Table 1. Slopes of 1984-1999 Trend Lines fit to Force of Mortality Estimates (10000:) for Single-year Age Intervals 0-99

Age	Total Male	Total Female	HISP Male	HISP Female	BNH Male	BNH Female	NBNH Male	NBNH Female
0	-3.11736	-2.29437	-2.84296	-1.97295	-2.80308	-2.32480	-3.09614	-2.23654
1	-0.22032	-0.18577	-0.21618	-0.19832	-0.10973	-0.09641	-0.23771	-0.19702
2	-0.14572	-0.12105	-0.16757	-0.09553	-0.12147	-0.11589	-0.14177	-0.12597
3	-0.11040	-0.07566	-0.10320	-0.08198	-0.09207	-0.04677	-0.11406	-0.07901
4	-0.10815	-0.05581	-0.09027	-0.06000	-0.06331	-0.04503	-0.12149	-0.05716
5	-0.07343	-0.04721	-0.05293	-0.02364	-0.04216	-0.02540	-0.08508	-0.05711
6	-0.09262	-0.05188	-0.06516	-0.03635	-0.07680	-0.03932	-0.10244	-0.05802
7	-0.07138	-0.04199	-0.06265	-0.03432	-0.05548	-0.03069	-0.07740	-0.04625
8	-0.06194	-0.03051	-0.02084	-0.02451	-0.04904	-0.04573	-0.07546	-0.02934
9	-0.06063	-0.03226	-0.01771	0.00053	-0.03869	-0.04284	-0.07716	-0.03868
10	-0.06108	-0.03126	-0.04926	-0.00908	-0.04604	-0.01968	-0.06736	-0.03914
11	-0.06556	-0.02154	-0.03404	-0.01099	-0.04341	-0.01642	-0.07739	-0.02515
12	-0.06738	-0.02775	-0.02700	-0.00210	-0.06060	-0.02375	-0.07781	-0.03435
13	-0.05946	-0.03327	-0.02341	-0.03235	0.01717	-0.00937	-0.08311	-0.03815
14	-0.06444	-0.01800	-0.02095	0.03198	-0.01211	0.04020	-0.08409	-0.04047
15	-0.08248	-0.04979	-0.05900	-0.03158	0.10606	-0.02996	-0.12641	-0.05785
16	-0.08401	-0.01693	-0.09403	-0.00871	0.21281	0.04205	-0.14279	-0.03081
17	-0.11518	-0.02396	-0.16026	-0.00007	0.37822	0.02448	-0.20796	-0.03850
18	-0.14847	-0.05737	-0.23966	-0.05612	0.63197	0.00730	-0.28939	-0.07060
19	-0.14504	-0.07267	-0.30123	-0.04542	0.50720	0.02511	-0.24748	-0.09839
20	-0.20575	-0.05911	-0.32232	-0.02836	0.42081	0.01968	-0.31108	-0.08184
21	-0.14403	-0.07198	-0.34013	-0.04545	0.48890	0.01329	-0.22895	-0.09508
22	-0.19296	-0.04813	-0.36649	-0.05251	0.54263	0.06103	-0.29519	-0.06941
23	-0.21693	-0.08075	-0.35658	-0.02655	0.39826	-0.08137	-0.30239	-0.09434
24	-0.26192	-0.08355	-0.35545	-0.08317	0.08736	-0.02450	-0.30893	-0.09735
25	-0.28740	-0.07579	-0.49594	-0.10080	-0.00110	-0.02024	-0.29718	-0.08501
26	-0.26991	-0.07572	-0.45657	-0.08670	0.01034	-0.07618	-0.28870	-0.07725
27	-0.28435	-0.04891	-0.48932	-0.04723	-0.08319	-0.03994	-0.28315	-0.05516
28	-0.29055	-0.05469	-0.51896	-0.11917	0.03530	0.03911	-0.30424	-0.06174
29	-0.29451	-0.05817	-0.58144	-0.07451	-0.24000	-0.09609	-0.25717	-0.05502
30	-0.38081	-0.06122	-0.77597	-0.12288	-0.42851	-0.09761	-0.30793	-0.05013
31	-0.26161	-0.03383	-0.55540	-0.09884	-0.35802	-0.03656	-0.20101	-0.02971
32	-0.27355	-0.03452	-0.66572	-0.06272	-0.56801	-0.05160	-0.16755	-0.03467
33	-0.27522	-0.02095	-0.62776	-0.10636	-0.50604	-0.15613	-0.18480	0.00627
34	-0.22210	-0.03173	-0.57205	-0.07836	-0.60736	-0.13014	-0.11234	-0.01914
35	-0.28366	-0.00453	-0.79602	-0.05829	-0.83117	-0.04085	-0.12828	-0.00044
36	-0.23200	-0.00239	-0.50251	-0.17267	-0.58755	0.04353	-0.14108	0.00373
37	-0.16491	0.05605	-0.50599	-0.00992	-0.70377	0.14513	-0.05999	0.02915
38	-0.14900	0.02185	-0.48228	-0.05335	-0.34865	0.14926	-0.09184	-0.00951

Table 1 (continued). Slopes of 1984-1999 Trend Lines fit to Force of Mortality Estimates (10000:) for Single-year Age Intervals 0-99

Age	Total Male	Total Female	HISP Male	HISP Female	BNH Male	BNH Female	NBNH Male	NBNH Female
39	-0.11407	0.00248	-0.33811	0.05317	-0.48435	0.13512	-0.06268	-0.05619
40	-0.15801	-0.07563	-0.51343	-0.03399	-0.46877	-0.07833	-0.09602	-0.11080
41	0.02209	0.02732	-0.37570	0.06250	0.33766	0.29469	0.00738	-0.04665
42	-0.11507	-0.06898	-0.50647	0.00979	-0.04535	0.17065	-0.09741	-0.14320
43	0.02170	-0.04497	-0.22928	-0.02312	0.32880	0.18499	-0.00370	-0.11233
44	-0.09868	-0.13885	-0.42077	-0.06438	0.11398	0.01537	-0.09508	-0.19370
45	-0.20077	-0.23433	-0.24006	0.02293	0.38801	-0.05744	-0.25089	-0.30280
46	-0.18596	-0.21315	0.10190	-0.09449	0.79306	0.08733	-0.28824	-0.27071
47	-0.36885	-0.29167	-0.08103	-0.07255	0.20302	-0.28311	-0.43380	-0.33378
48	-0.37354	-0.30217	0.18460	-0.04806	0.88790	0.08716	-0.49240	-0.37294
49	-0.57885	-0.39652	-0.09471	-0.18338	0.17228	-0.31818	-0.67717	-0.43761
50	-0.99749	-0.56236	-0.59370	-0.23831	-0.21354	-0.71009	-1.03124	-0.56384
51	-0.96033	-0.55371	-0.35484	-0.16091	-0.36026	-1.02372	-0.96792	-0.51366
52	-1.28248	-0.64137	-0.76630	-0.35858	-0.05898	-0.61915	-1.34372	-0.64846
53	-1.19394	-0.56592	-0.53105	-0.16060	0.19173	-0.69881	-1.32123	-0.58870
54	-1.50686	-0.78904	-0.54298	-0.51244	-0.60092	-1.32094	-1.63620	-0.76268
55	-1.74657	-0.76587	-0.52425	-0.29434	-1.48099	-1.47992	-1.85763	-0.75389
56	-1.76696	-0.68069	-0.74860	-0.45285	0.18013	-0.91751	-1.97919	-0.70031
57	-1.98501	-0.81008	-0.79838	-0.44864	-1.21156	-1.46405	-2.14208	-0.81490
58	-2.28267	-0.93471	-1.02436	-0.51000	0.45997	-0.74884	-2.58376	-1.01952
59	-2.54589	-0.88111	-1.04234	-0.38194	-0.71122	-1.55401	-2.83375	-0.90716
60	-3.00265	-1.26963	-1.45816	-1.06507	-2.32029	-2.27486	-3.17836	-1.23239
61	-2.75669	-0.92928	-1.28704	-0.59741	-0.60857	-1.65057	-3.05286	-0.94444
62	-3.05261	-1.13286	-1.05397	-0.87947	-2.54369	-2.94969	-3.26985	-1.04409
63	-3.32891	-1.03569	-1.65775	-0.74760	-1.38877	-2.01969	-3.62198	-1.02603
64	-3.49978	-1.22013	-1.32246	-0.46542	-4.11722	-3.49491	-3.65740	-1.13659
65	-4.45491	-1.52692	-1.91831	-0.61276	-8.30829	-5.22448	-4.36121	-1.33669
66	-4.34387	-1.55881	-0.82080	-0.86399	-9.00647	-4.04249	-4.26483	-1.44981
67	-4.72048	-1.57733	-2.08637	-0.99264	-7.02169	-5.09561	-4.70814	-1.37194
68	-4.91294	-1.56542	-1.31324	-0.25752	-6.07210	-2.79534	-5.00988	-1.55541
69	-5.18393	-1.42660	-1.68679	-0.34878	-5.18628	-1.27207	-5.37024	-1.52872
70	-6.20567	-1.96577	-2.69507	-1.37121	-3.54356	-2.44841	-6.54482	-1.96611
71	-6.06812	-1.59946	-1.38242	-0.69278	-2.65879	-0.91237	-6.53094	-1.71005
72	-8.17429	-2.05159	-1.81741	-0.96011	-3.89894	0.06138	-8.74647	-2.25565
73	-8.13514	-2.11424	-1.61063	-0.12157	-5.89501	-0.82179	-8.58536	-2.29464
74	-9.14701	-2.48838	-1.20947	-0.86166	-10.56990	-3.10739	-9.44789	-2.52648
75	-9.31418	-2.86810	-0.74533	-1.11492	-8.38724	-3.18508	-9.80873	-2.90549
76	-10.50587	-3.16005	-0.84337	-1.73765	-5.39648	-0.42111	-11.35331	-3.40955
77	-10.46667	-2.64758	-3.52253	-0.44253	-2.50194	-1.10495	-11.46112	-2.88654

Table 1 (continued). Slopes of 1984-1999 Trend Lines fit to Force of Mortality Estimates (10000:) for Single-year Age Intervals 0-99

Age	Total Male	Total Female	HISP Male	HISP Female	BNH Male	BNH Female	NBNH Male	NBNH Female
78	-11.78126	-3.52415	-5.75361	-2.30771	-4.74092	-4.50863	-12.71112	-3.55771
79	-12.95995	-3.12117	-3.77003	-0.97065	-12.06647	-4.77385	-13.77681	-3.14293
80	-14.32550	-4.55346	-7.90976	-2.29853	-1.48000	-0.87330	-15.82447	-4.95441
81	-11.33378	-2.86728	-2.43025	-1.40217	-2.39024	0.90189	-12.73456	-3.26152
82	-11.93262	-2.90551	-6.73290	-2.38908	1.91839	6.64459	-13.61786	-3.71726
83	-10.19029	-4.59043	-4.18967	0.28546	5.54667	3.88680	-12.11296	-5.52836
84	-9.49731	-3.82410	-5.37741	0.37711	-9.81298	-4.65749	-10.18849	-4.03992
85	-2.37652	-0.46961	3.03178	-0.48603	16.14560	14.55366	-4.79961	-1.72456
86	-1.95692	-0.87983	-3.47444	-2.53283	12.29486	13.71667	-3.52735	-1.95835
87	-2.70471	-0.19206	-8.57518	0.91517	17.54085	20.80766	-4.63023	-1.89715
88	-9.52847	-4.11086	1.91038	-2.89465	7.85551	17.26271	-12.33230	-5.83376
89	-3.14019	2.39481	7.17374	2.30384	37.51875	35.45789	-9.53694	-0.89183
90	-14.42576	-4.87971	-5.35038	-0.01524	17.21440	19.89977	-18.97520	-7.12466
91	-18.35973	-5.47103	-12.72068	-4.32377	-9.86456	6.28881	-19.60855	-6.24198
92	-11.84064	-3.32034	-8.36239	16.27387	-17.31709	17.65514	-11.30013	-5.64480
93	12.14459	2.81661	7.23221	8.63429	19.46010	27.75772	12.22537	0.50121
94	21.10540	13.45303	10.82170	15.95775	3.25740	24.83796	24.53980	12.43704
95	12.83822	22.76977	3.28813	24.98862	-12.83601	22.50035	18.02303	23.22105
96	8.05982	17.76929	-9.07942	6.11609	-34.90594	6.99124	15.53333	19.83496
97	29.87594	33.34392	-30.73275	4.21377	21.58619	28.88715	36.29286	35.14018
98	42.55061	36.91145	-28.27360	16.27383	31.75453	7.84680	49.04286	41.42042
99	107.11806	87.82886	20.38040	43.49755	74.10158	75.58458	116.28971	89.62029
100	-37.02193	69.40523	-11.12957	19.69687	0.01905	36.50675	-87.02123	74.40589

BNH = Black Non-Hispanic
HISP = Hispanic
NBNH = Non-Black Non-Hispanic

Table 2. Sum of Squared Errors for Prediction of Average Force of Mortality in Single-year Age Intervals 80-95, based on Models fit to ages 80-95

Year	Race/Ethnic Group	Male Logistic	Male Gompertz	Male Weibull	Female Logistic	Female Gompertz	Female Weibull
1984	HISP	0.00199	0.00191	0.00477	0.00088	0.00089	0.00166
1984	BNH	0.00516	0.00513	0.00682	0.00221	0.00212	0.00444
1984	NBNH	0.00204	0.00208	0.00595	0.00029	0.00042	0.00232
1985	HISP	0.00158	0.00169	0.00179	0.00045	0.00049	0.00137
1985	BNH	0.00849	0.00821	0.01325	0.00227	0.00219	0.00405
1985	NBNH	0.00203	0.00239	0.00449	0.00032	0.00049	0.00241
1986	HISP	0.00087	0.00092	0.00190	0.00086	0.00095	0.00127
1986	BNH	0.00663	0.00650	0.00963	0.00232	0.00230	0.00357
1986	NBNH	0.00371	0.00419	0.00554	0.00078	0.00103	0.00252
1987	HISP	0.00280	0.00292	0.00393	0.00048	0.00055	0.00121
1987	BNH	0.01443	0.01429	0.01772	0.00381	0.00381	0.00495
1987	NBNH	0.00341	0.00375	0.00644	0.00069	0.00089	0.00310
1988	HISP	0.00277	0.00295	0.00431	0.00110	0.00121	0.00172
1988	BNH	0.01597	0.01587	0.01861	0.00387	0.00389	0.00519
1988	NBNH	0.00484	0.00523	0.00852	0.00075	0.00090	0.00374
1989	HISP	0.00178	0.00172	0.00468	0.00102	0.00112	0.00243
1989	BNH	0.00725	0.00735	0.00832	0.00219	0.00221	0.00354
1989	NBNH	0.00160	0.00178	0.00630	0.00042	0.00046	0.00377
1990	HISP	0.00123	0.00108	0.00542	0.00063	0.00066	0.00231
1990	BNH	0.00215	0.00207	0.00705	0.00063	0.00056	0.00368
1990	NBNH	0.00044	0.00039	0.00608	0.00014	0.00010	0.00369
1991	HISP	0.00113	0.00106	0.00479	0.00030	0.00030	0.00246
1991	BNH	0.00307	0.00281	0.00849	0.00104	0.00095	0.00431
1991	NBNH	0.00050	0.00025	0.00670	0.00017	0.00010	0.00376
1992	HISP	0.00101	0.00102	0.00325	0.00037	0.00040	0.00191
1992	BNH	0.00375	0.00345	0.00868	0.00088	0.00081	0.00343
1992	NBNH	0.00089	0.00054	0.00750	0.00026	0.00015	0.00384
1993	HISP	0.00090	0.00093	0.00288	0.00025	0.00029	0.00124
1993	BNH	0.00111	0.00098	0.00444	0.00145	0.00131	0.00443
1993	NBNH	0.00113	0.00065	0.00800	0.00027	0.00011	0.00417
1994	HISP	0.00031	0.00036	0.00149	0.00079	0.00066	0.00326
1994	BNH	0.00239	0.00233	0.00478	0.00081	0.00078	0.00250
1994	NBNH	0.00086	0.00060	0.00647	0.00024	0.00015	0.00367
1995	HISP	0.00165	0.00180	0.00225	0.00045	0.00041	0.00243
1995	BNH	0.00492	0.00480	0.00759	0.00128	0.00125	0.00280
1995	NBNH	0.00052	0.00054	0.00487	0.00015	0.00010	0.00337
1996	HISP	0.00063	0.00072	0.00160	0.00011	0.00013	0.00151
1996	BNH	0.00125	0.00133	0.00107	0.00050	0.00055	0.00107
1996	NBNH	0.00017	0.00032	0.00393	0.00006	0.00005	0.00315

Table 2 (continued). Sum of Squared Errors for Prediction of Average Force of Mortality in Single-year Age Intervals 80-95, based on Models fit to ages 80-95

Year	Race/Ethnic Group	Male Logistic	Male Gompertz	Male Weibull	Female Logistic	Female Gompertz	Female Weibull
1997	HISP	0.00033	0.00032	0.00229	0.00028	0.00023	0.00240
1997	BNH	0.00082	0.00087	0.00149	0.00066	0.00066	0.00197
1997	NBNH	0.00036	0.00034	0.00497	0.00024	0.00014	0.00382
1998	HISP	0.00100	0.00095	0.00360	0.00016	0.00020	0.00154
1998	BNH	0.00085	0.00092	0.00100	0.00060	0.00060	0.00204
1998	NBNH	0.00033	0.00032	0.00505	0.00036	0.00026	0.00399
1999	HISP	0.00056	0.00059	0.00254	0.00042	0.00045	0.00217
1999	BNH	0.00215	0.00229	0.00219	0.00045	0.00053	0.00151
1999	NBNH	0.00048	0.00052	0.00519	0.00026	0.00024	0.00389
Overall Sum		0.12424	0.12404	0.26864	0.03894	0.03903	0.13957
Sum Both Sexes		0.16318	0.16307	0.40821			
Overall HISP		0.02054	0.02096	0.05150	0.00856	0.00894	0.03088
Overall BNH		0.08039	0.07918	0.12112	0.02497	0.02451	0.05346
Overall NBNH		0.02331	0.02390	0.09601	0.00541	0.00558	0.05522
Sum Both Sexes Overall HISP		0.02910	0.02990	0.08239			
Sum Both Sexes Overall BNH		0.10536	0.10369	0.17459			
Sum Both Sexes Overall NBNH		0.02872	0.02948	0.15124			

BNH = Black Non-Hispanic
HISP = Hispanic
NBNH = Non-Black Non-Hispanic

Table 3. Sums of Squared Errors for Prediction of Average Force of Mortality in Single-year Age Intervals 80-99, based on models fit to ages 90-95

Year	Race/Ethnic Group	Male Logistic	Male Gompertz	Male Weibull	Female Logistic	Female Gompertz	Female Weibull
1984	HISP	0.00767	0.00545	0.03004	0.01139	0.00991	0.02753
1984	BNH	0.01206	0.01173	0.02171	0.01499	0.01354	0.03418
1984	NBNH	0.01462	0.02307	0.00775	0.00316	0.00709	0.00511
1985	HISP	0.00870	0.00918	0.01127	0.00156	0.00162	0.00899
1985	BNH	0.04023	0.04215	0.04388	0.01383	0.01244	0.03200
1985	NBNH	0.01458	0.02095	0.00968	0.00448	0.00902	0.00605
1986	HISP	0.01638	0.01559	0.03085	0.00531	0.00523	0.01250
1986	BNH	0.02156	0.02283	0.02309	0.01956	0.01865	0.03461
1986	NBNH	0.02101	0.02714	0.01486	0.00553	0.00875	0.01038
1987	HISP	0.00967	0.01095	0.01157	0.00567	0.00691	0.00610
1987	BNH	0.02479	0.02630	0.02727	0.01891	0.01808	0.03309
1987	NBNH	0.01922	0.02584	0.01827	0.00428	0.00860	0.00913
1988	HISP	0.03174	0.03713	0.02036	0.00452	0.00551	0.00580
1988	BNH	0.03504	0.03553	0.04211	0.00938	0.00872	0.02161
1988	NBNH	0.01292	0.01815	0.01957	0.00172	0.00525	0.01087
1989	HISP	0.00365	0.00550	0.00812	0.01259	0.01647	0.00758
1989	BNH	0.01133	0.01144	0.01877	0.00772	0.00699	0.02088
1989	NBNH	0.00660	0.01240	0.01323	0.00280	0.00728	0.01045
1990	HISP	0.04297	0.05496	0.02255	0.01320	0.01797	0.00607
1990	BNH	0.02186	0.02634	0.01528	0.00451	0.00623	0.00785
1990	NBNH	0.00966	0.01687	0.01655	0.00172	0.00461	0.01309
1991	HISP	0.01049	0.01493	0.00809	0.01295	0.01924	0.00414
1991	BNH	0.01020	0.01178	0.01760	0.00122	0.00136	0.01113
1991	NBNH	0.00141	0.00474	0.01835	0.00033	0.00116	0.01600
1992	HISP	0.00813	0.01077	0.00661	0.00397	0.00626	0.00289
1992	BNH	0.00968	0.01168	0.01284	0.00143	0.00173	0.00910
1992	NBNH	0.00269	0.00909	0.01430	0.00040	0.00213	0.01317
1993	HISP	0.00991	0.01329	0.00371	0.00319	0.00466	0.00184
1993	BNH	0.00144	0.00149	0.01201	0.00251	0.00332	0.00893
1993	NBNH	0.00371	0.01173	0.01281	0.00047	0.00318	0.01323
1994	HISP	0.00865	0.01093	0.00254	0.01406	0.01961	0.00423
1994	BNH	0.00526	0.00583	0.00959	0.00170	0.00127	0.01210
1994	NBNH	0.00553	0.01435	0.00939	0.00059	0.00324	0.01154
1995	HISP	0.01305	0.01558	0.00364	0.01239	0.01709	0.00401
1995	BNH	0.01164	0.01343	0.00892	0.00172	0.00182	0.00812
1995	NBNH	0.00679	0.01532	0.00757	0.00095	0.00458	0.00960
1996	HISP	0.01670	0.01987	0.00475	0.01694	0.02180	0.00440
1996	BNH	0.00161	0.00176	0.00321	0.00128	0.00117	0.00747
1996	NBNH	0.00872	0.01834	0.00450	0.00249	0.00799	0.00612

Table 3 (continued). Sums of Squared Errors for Prediction of Average Force of Mortality in Single-year Age Intervals 80-99, based on models fit to ages 90-95

Year	Race/Ethnic Group	Male Logistic	Male Gompertz	Male Weibull	Female Logistic	Female Gompertz	Female Weibull
1997	HISP	0.01867	0.02376	0.00511	0.02507	0.03323	0.00826
1997	BNH	0.01054	0.01217	0.00380	0.00302	0.00388	0.00461
1997	NBNH	0.02795	0.04689	0.00805	0.00753	0.01730	0.00454
1998	HISP	0.04751	0.05677	0.02045	0.02638	0.03258	0.00880
1998	BNH	0.01400	0.01559	0.00461	0.00728	0.00919	0.00300
1998	NBNH	0.03777	0.05976	0.01151	0.01264	0.02568	0.00417
1999	HISP	0.05028	0.05962	0.02075	0.04471	0.05565	0.01746
1999	BNH	0.02593	0.02877	0.01015	0.00900	0.01142	0.00302
1999	NBNH	0.05380	0.08180	0.01898	0.01764	0.03463	0.00465
Overall Sum		0.80835	1.04955	0.69061	0.39872	0.54408	0.53044
Sum Both Sexes		1.20706	1.59363	1.22104			
Overall HISP		0.30417	0.36428	0.21042	0.21391	0.27375	0.13062
Overall BNH		0.25716	0.27884	0.27482	0.11807	0.11982	0.25171
Overall NBNH		0.24701	0.40643	0.20536	0.06674	0.15051	0.14811
Sum Both Sexes Overall HISP		0.51808	0.63803	0.34104			
Sum Both Sexes Overall BNH		0.37523	0.39866	0.52653			
Sum Both Sexes Overall NBNH		0.31375	0.55694	0.35348			

BNH = Black Non-Hispanic
HISP = Hispanic
NBNH = Non-Black Non-Hispanic

Appendix Table A. Availability of State-Level Data on Mortality by Hispanic Origin.

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997+
Alabama	0	0	0	0	1	1	1	1	1	1	1	1	1	1
Alaska	0	0	0	0	0	1	1	1	1	1	1	1	1	1
Arizona	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Arkansas	1	1	1	1	1	1	1	1	1	1	1	1	1	1
California	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Colorado	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Connecticut	0	0	0	0	0	1	1	1	1	1	1	1	1	1
Delaware	0	0	0	0	0	1	1	1	1	1	1	1	1	1
District of Columbia	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Florida	0	0	0	0	0	1	1	1	1	1	1	1	1	1
Georgia	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Hawaii	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Idaho	0	0	0	0	0	1	1	1	1	1	1	1	1	1
Illinois	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Indiana	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Iowa	0	0	0	0	0	1	1	1	1	1	1	1	1	1
Kansas	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Kentucky	0	0	0	0	1	1	1	1	1	1	1	1	1	1
Louisiana	0	0	0	0	0	1	1	1	1	1	1	1	1	1
Maine	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Maryland	0	0	0	0	0	1	1	1	1	1	1	1	1	1
Massachusetts	0	0	0	0	0	1	1	1	1	1	1	1	1	1
Michigan	0	0	0	0	0	1	1	1	1	1	1	1	1	1
Minnesota	0	0	0	0	0	1	1	1	1	1	1	1	1	1
Mississippi	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Missouri	0	0	0	0	0	1	1	1	1	1	1	1	1	1
Montana	0	0	0	0	1	1	1	1	1	1	1	1	1	1
Nebraska	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Nevada	1	1	1	1	1	1	1	1	1	1	1	1	1	1
New Hampshire	0	0	0	0	0	0	0	0	0	1	1	1	1	1
New Jersey	1	1	1	1	1	1	1	1	1	1	1	1	1	1
New Mexico	1	1	1	1	1	1	1	1	1	1	1	1	1	1
New York	1	1	1	1	1	1	1	1	1	1	1	1	1	1
North Carolina	0	0	0	0	1	1	1	1	1	1	1	1	1	1
North Dakota	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Ohio	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Oklahoma	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Oregon	0	0	0	0	1	1	1	1	1	1	1	1	1	1
Pennsylvania	0	0	0	0	0	1	1	1	1	1	1	1	1	1
Rhode Island	0	0	0	0	1	1	1	1	1	1	1	1	1	1
South Carolina	0	0	0	0	0	1	1	1	1	1	1	1	1	1

Appendix Table A (continued). Availability of State-Level Data on Mortality by Hispanic Origin.

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997+
South Dakota	0	0	0	0	0	1	1	1	1	1	1	1	1	1
Tennessee	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Texas	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Utah	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Vermont	0	0	0	0	0	1	1	1	1	1	1	1	1	1
Virginia	0	0	0	0	0	1	1	1	1	1	1	1	1	1
Washington	0	0	0	0	1	1	1	1	1	1	1	1	1	1
West Virginia	0	0	0	0	0	1	1	1	1	1	1	1	1	1
Wisconsin	0	0	0	0	0	1	1	1	1	1	1	1	1	1
Wyoming	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Total	23	23	23	23	30	49	49	49	49	50	50	50	50	51

0 = Not Available; 1 = Available

**Figure 1. Force of Mortality Among Non-Black Non-Hispanic Males
1984-1999**

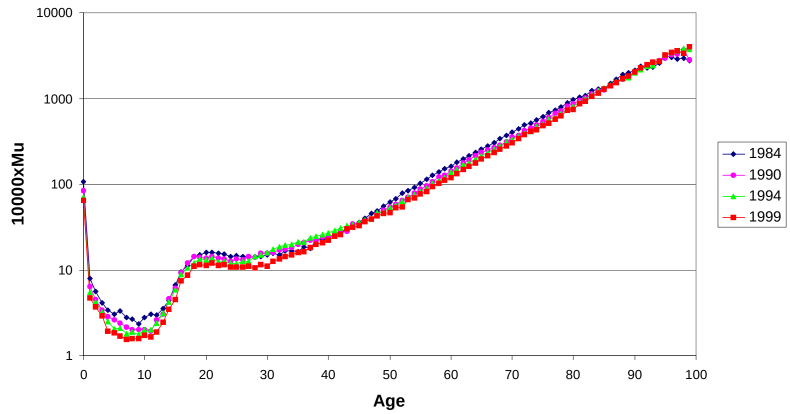


**Figure 2. Force of Mortality Among Black Non-Hispanic Males
1984-1999**

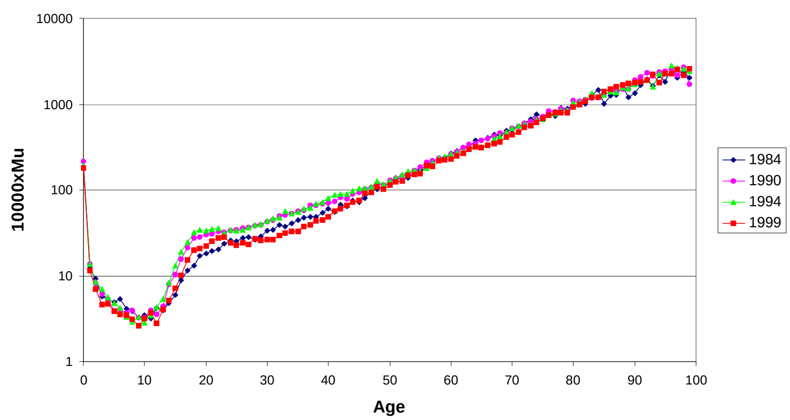
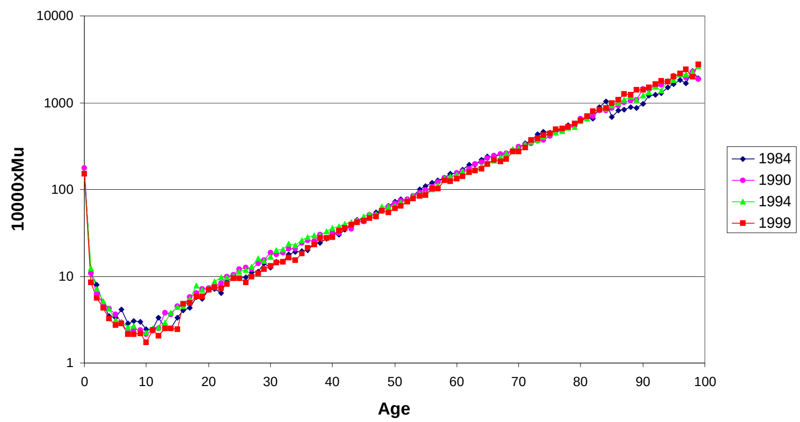
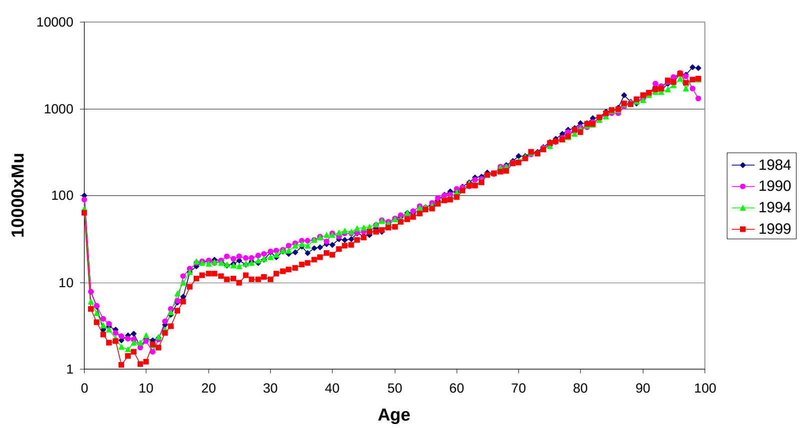


Figure 3. Force of Mortality Among Black Non-Hispanic Females 1984-1999



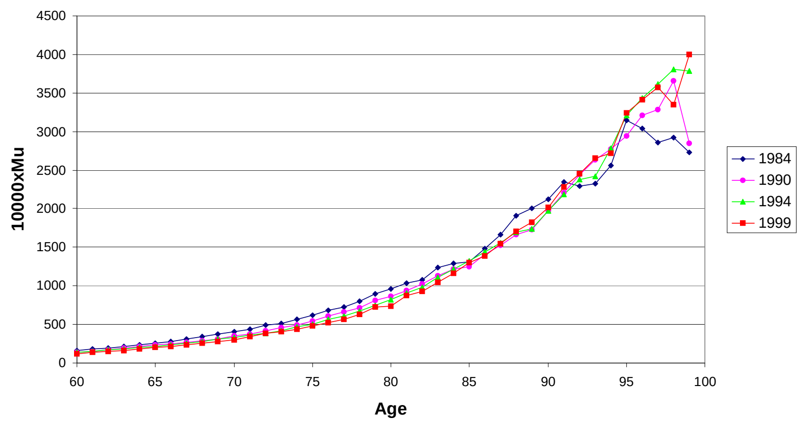
U S C E N S U S B U R E A U

Figure 4. Force of Mortality Among Hispanic Males 1984-1999



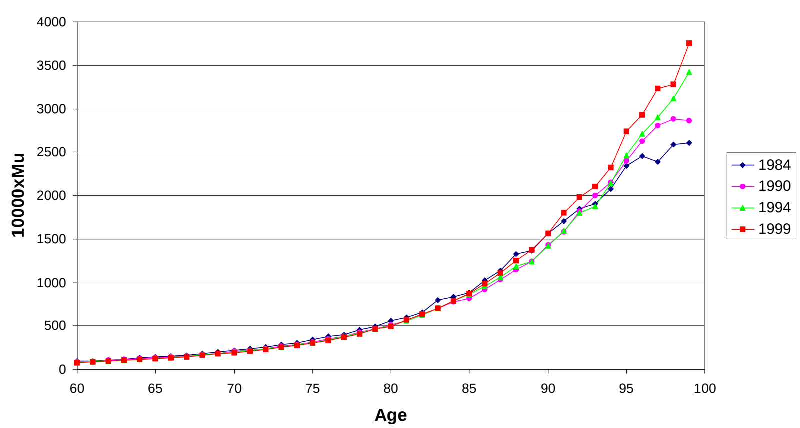
U S C E N S U S B U R E A U

Figure 5. Force of Mortality Among Non-Black Non-Hispanic Males
Ages 60-99
1984-1999



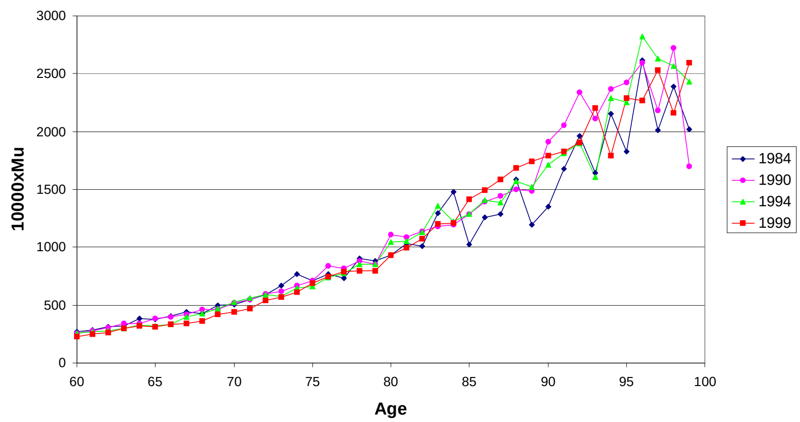
U S C E N S U S B U R E A U

Figure 6. Force of Mortality Among Non-Black Non-Hispanic Females
Ages 60-99
1984-1999



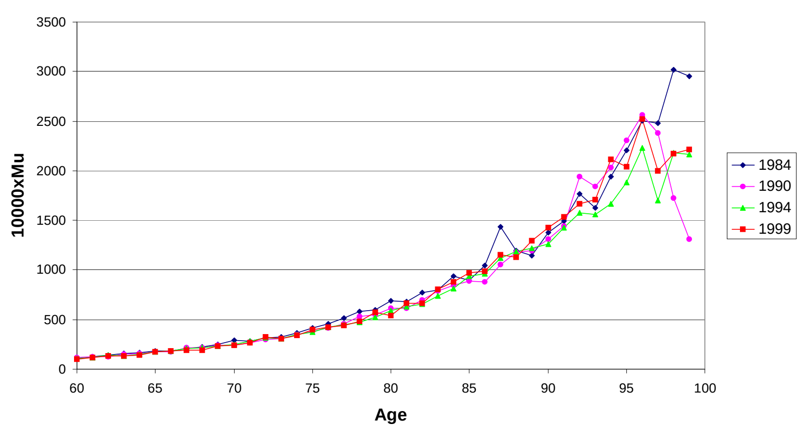
U S C E N S U S B U R E A U

Figure 7. Force of Mortality Among Black Non-Hispanic Males Ages 60-99 1984-1999



U S C E N S U S B U R E A U

Figure 8. Force of Mortality Among Hispanic Males Ages 60-99 1984-1999



U S C E N S U S B U R E A U

Figure 9. Observed Force of Mortality and Models Fit to Ages 80-95 Non-Black Non-Hispanic Males 1999

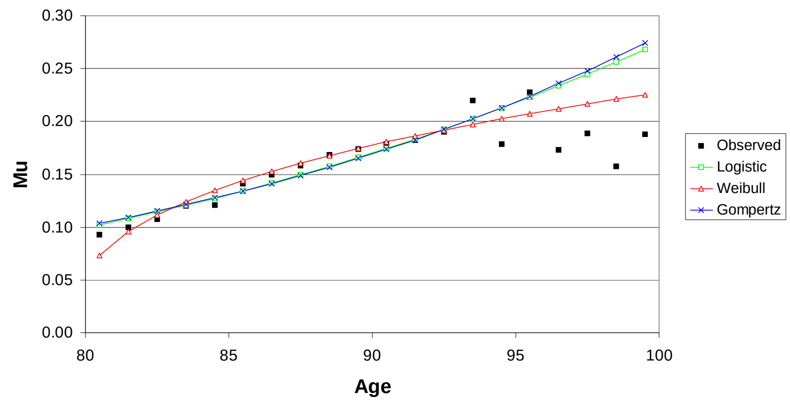


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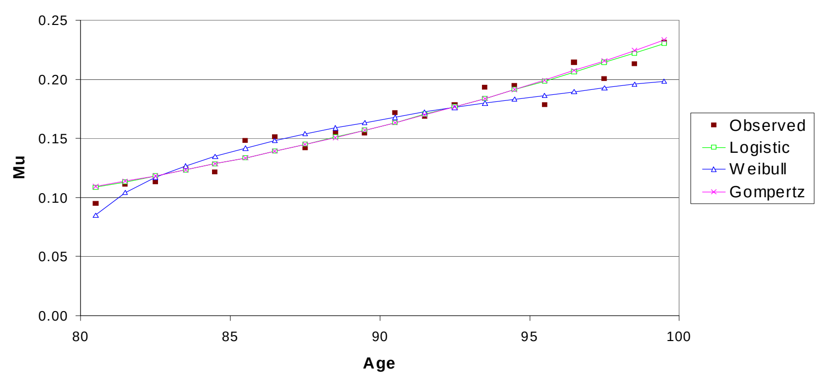
Figure 10. Observed Force of Mortality and Models Fit to Ages 80-95 Black Non-Hispanic Males 1996



U S C E N S U S B U R E A U

Figure 11. Observed Force of Mortality and Models Fit to Ages 80-95 Non-Black Non-Hispanic Females 1999

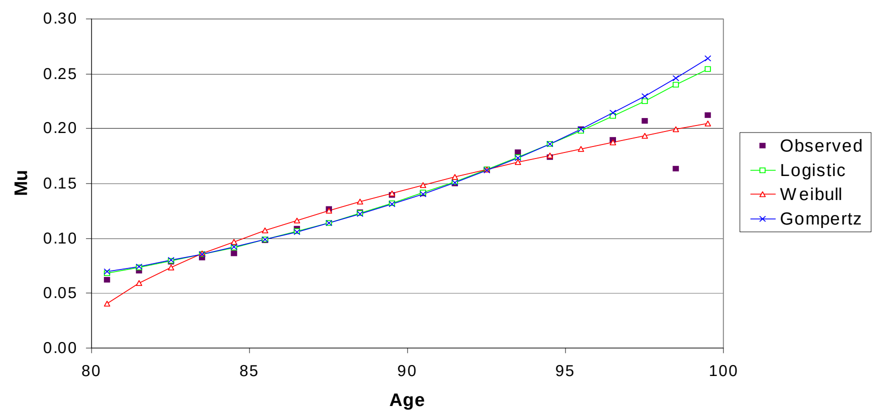


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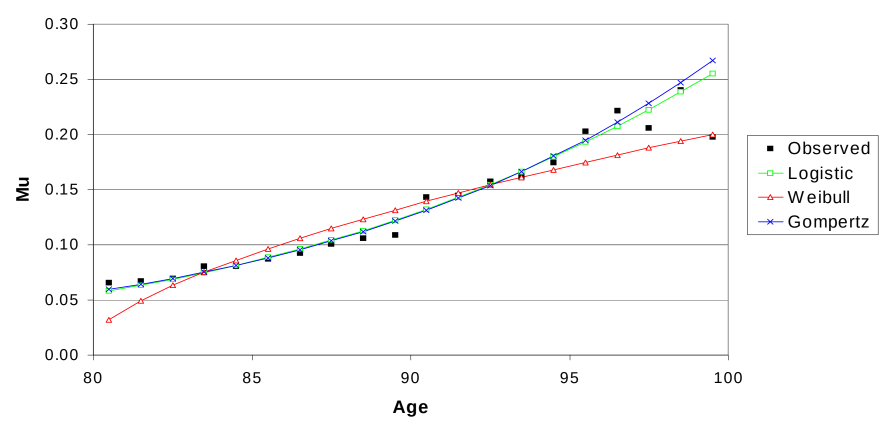
Figure 12. Observed Force of Mortality and Models Fit to Ages 80-95 Black Non-Hispanic Females 1990



U S C E N S U S B U R E A U

Occupational Employment, Forecasts, and Analysis

Session Chair: George Stamas, Bureau of Labor Statistics

Estimating the Number of Pharmacy Students and Residents Who May Seek Employment with the Department Of Veterans Affairs

Dilpreet K. Singh, MS, MPA, Linda D. Johnson, PhD, RN, Lori Golterman, PharmD, Evert M. Melander, MBA and Gloria J. Holland, PhD, U. S. Department of Veterans Affairs

The Department of Veterans Affairs (VA) is one of the largest health care systems in the world. VA employs over 5,200 pharmacists; however, of this group 41% of Pharmacy Supervisors and 33% of Pharmacy Chiefs are eligible for retirement. The shortage of pharmacists and the increased demand for prescriptions continues to add pressure to a workforce which is already stressed.

A significant percent of all pharmacy students and residents trained in the United States receive a part or all of their training with VA. VA clinical trainees can be a great source of future recruits at VA. A Pharmacist Recruitment and Retention Survey was conducted to assist with VA's recruitment efforts. This paper presents some of the results of the survey including major factors that led pharmacists to seek and accept employment with VA.

An Evaluation of the National Center for Education Statistics Projections of Newly Hired Teachers

William Hussar, Department of Education

This paper is a follow-up to the 1999 National Center for Education Statistics (NCES) report, Predicting the Need for Newly Hired Teachers in the United States to 2008–09 (Hussar 1999). In that earlier report, projections for the number of newly hired teachers to 2008–09 were presented for both the public and private sectors. These projections were developed using an algebraic model based on teacher demographic data from 1993–94 Schools and Staffing Surveys (SASS) and 1994–95 Teacher Follow-up Surveys (TFS). The first section of this report reviews the methodology used to produce projections of newly hired teachers and the assumptions underlying this methodology. The second section consists of an evaluation of the 1999–2000 and 2003–04 projections of the newly hired teachers from the original report using data from the 1999–2000 SASS and the 2003–04 SASS. In this section, the percentage difference between the actual numbers and the projections are calculated and possible explanations are offered for some of the larger differences. Beside the evaluation of the teacher projections, there is also an evaluation of projections of the age distribution for 1999–2000 and 2003–04.

Occupational Change During the 20th Century

Ian Wyatt, Bureau of Labor Statistics

Occupational changes during the 20th Century provides an analysis of census occupational data over the 1910-2000 period. While some changes may be obvious, such as the decline of agricultural employment, the scale of the changes is still quite impressive. Other changes, such as the trends in the employment of lawyers, are quite surprising. In addition to simply describing the changes, the article attempts to explain the causes of the many changes in occupational employment.

Estimating the Number of Pharmacy Students and Residents Who May Seek Employment with the Department Of Veterans Affairs

Dilpreet K. Singh, MS, MPA, Linda D. Johnson, PhD, RN, Lori Golterman, PharmD, Evert M. Melander, MBA, and Gloria J. Holland, PhD

1. INTRODUCTION

Recently, it was reported that, "The critical labor shortages from the past decade spawned a dramatic rise in demand for freshly graduated pharmacists. The demand for pharmacists is skyrocketing due to the aging population."(1)

The Department of Veterans Affairs (VA) is one of the largest health care systems in the world. VA employs over 5,200 pharmacists, however, of this group 41% of Pharmacy Supervisors and 33% of Pharmacy Chiefs are eligible for retirement. The shortage of pharmacists and the increased demand for prescriptions continues to add pressure to a workforce which is already stressed.

One of VA's goals is to be a preferred training site and an employer of choice for those in the medical field. A significant percent of all pharmacy students and residents trained in the United States receive a part or all of their training with VA. VA clinical trainees can be a great source of future recruits at VA. A Pharmacist Recruitment and Retention Survey was conducted to assist with VA's recruitment efforts. This paper presents some of the results of the survey including major factors that led pharmacists to seek and accept employment with VA.

2. SCOPE OF CLINICAL TRAINING PROGRAMS

The Office of Academic Affiliations (OAA) in VA conducts an education and training program for health professional trainees through partnerships with affiliated academic institutions. Over 92,000 medical and associated health students, physician residents and fellows receive some or all of their clinical training at VA facilities, annually. These include approximately 31,000 physician residents, 17,000 medical students and 44,000 associated health trainees. The associated health training program includes 40 health professions, such as nurses, pharmacists, dentists, audiologists, dietitians, social workers, psychologists, physical therapists, optometrists, podiatrists, physician assistants, and respiratory therapists. Approximately $67 million of VA funding is provided each year to almost 3,500 associated health trainees. Of this, pharmacy residency training is budgeted for about $12 million and is the largest pharmacy residency program in the country. In addition, a great majority of associated health trainees receive clinical experiences on a without compensation (WOC) basis.

3. BACKGROUND

OAA conducts an annual Learners' Perceptions Survey (LPS) to determine satisfaction of trainees with their VA clinical training experience. Since one of VA's goals is to be an employer of choice, two employment related questions were included in the LPS:

a. Before this clinical training experience, how likely were you to consider a future employment opportunity at a VA medical facility – Very likely, Somewhat likely, Had not thought about it, Somewhat unlikely, or Very unlikely?

b. As a result of this clinical training experience, how likely would you be to consider a future employment opportunity at a VA medical facility – A lot more likely, Somewhat more likely, No difference, Somewhat less likely, or A lot less likely?

The 2006 LPS results indicated that training at a VA facility doubles the likelihood of pharmacy students and residents to consider employment with VA (37% before to 76% after training). To further explore this finding, a Pharmacist Recruitment and Retention Survey was conducted to determine the number of VA pharmacists (appointed within the last five years) who received a part or all of their training at VA and to identify major factors including clinical education that impact seeking employment with VA.

4. PHARMACISTS RECRUITMENT AND RETENTION SURVEY

a. Literature Review and Focus Group Studies: A systematic review of literature was conducted followed by focus group studies at four VA medical centers with the assistance of Schulman, Ronca, & Bucuvalas, Inc., a contractor with expertise in conducting large scale surveys. The literature review served as a basis for developing a draft questionnaire. The purpose of the focus groups was to refine the questionnaire in order to make it more relevant to the target audience, namely, pharmacists recently employed at VA. Their comments were used to revise the questionnaire which included deleting less relevant items and adding more relevant items that were missed.

b. Questionnaire Finalized: A VA workgroup was established to guide the process of determining factors that impact recruitment of pharmacists at VA. One of the goals was to estimate the number of pharmacy students and residents who may seek future employment with VA. The workgroup consisted of representatives from the Office of Academic Affiliations, Pharmacy Benefits Management Strategic Healthcare Group, Healthcare Recruitment and Retention Office, and Office of Human Resources and Labor Relations. The draft questionnaire was finalized by the workgroup.

Some of the questions included in the Pharmacists Recruitment and Retention Survey Questionnaire are provided at the end of this document. The respondents were asked to rate their satisfaction using a 5-point Likert scale.

c. Sample Disposition: A sample of VA pharmacists who were appointed within the last five years was drawn from the VA Payroll System. Approximately, 1,400 recently appointed VA pharmacists were contacted by the Chiefs of Pharmacy Service via e-mail to complete the survey. Response to the survey was voluntary and could be completed in 10-15 minutes. The timeframe for completing the survey was two weeks.

5. RESULTS OF THE SURVEY

a. Response Rate: Of the 1,400 VA participants, 809 VA pharmacists responded to the web-based survey with a response rate of 57.8 percent.

b. VA Pharmacists Trained at VA: The employees surveyed represented both those trained at VA and those never trained at VA. Based on this survey, almost half (47%) of those who were appointed to VA within the past five years had trained at VA.

c. Importance of VA's Training in making Decision to Accept VA Employment (Figure #1): Fifty seven percent of those who trained at VA considered their training as very or moderately important in their decision to seek VA employment.

d. Recommend VA Training to Others (Figure #2): "Recommending VA Training to Others" is a proxy measure for training satisfaction. Overall, 87 percent of the respondents who trained at VA would be very or somewhat likely to recommend training to others.

Trainees whose training was longer than three months were much more likely to recommend VA training to others, with recommendation rates in the 90 percent range. Virtually everyone who trained for 4 to 6 months would recommend their VA training to others, with recommendation rates dropping slightly as the length of training increased.

e. Performance Score (Figure #3): On a scale of 0 to 100, VA clinical training was given a score of 85, where 100 is a perfect score and 70 is a passing score. Figure 3 also includes performance score by level of education of pharmacists. The performance score given by the pharmacists with graduate degrees is slightly higher than for those with baccalaureate degree (88 for MA and 86 for PharmD vs. 82 for BA).

f. VA vs. Non-VA Training (Figure #4): When VA training was compared to non-VA training, VA training was given a higher rating than non-VA training for all three areas, i.e., Personal mentoring (96% vs.48%), Quality of preceptors (74% vs. 51%), and Orientation program (46% vs. 36%).

g. Importance of Factors in Job Search (Figure #5): In job search, several factors were considered very or somewhat important by over 60% of the pharmacists. Specifically, Other Benefits i.e., vacation, sick leave, etc. (97%), Salary (95%), Desired Work Schedule (94%), Working Environment (94%), Opportunities for Career Advancement and Learning including earning and promotion potential (88%), Completely Electronic Health Record (78%), Physical Environment (76%), Interdisciplinary Care (75%), Computerized Medication Delivery (69%), Opportunity to Practice in Pharmacist-run Clinics (69%), and Ability to Relocate within the System (65%).

h. VA vs. Non-VA Employment Comparisons (Figure #6): Among those who looked for a job both in VA and non-VA, 50 percent or more found VA to be somewhat or a lot better in various areas: Completely Electronic Health Record at 85 percent; Computerized Medication Delivery (72%), Ability to Relocate within the System (69%), Opportunity to Practice in Pharmacist-Run Clinics (67%), Prescriptive Authority (65%), Desired Work Schedule (62%), Benefits (52%) and Interdisciplinary Care (51%).

6. HIGHLIGHTS

- Almost half (47%) of the VA pharmacists appointed within the past five years received training at VA.

- Fifty seven percent of those who trained at VA considered their training as very or moderately important in their decision to seek VA employment.

- Close to nine in ten (87%) of those who trained at VA would be very or somewhat likely to recommend VA training to others.

7. CONCLUSION

Since there is a shortage of pharmacists, VA trainees serve as an excellent recruitment pool. Based on the Learners' Perceptions Survey, VA training doubles the likelihood that pharmacy students and residents will seek employment with VA. Results of the Recruitment and Retention Survey show that almost half (47%) of the recently employed pharmacists were trained at VA. This information may assist in estimating the number of VA pharmacy students and residents who might seek employment with VA. However, other major factors that have an impact on the search for employment must also be considered, such as Salary, Other Benefits, Desired Work Schedule, Working Environment, and Opportunities for Career Advancement and Learning.

Reference (1): "Pharmacy Pay Still on Rise," Drug Store News; July 17, 2006, Vol. 28 Issue 9, P18.

APPENDIX

The following are some of the questions from the Pharmacists Recruitment and Retention Survey:

1. When you were a pharmacy student, did you receive any pharmacy education at a VA facility? (Externship, Internship)

2. How important was your VA pharmacy training in your decision to accept your current job?

3. How likely are you to recommend training at a VA facility to others?

4. On a scale of 0 to 100, where 100 is a perfect score and 70 is a passing score, what numerical score would you give your most recent VA pharmacy training?

5. How would you rate each of the following aspects of your most recent VA [or non-VA] pharmacy training?

a. Personal mentoring

b. Quality of preceptors

c. Orientation program

6. How important were each of the following factors in your employment search?

a. Opportunities for career advancement and learning (including earning and promotion potential)

b. Salary

c. Other benefits (vacation, sick leave, etc.)

d. Student loan repayment

e. Tuition reimbursement for future degree

f. Interdisciplinary care

g. Working environment (morale, health care staff, ancillary/support staff and services, workspace, etc.)

h. Physical environment (building, equipment, parking, safety, etc.)

i. Ability to relocate within the system

j. Desired work schedule

k. Prescriptive authority

l. Opportunity to practice in pharmacist-run clinics

m. Research Opportunities

n. Computerized medication delivery

o. Completely electronic health record

7. Thinking back to when you made your decision to accept employment, how did VA compare to other non-VA employment opportunities you had?

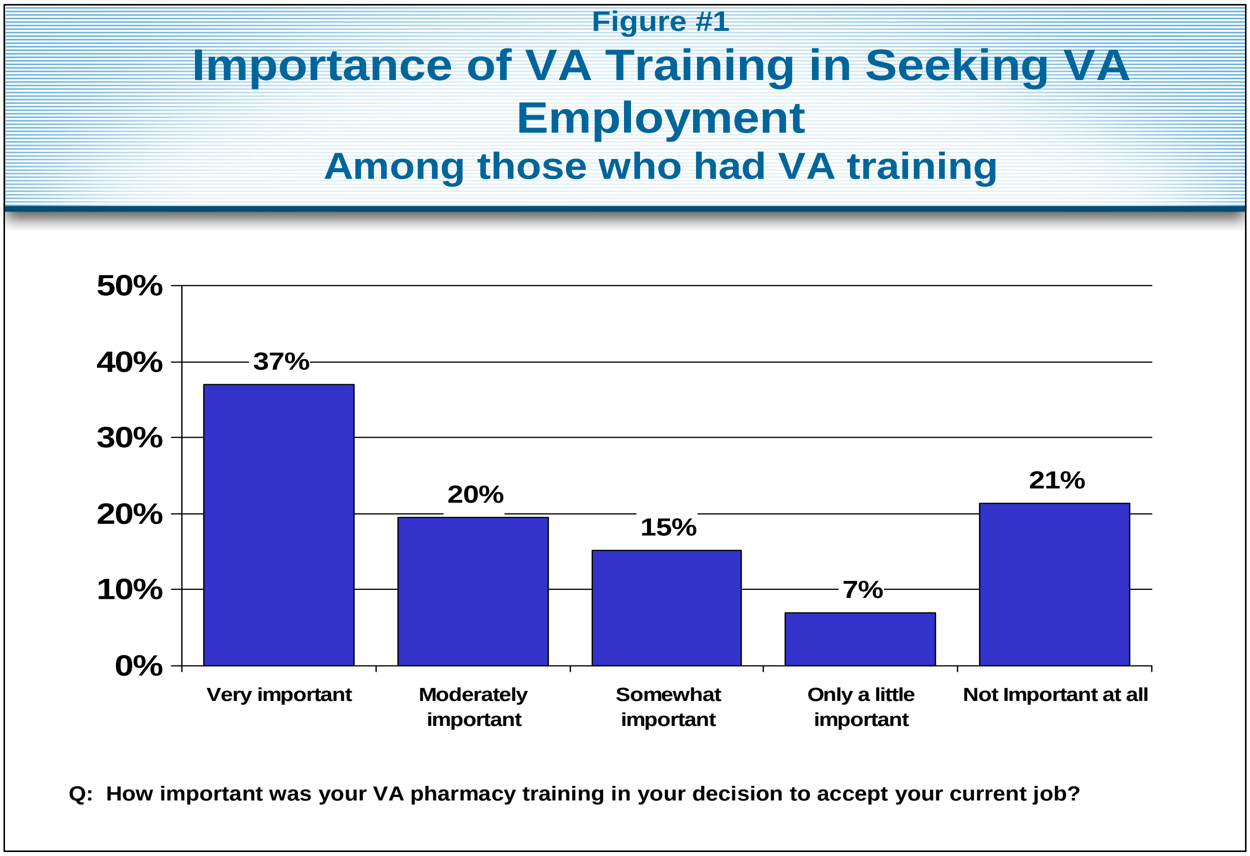


Figure #1
Importance of VA Training in Seeking VA Employment
Among those who had VA training
50%
40%
30%
20%
10%
0%
37%
20%
15%
7%
21%
Very important
Moderately important
Somewhat important
Only a little important
Not Important at all
Q: How important was your VA pharmacy training in your decision to accept your current job?

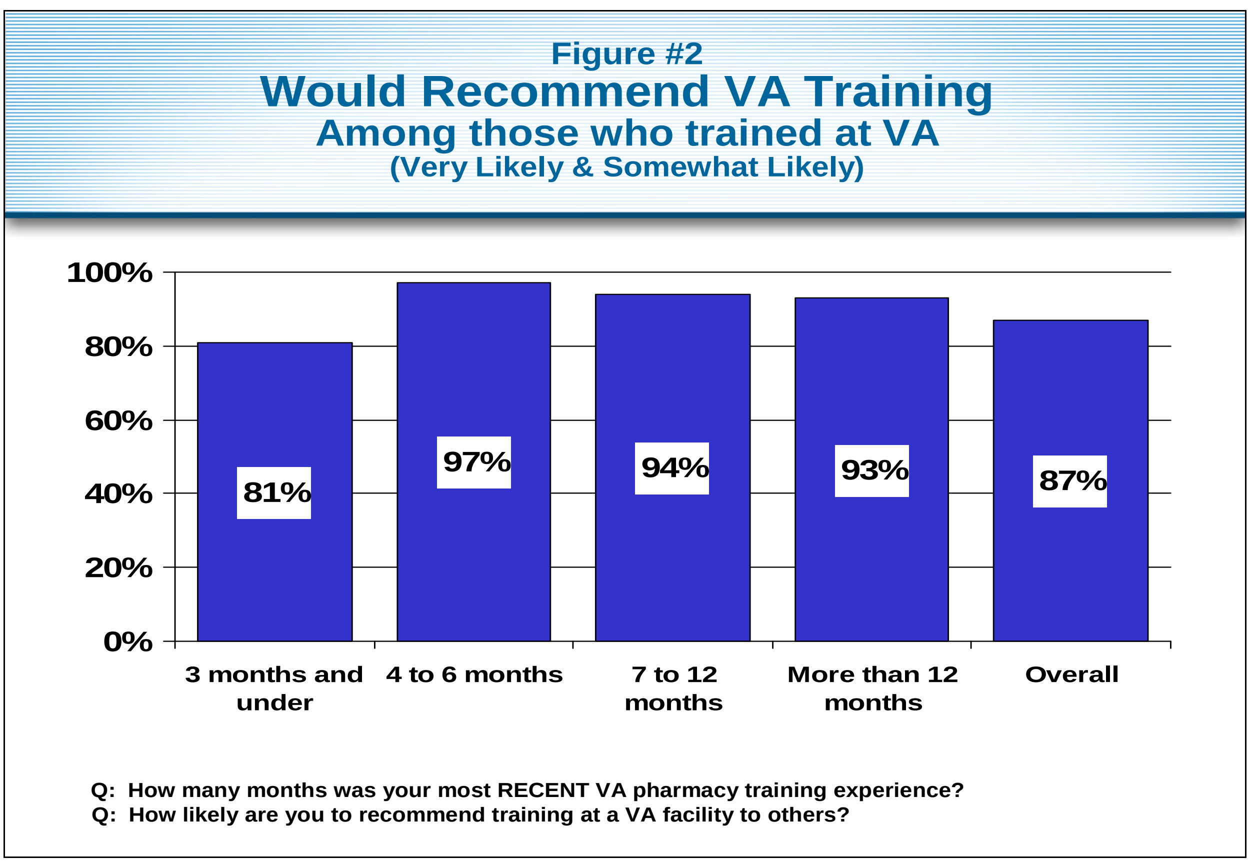


Figure #2
Would Recommend VA Training
Among those who trained at VA
(Very Likely & Somewhat Likely)
100%
80%
60%
40%
20%
0%
81%
97%
94%
93%
87%
3 months and under
4 to 6 months
7 to 12 months
More than 12 months
Overall
Q: How many months was your most RECENT VA pharmacy training experience?
Q: How likely are you to recommend training at a VA facility to others?

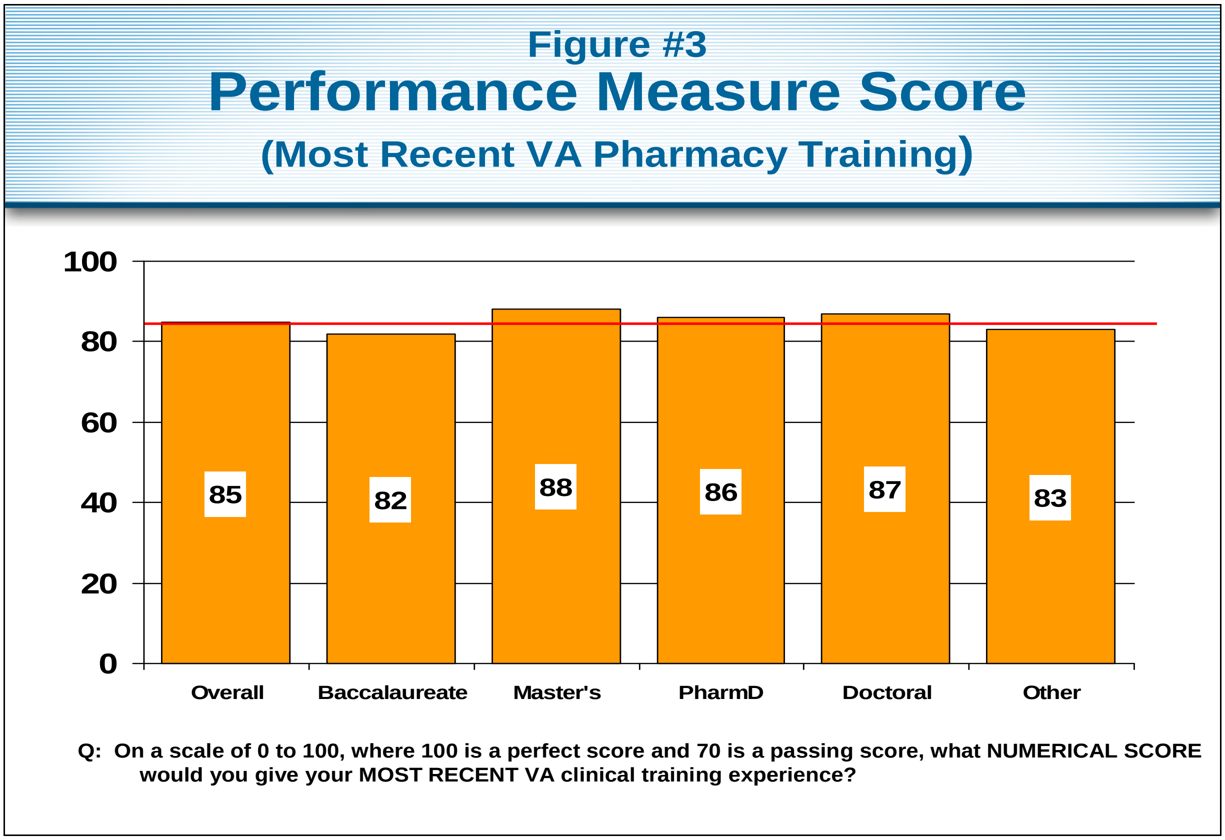


Figure #3
Performance Measure Score
(Most Recent VA Pharmacy Training)
100
80
60
40
20
0
85
82
88
86
87
83
Overall
Baccalaureate
Master's
PharmD
Doctoral
Other
Q: On a scale of 0 to 100, where 100 is a perfect score and 70 is a passing score, what NUMERICAL SCORE would you give your MOST RECENT VA clinical training experience?

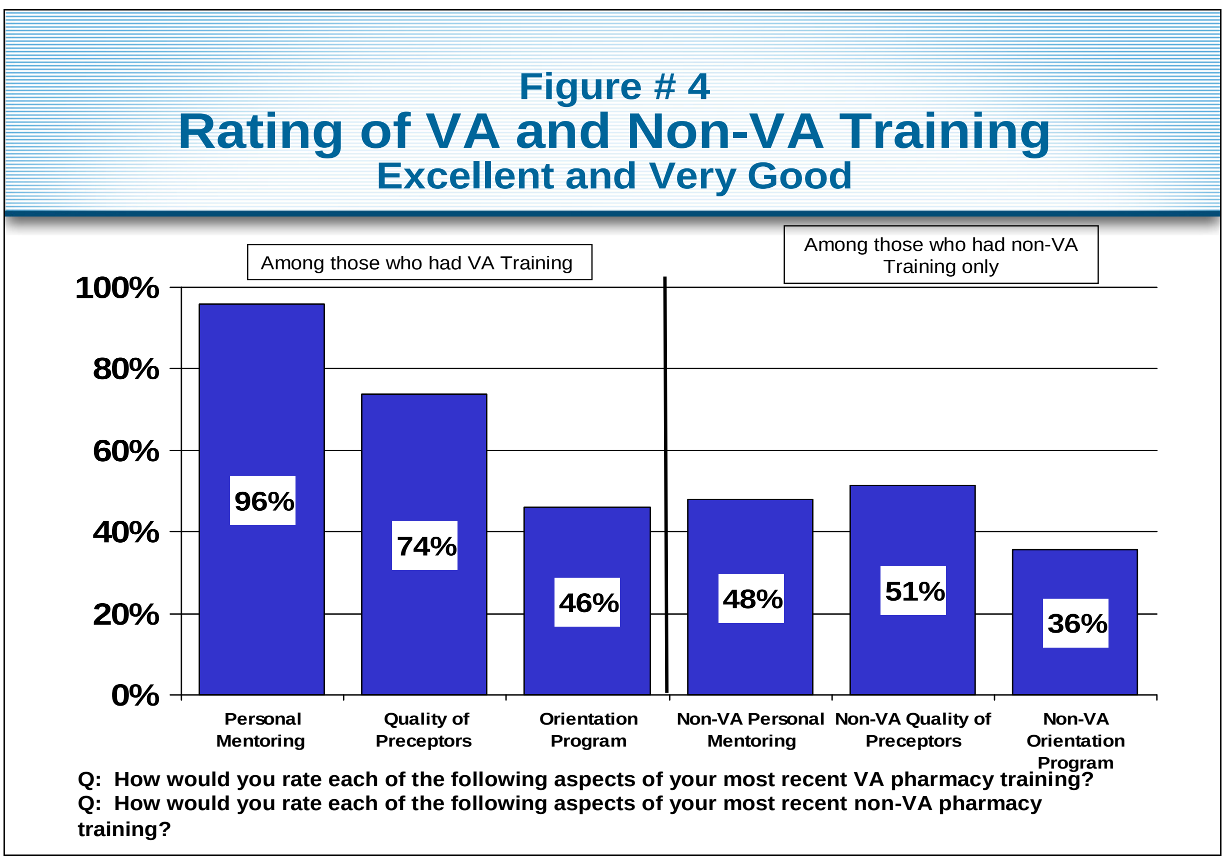
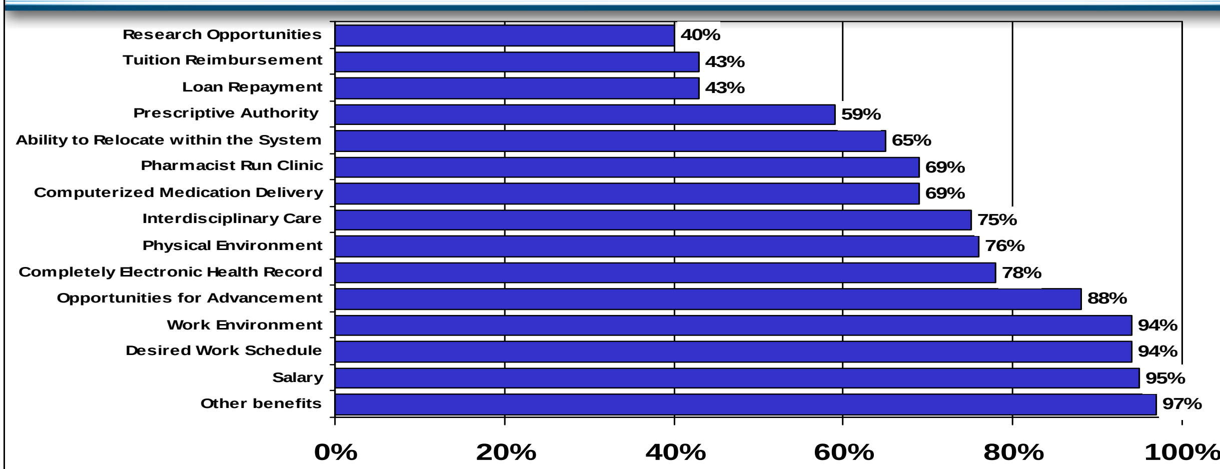


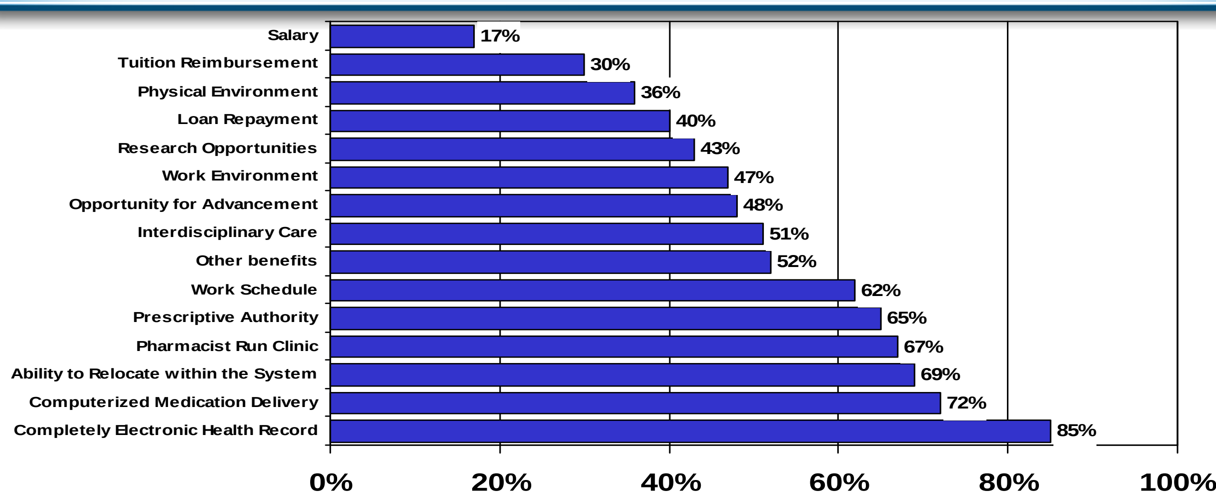
Figure # 4
Rating of VA and Non-VA Training
Excellent and Very Good
Among those who had VA Training
Among those who had non-VA Training only
100%
80%
60%
40%
20%
0%
96%
74%
46%
48%
51%
36%
Personal Mentoring
Quality of Preceptors
Orientation Program
Non-VA Personal Mentoring
Non-VA Quality of Preceptors
Non-VA Orientation Program
Q: How would you rate each of the following aspects of your most recent VA pharmacy training?
Q: How would you rate each of the following aspects of your most recent non-VA pharmacy training?

Figure #5
Importance of Factors in Job Search
Very and Somewhat Important
All Pharmacists



Q: How important were each of following factors in your employment search?

Figure #6
VA vs. Non-VA Employment Comparisons
Among those who looked in both areas
VA a lot or somewhat better



Q: Thinking back to when you made your decision as to where to accept employment, how did VA compare to other non-VA employment opportunities you had?

An Evaluation of the National Center for Education Statistics Projections of Newly Hired Teachers

William J. Hussar
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This paper is intended to promote the exchange of ideas among researchers and policy makers. The views expressed in it are those of the author and do not necessarily reflect the views of the U.S. Department of Education or the Institute of Education Sciences.

Objective

This paper is a follow-up to the 1999 National Center for Education Statistics (NCES) report, *Predicting the Need for Newly Hired Teachers in the United States to 2008–09* (Hussar 1999). In the 1999 report, projections for the number of newly hired teachers to 2008–09 were presented for both the public and private schools. The projections in the 1999 report were developed using an algebraic model based on teacher demographic data from 1993–94 Schools and Staffing Surveys (SASS) and 1994–95 Teacher Follow-up Surveys (TFS). The first section of this paper reviews the methodology used to produce those projections of newly hired teachers and the assumptions underlying this methodology. The second section consists of an evaluation of the 1999–2000 and 2003–04 projections of the newly hired teachers from the original report using actual data from the 1999–2000 SASS and the 2003–04 SASS. In this section, the percentage difference between the actual numbers and the projections are calculated and possible explanations are offered for some of the larger differences. Beside the evaluation of the teacher projections, there also is an evaluation of projections of the age distribution for teachers in 1999–2000 and 2003–04.

Methodology and Data Sources

The Newly Hired Teachers Model produces projections for the number of teachers who will be hired in a given year, who had not been teaching the previous year. The model is estimated separately for public and private school teachers. Teachers who move from teaching in one sector to the other sector are considered newly hired teachers. If a teacher moves from teaching in one public school to a different public school, that teacher would not be counted as a newly hired teacher for the purposes of this model. On the other hand, if a teachers moves from a public school to a private school, that teacher would be counted as a newly hired private school teacher since the teacher is moving between sectors.

In order to evaluate the projections of the number of newly hired teachers, data were drawn from a number of NCES sources: the 1993–94 SASS; 1994–95 TFS; the Common Core of Data (CCD); the Private School Universe Survey (*PSS*); and the *Projections of Education Statistics to 2008* (Gerald and Hussar 1998). The teacher numbers coming from SASS and the TFS were for full-time and part-time teachers while those for the other surveys were for full-time-equivalent (FTE) teachers.

The following is a general outline of the Newly Hired Teachers Model that was used to produce the projections in Hussar (1999). A more thorough presentation can be found in section II of the original report, which is available on-line (http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=1999026). This model measures the demand for new teacher hires and it was assumed that there would be enough supply to meet the demand. Due to difficulties in deciding whom to include in the pool of potential teachers, there were no attempts to measure the supply of newly hired teachers.

In step 1 of the Newly Hired Teachers Model, the age distributions of full-time and part-time teachers from the 1993–94 SASS were applied to the national number of FTE teachers in 1993–94 from the CCD (public school teachers) and the PSS (private school teachers).

In step 2, the age-specific continuation rates from the 1994–95 TFS were applied to the 1993–94 FTE count of teachers by age; the results being an estimate of the number of FTE teachers who remained teaching in 1994–95 by individual age. Summing these remaining teachers over all ages produced the estimate of those who remained teaching in 1994–95. Subtracting the remaining teachers from the total FTE teacher count for 1993–94 produced an estimate of the number of new FTE teacher hires replacing those leaving teaching.

In step 3, the total number of FTE teachers in 1993–94 was subtracted from the projection of FTE teachers for 1994–95 to produce an estimate of the number of new FTE teacher hires that were due to the overall increase in the teaching workforce.

In step 4, the projected number of new FTE teachers hired to replace those leaving teaching from step 2 was added to the projected number of new FTE teachers hired as the size of the teacher labor increases or decreases, to get an estimate of the total number of new FTE teachers hired in 1994–95.

In step 5, the age distribution for new hired full-time and part-time teacher hires from the 1993-94 SASS was applied to the estimate of total number of new FTE teacher hires in 1994–95 to produce an estimate of the number of new FTE teacher hires by age.

In step 6, for each individual age, the estimate of the number of remaining FTE teachers from step 2 was added to the estimate of the number of newly hired FTE teachers from step 5 to produce estimates of the total number of FTE teachers by age in 1994–95.

Steps 2 through 6 were then repeated for each year from 1995–96 through 2008–09, so that the Newly Hired Teacher Model produced projections for the number of new teacher hires. Actual FTE teacher numbers from the CCD and PSS were used for the period from 1994–95 and 1995–96 and three alternative scenarios were used for the remaining period.

A number of assumptions were made in order to make these projections. They include: (1) that the supply of newly hired teachers equaled the demand for newly hired teachers; (2) the age distribution of FTE teachers in 1993–94 was similar to that of full-time and part-time teachers in that year (Step 1); (3) the age-specific continuation rates for FTE teachers for each year from 1994–95 through 2008–09 were similar to the age-specific continuation rates for full-time and part-time teachers from the 1994–95 TFS (Step 2); (4) the age distribution for newly hired FTE teachers from 1994–95 through 2008–09 were similar to that of newly hired full-time and part-time teachers in the 1993–94 SASS (Step 3); and (5) the actual number of FTE teachers for each year from 1996–97 through 2008–09 were similar to the projections for FTE teachers used throughout the projections period.

Some work has been done examining the second, third, and fourth assumptions listed above. To examine the second assumption, the age distribution of full-time teachers was compared with that for part-time teachers, by sector. In general, the percentage of full-time teachers in each age group was similar to that for private school teachers, though there were some exceptions.

To examine the third assumption, comparisons were made across the four TFS of the continuation rates for all teachers and for teachers by age (see table 1). In general, the differences were either not statistically significant or, if statistically significant, generally of small size (less than 2 percent). However, there is evidence that even relatively small difference in continuation rates, as measured by the continuation rate for all teachers, can result in large differences in the projections of newly hired teachers. The original report included sensitivity analyses examining the effect of changing the continuation rates. Projections of newly hired teachers were computed using the continuation rates from the three TFS that were available at the time (the 1988–89 TFS, the 1991–92 TFS, and the 1994–95 TFS) with all other inputs held constant. The results from the sensitivity analysis showed that a relatively small difference in continuation rates could result in a sizable difference in the predicted number of new teacher hires. For example, the continuation rate for all teachers from the 1991–92 TFS was 1.4 percent higher than that from the 1993–94 TFS, resulting in a predicted number of new teacher hires for the 1998–99 through 2008–09 period that was 19 percent lower.

In the original report (Hussar 1999), there was a suggestion that the age distribution of newly hired teachers may not remain constant (assumption 4): “One factor that may change this distribution over time is the aging of the baby boom generation. As this generation retires, there may be relatively fewer people in their forties and fifties who became newly hired teachers thus pushing the average age of newly hired teachers lower.” (Hussar 1999, pp. 6-7) Elements of this prediction did occur, as the percentage of newly hired public school teachers in their forties did decline from 21 in 1987–88 percent to 16 in 2003–04 while the percentage of newly hired teachers less than 25 years old increased from 18 percent to 24 percent. There were other changes in the age distribution of newly hired teachers. For example, for both public and private schools, the percentage of new teacher hires aged 25-29 and 30-39 declined from 1987–88 through 2003–04, while the percentage of newly hired teachers age 50 to 59 increased during that time. (See table 2)

As the age distribution of newly hired teachers did not remain constant over time, an exercise was conducted to examine the impact of the changes in the age distribution. Forecasts for newly hired teachers for each sector were calculated in identical fashion to scenario 1 of 1999 report (Hussar 1999, tables 7 and 9), except that the 1993–94 age distributions were replaced with the 1999–2000 and 2003–04 age distributions. (In scenario 1, the projected number of teachers from 1996–97 through 2008–09 equaled the school enrollment projections from Gerald and Hussar (1998) multiplied by the actual 1995–96 pupil/teacher ratio (the pupil/teacher ratio is fixed at the 1995–96 value)). For both public and private schools, the differences between the projections from scenario 1 and those from the new scenarios were, in most instances, less than 5 percent.

Evaluation

An evaluation of the Newly Hired Teachers Model was conducted comparing projections from Hussar (1999) with data from the 1999–2000 and 2003–04 Schools and Staffing Survey (SASS). Three alternative sets of projections were presented in that report for each sector, based on alternative growth paths for the number of teachers. One of these, scenario 1, was described in the previous paragraph. In scenario 2, the number of teachers for each year was fixed at the 1995–96 value. (The projections from this scenario were excluded from the evaluation however, as the purpose of this scenario was to examine the impact on the number of new hired teachers solely due to teachers leaving the profession.) In scenario 3, the projected number of teachers equaled those in the middle alternative projections in Gerald and Hussar (1998). For this evaluation, a new scenario 4 was also examined. In scenario 4, the historical numbers of teachers from 1996–97 through 2003–04 were used as a basis for reestimating the number of new teacher hires. (See table 3.)

To conduct the comparisons of the projections of FTE new teacher hires for 1999–2000 and 2003–04 from Hussar (1999) with the actual numbers of full-time and part-time new teacher hires from the 1999–2000 SASS and the 2003–04 SASS, estimates are needed for the actual number of new FTE teacher hires. (See table 4.) To do this, the counts of new teacher hires from SASS were multiplied by the ratios of the FTE teachers to the full-time plus part-time teacher totals to produce the estimates of FTE new teacher hires. The accuracy of this evaluation is affected by the accuracy of this methodology. Further, for public school teachers only, the accuracy of the evaluation is affected by the degree to which the SASS and CCD surveys reflect the same stock of teachers. For example, if there were some new schools that were included in the CCD universe but not reflected in the SASS universe, the SASS estimate of newly hired FTE teachers would be an underestimate. Note that these potential problems could affect the evaluation in either direction: i.e. a projection could appear to be less accurate than it really is but it could also appear to be more accurate.

In both 1999–2000 and 2003–04, the projected numbers for newly hired public school teachers generally were within 10 percent of the actual numbers for scenarios 1, 3, and 4. The one exception was with scenario 4: the projected value of the number of newly hired teachers in 1999–2000 was 26 percent higher than the actual value for the number of newly hired teachers. Concerning newly hired private school teachers, the projections from all four scenarios were substantially lower (between 15 and 45 percent) than the actual values for 1999–2000 and 2003–04. (See table 4.)

There are a number of possible explanations for these sizable differences between the actual numbers and the projected numbers. As just noted, two causes for these findings could be problems with the methodology used to estimate the number of new FTE teacher hires using the full-time and part-time teacher numbers and, for the public school teachers only, the problems with the comparability of the 1999–2000 CCD universe and the SASS public school sampling frame. There were some changes to the 2003-04 SASS sampling frame that resulted in the SASS count of schools compared to the CCD count of schools dropping from 95 percent to 92 percent, between 1993-94 and 2003-04. Certain types of special schools, such as vocational and alternative schools are excluded from SASS. Differences between actual and projected numbers also could also be caused by problems with the key model assumptions listed at the end of the Methodology and Data section. To examine potential problems with some of these assumptions, alternative scenarios for newly hired public school teachers were developed using more recent demographic data for teachers (i.e., continuation rates and the age distribution of newly hired teachers).

The continuation rates from the 1994–95 TFS for public school teachers were replaced with those from the 2000–2001 TFS, resulting in a decline in the continuation rate for all teachers from 93.2 percent to 92.4 (this was not a statistically significant difference). However, this had a large impact on the projected number of new teachers hires, increasing the difference between the actual and forecasted number for new teacher hires to 36 percent. (See tables 1 and 4.) This example again illustrates how sensitive the model is to differences in the continuation rates. If the continuation rates of public school teachers had been higher than the 1994–95 TFS rates for several years between 1993–94 and 1999–2000, this could have been a reason why the number of newly hired public school teachers was lower than had been projected for 1999–2000.

The replacement of the age distribution of newly hired teachers from the 1993–94 SASS with the age distribution from the 1999–2000 SASS using scenario 4 for public schools had little impact on the accuracy of the projections: the difference between the projected number of new teacher hires and the actual number remained at 26 percent. (See tables 1 and 4.)

One difficulty in determining the accuracy of the newly hired teacher projections is the infrequency in the administrations of SASS and TFS, which are the sources of much of the data used to compute the newly hired teacher projections and also the newly hired teacher numbers themselves. Since the release of the original report in 1999, the NCES administered SASS and TFS only two times and the next SASS is not scheduled to be administered until 2007–08. With the limited number of data points for both newly hired teachers and also key inputs such as the continuation rates, it is difficult to determine if the weaknesses described here only pertain to the years examined or indicate a greater problem with the model. At this point, there do not appear to be enough data points to better model the continuation rates.

One limitation of the evaluation of the projections from the 1999 report was that there was a six year gap between the administration of the SAS and TFS used in the preparation of the report, and the next survey administration in 1999–2000 and 2000–01. Hence, the projections of new teacher hires to be evaluated were 6-year-out projections. The Newly Hired Teacher Model may perform substantially better in producing more short-term projections. Although not computed for this paper, there is a way to test this hypothesis. Projections for 2003–04 could be computed using numbers from the 1999–2000 SASS and the 2000–01 TFS as well as other numbers released before the release of the 2000–01. This would permit an evaluation of one set of 3-year out projections.

Besides producing projections of the number of newly hired teachers, the Newly Hired Teacher Model generated projections of the age distribution of teachers. (See table 5 and figures 1 and 2) For both public and private schools, there were a number of projected changes in the age distribution from 1993–94 through 2003–04, including declines for both sectors in the percentages of teachers in their forties and increases for both sectors in the percentages of teachers in their 50s. While there were differences between the actual values for the age distribution and the projected values for both sectors (using scenario 1), the model correctly predicted the general changes in the age distribution that occurred in both sectors. For example, the model predicted that the percentage of public school teachers in their forties would decline from 42 percent in 1993–94 to 28 in 2003–04 (the actual value for 2003-04 was 26 percent).

Conclusions

The model did reasonably well predicting the trends for the age distribution of both public and private school teachers. As noted above, the model had predicted large changes of the percentages of teachers in their forties and fifties that did occur. The model did less well producing the number of newly hired teachers in both public and private schools. While a number of possibilities were suggested, the causes of the problems are not known, and, given how infrequently the SASS and TFS are administered, it may be some time before that can be determined. In any case, the sensitivity of the teachers hires to the continuation rates points out an important policy lever in that small changes in teacher retention can have a large impact on hiring for replacement teachers.

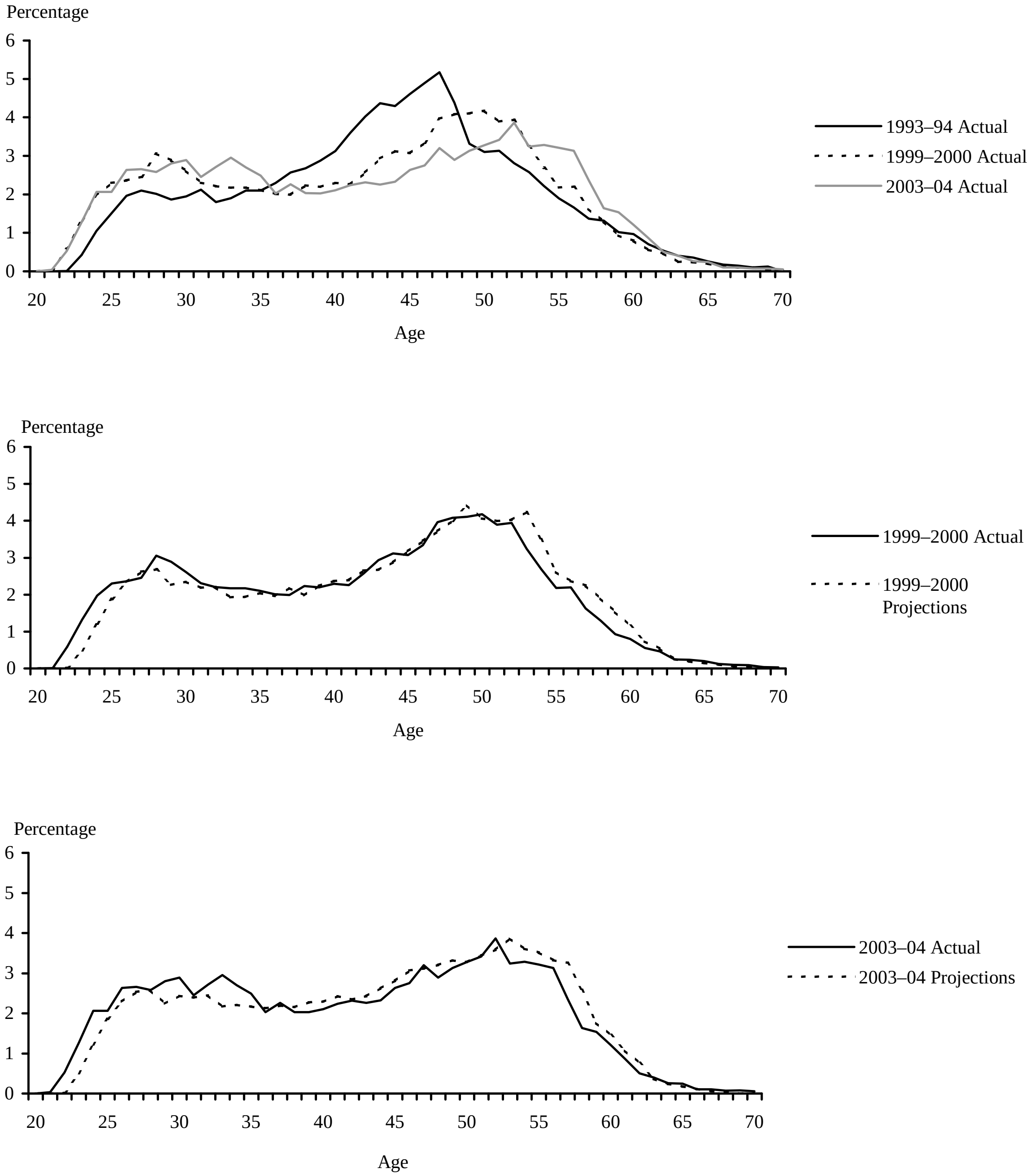
References

Gerald, D.E., and Hussar, W.J. (1998). *Projections of Education Statistics to 2008* (NCES 1998-016) U.S. Department of Education, National Center for Education Statistics. Washington, DC: U.S. Government Printing Office.

Hussar, W.J. (1999). *Predicting the Need for Newly Hired Teachers in the United States to 2008-09* (NCES 1999-026) U.S. Department of Education, National Center for Education Statistics. Washington, DC: U.S. Government Printing Office.

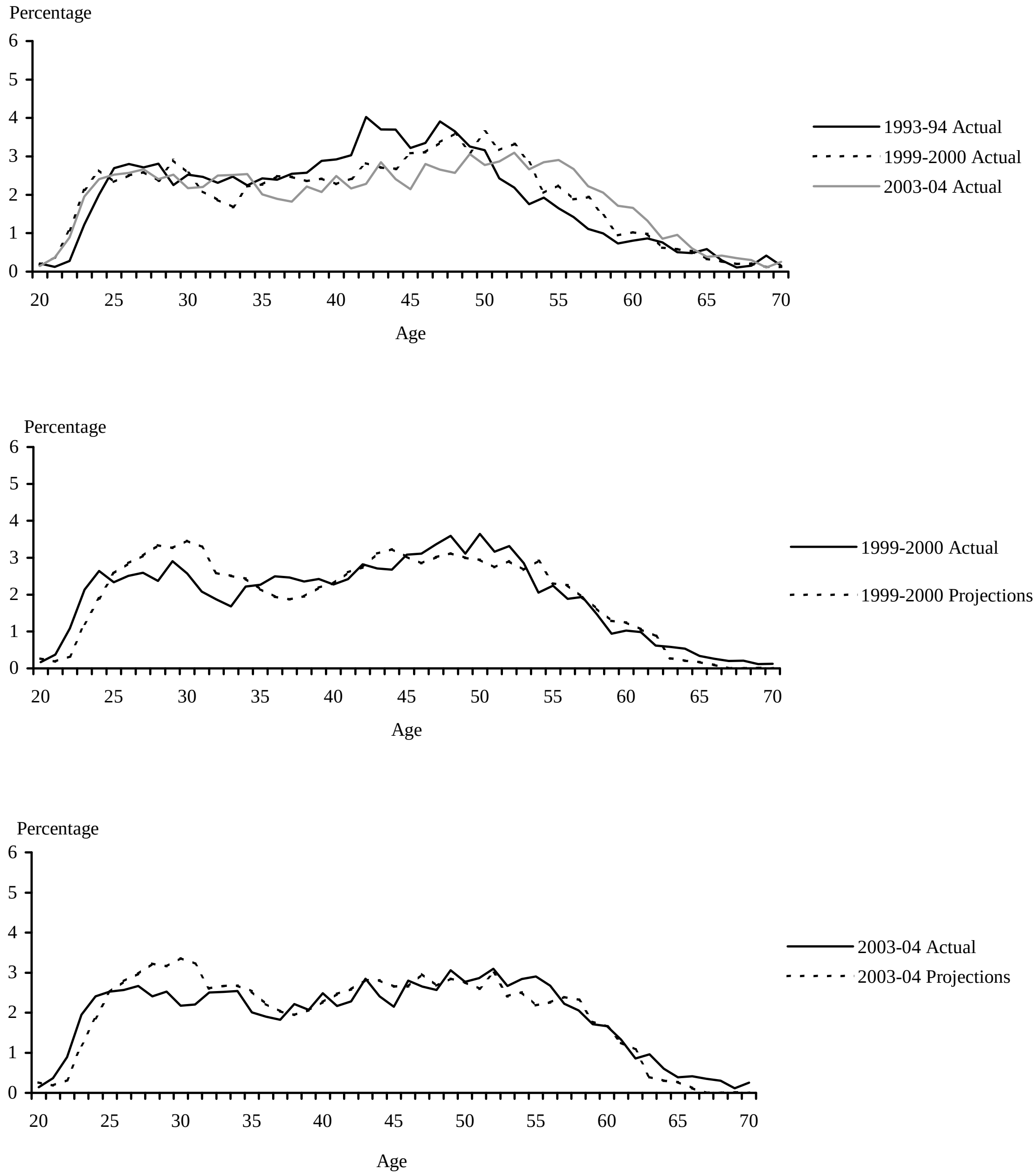
Hussar, W.J. (2006). *Projections of Education Statistics to 2015* (NCES 2006-084) U.S. Department of Education, National Center for Education Statistics. Washington, DC: U.S. Government Printing Office.

Figure 1. Actual and projected percentage distribution of full-time and part-time public school teachers, by age: 1993–94, 1999–2000, and 2003–04



NOTE: Projections of the age distribution of teachers correspond of the projections of newly hired presented in table 7, scenario 1 of *Predicting the Need for Newly Hired Teachers in the United States to 2008–09.* These projections were produced using the 1994–95 to 1994–95 continuation rates and the 1994–95 age distributions of newly hired teachers.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey (SASS), "Public School Teacher Questionnaire," 1993–94, 1999–2000, and 2003–2004; *Predicting the Need for Newly Hired Teachers in the United States to 2008–09;* and unpublished data.

Figure 2. Actual and projected percentage distribution of full-time and part-time private school teachers, by age: 1993–94, 1999–2000, and 2003–04



NOTE: Projections of the age distribution of teachers correspond of the projections of newly hired presented in table 9, scenario 1 of *Predicting the Need for Newly Hired Teachers in the United States to 2008–09.* These projections were produced using the 1994–95 to 1994–95 continuation rates and the 1994–95 age distributions of newly hired teachers.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey (SASS), "Private School Teacher Questionnaire," 1993–94, 1999–2000, and 2003–2004; *Predicting the Need for Newly Hired Teachers in the United States to 2008–09;* and unpublished data.

Table 1. Continuation rates of full-time and part-time school teachers, by age and control of school: Various years, 1987–88 to 1988–89 through 1999–2000 to 2000–01

Control of school and school year	Total	Continuation rates, by age						
		Less than 25 years	25-29 years	30-39 years	40-49 years	50-59 years	60-64 years	65 years or more
Public								
1987–88 to 1988–89	94.4	95.9	91.0	94.2	97.4	94.3	76.6	83.3
1990–91 to 1991–92	94.9	90.9	91.0	95.8	98.0	93.3	73.2	59.1
1993–94 to 1994–95	93.4	96.2	90.0	93.3	96.1	93.7	69.5	65.9
1999–2000 to 2000–01	92.4	95.8	89.3	93.2	94.5	92.9	76.8	77.6
Private								
1987–88 to 1988–89	87.3	81.2	82.7	87.6	89.4	88.6	84.1	92.1
1990–91 to 1991–92	87.7	76.2	82.2	86.3	92.3	90.4	82.2	79.3
1993–94 to 1994–95	88.1	80.0	86.9	85.1	91.3	91.8	86.9	58.1
1999–2000 to 2000–01	83.0	61.7	72.2	80.2	86.1	92.3	78.8	75.2

NOTE: The continuation rate for teachers for each sector is the percentage of teachers in that sector who continued teaching in the same sector from the first year to the next.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Teacher Follow-up Survey (TFS), "Public School Teacher Questionnaire," 1988–89 through 2000–01 and "Private School Teacher Questionnaire," 1988–89 through 2000–01; and unpublished tabulations.

Table 2. Percentage distribution of full-time and part-time newly hired teachers, by age and control of school: Selected years, 1987–88 through 2003–04

Control of school and school year	Total	Age: Less than 25 years	25-29 years	30-39 years	40-49 years	50-59 years	60-64 years	65 years or more
Public								
1987–88[1]	100	18	24	33	21	4	#	#
1990–91[1]	100	17	24	31	21	6	1	#
1993–94[1]	100	16	29	25	25	5	1	#
1999–2000	100	24	23	22	19	11	1	1
2003–04	100	24	19	25	16	13	1	1
Private								
1987–88[2]	100	17	23	32	18	5	3	2
1990–91[2]	100	16	26	29	21	6	1	1
1993–94[2]	100	19	24	25	23	7	1	1
1999–2000	100	19	17	24	22	14	3	1
2003–04	100	17	16	23	23	15	4	2

Rounds to zero.

[1] The number of newly hired full-time and part-time public school teachers used to construct the age distribution includes: 1) new teachers who had never taught before in either public or private schools; 2) returning teachers who had taught in public and/or private schools in the past but had not taught last year; and 3) teachers who had taught in a private school last year and had never before taught in a public school. It does not include a fourth component, the number of newly hired teachers who had been teaching in a private school the previous year but had earlier experience teaching in public schools.

[2] The number of newly hired full-time and part-time private school teachers used to construct the age distribution includes: 1) new teachers who had never taught before in either public or private schools; 2) returning teachers who had taught in public and/or private schools in the past but had not taught last year; and 3) teachers who had taught in a public school last year and had never before taught in a private school. It does not include a fourth component, the number of newly hired teachers who had been teaching in a public school the previous year but had earlier experience teaching in private schools.

NOTE: Detail may not sum to totals because of rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey (SASS), "Public School Teacher Questionnaire," 1987–88 through 2003–04 and "Private School Teacher Questionnaire," 1987–88 through 2003–04; and unpublished tabulations.

Table 3. Actual and projected numbers for school teachers, by control of school: 1994–95 through 2003–04

[In thousands]

Control of school and school year	Full-time and part-time school teachers	Full-time-equivalent teachers: Scenario 1 (Constant pupil/teacher ratio[1])	Scenario 2 (Constant number of teachers[2])	Scenario 3 (*Projections of Education Statistics to 2008* [3])	Scenario 4 (Actual numbers)
Public					
1993–94	2,561	2,504	2,504	2,504	2,504
1994–95	—	2,552	2,552	2,552	2,552
1995–96	—	2,598	2,598	2,598	2,598
1996–97	—	2,644	2,598	2,645	2,667
1997–98	—	2,683	2,598	2,697	2,746
1998–99	—	2,711	2,598	2,728	2,830
1999–2000	3,002	2,732	2,598	2,764	2,911
2000–01	—	2,749	2,598	2,802	2,941
2001–02	—	2,764	2,598	2,832	3,000
2002–03	—	2,777	2,598	2,866	3,034
2003–04	3,251	2,786	2,598	2,903	3,049
Private					
1993–94	378	366	366	366	366
1994–95[4]	—	374	374	373	374
1995–96	—	380	380	380	380
1996–97	—	386	380	387	387
1997–98[5]	—	391	380	394	388
1998–99	—	395	380	399	391
1999–2000[5]	449	398	380	404	395
2000–01	—	400	380	409	390
2001–02[5]	—	403	380	413	390
2002–03[5]	—	404	380	418	394
2003–04	467	405	380	423	396

—Not available.

[1] Numbers of FTE teachers from 1993–94 through 1995–96 are actual numbers. Projected numbers of FTE school teachers from 1996–97 through 2003–04 equal the elementary and secondary enrollment projections from the *Projections of Education Statistics to 2008* divided by the 1995-96 pupil/teacher ratio.

[2] Numbers of FTE public school teachers from 1993–94 through 1995–96 are actual numbers. Projected numbers of FTE public school teachers for 1996–97 through 2003–04 equal the total number of FTE public school teachers in 1995–96.

[3] Numbers of FTE teachers from 1993–94 through 1995–96 are actual numbers. Projected numbers of FTE teachers from 1996–97 through 2003–04 are from the middle alternative projections of the *Projections of Education Statistics to 2008.*

[4] Numbers of FTE private school teachers for scenarios 1, 2, 3 and 4 were estimated on the basis of past data.

[5] Numbers of FTE private school teachers for scenario 4 were estimated on the basis of past data.

NOTE: The projected numbers of FTE school teachers from 1996–97 through 2003–04 for scenarios 1, 2, and 3 are from table 1 (public school teachers) and table 2 (private school teachers) of *Predicting the Need for Newly Hired Teachers in the Unites States to 2008–09.*

SOURCE: U.S. Department of Education, National Center for Education Statistics, The NCES Common Core of Data (CCD), "State Nonfiscal Survey of Public Elementary/Secondary Education," 1994–95 through 2003–04; "Private School Universe Survey", 1994–95 through 2003–2004; Schools and Staffing Survey (SASS), "Public School Teacher Questionnaire," 1993–94 through 2003–04 and "Private School Teacher Questionnaire," 1993–94 through 2003–04; and *Predicting the Need for Newly Hired Teachers in the United States to 2008–09.*

Table 4. Estimated and alternative projected numbers for newly hired full-time-equvalent (FTE) teachers, by control of school: 1994–95 to 2003–04

[In thousands]

Control of school and school years	Estimated[1]	Projected: Scenario 1 (Constant pupil/teacher ratio[2])	Scenario 2 (Constant number of teachers[3])	Scenario 3 (*Projections of Education Statistics to 2008*[4])	Scenario 4 (*Actual FTE teacher numbers*)
Public					
1994–95[5]	—	220	220	220	220
1995–96[5]	—	220	220	220	220
1996–97	—	223	177	224	246
1997–98	—	220	177	233	261
1998–99	—	214	180	218	275
1999–2000	222	210	181	227	279
2000–01	—	212	184	235	238
2001–02	—	214	188	233	272
2002–03	—	218	192	244	257
2003–04	236	217	196	252	242
Private					
1994–95[5]	—	56	56	55	56
1995–96[5]	—	54	54	54	54
1996–97	—	53	47	54	54
1997–98	—	53	46	54	48
1998–99	—	52	46	53	50
1999–2000	83	51	46	54	52
2000–01	—	51	47	55	44
2001–02	—	52	47	55	48
2002–03	—	52	47	57	53
2003–04	67	52	47	57	51

—Not available.

[1] Estimates of newly hired FTE teachers, by sector, were calculated by multiplying the number of newly hired full-time and part-time school from the various Schools and Staffing Surveys (SASS) by the ratio of the number of FTE teachers from the Common Core of Education survey (CCD) or Private School Survey to the total number of full-time and part-time teachers from the various Schools and Staffing Surveys (SASS)).

[2] The numbers of newly hired teachers, by sector, from 1996–97 through 2003–04 in scenario 1 are based on the assumption that of the total number of teachers from 1996–97 through 2003–04 would equal the elementary and secondary enrollment projections from the *Projections of Education Statistics to 2008* divided by the 1995–96 pupil/teacher ratio.

[3] The numbers of newly hired teachers, by sector, from 1996–97 through 2003–04 in scenario 2 are based on the assumption that of the total number of teachers for 1996–97 through 2003–04 would equal the 1995–96 value.

[4] The numbers of newly hired teachers, by sector, from 1996–97 through 2003–04 in scenario 3 are based on the assumption that of the total number of teachers from 1996–97 through 2003–04 would equal those in the middle alternative projections in the *Projections of Education Statistics to 2008*.

[5] The numbers of newly hired teachers, by sector, for 1994–95 and 1995–96 are based on the assumption that of the total number of teachers for 1994–95 and 1995–96 are actual numbers.

NOTE: These projections were produced using the 1993–94 to 1994–95 continuation rates and the 1993–94 age distributions of newly hired teachers. The projections of newly hired teachers are from table 7 (public school teachers) and table 9 (private school teachers) of the *Predicting the Need for Newly Hired Teachers in the United States to 2008.*

SOURCE: U.S. Department of Education, National Center for Education Statistics, *Predicting the Need for Newly Hired Teachers in the United States to 2008–09; Projections of Education Statistics to 2008;* and The Newly Hired Teacher Model.

Table 5. Actual and projected percentage distribution of school teachers, by age and control of schools: Selected years, 1987–88 through 2003–04

Control of school and school year	Total	Age						
		Less than 25 years	25-29 years	30-39 years	40-49 years	50-59 years	60-64 years	65 years or more
Public-actual								
1987–88	100	2	10	33	35	17	3	1
1990–91	100	2	8	27	40	19	3	1
1993–94	100	1	9	22	42	21	3	1
1999–2000	100	4	13	22	32	26	2	1
2003–04	100	4	13	25	26	29	3	1
Public-projections[1]								
1999–2000	100	2	12	21	32	30	3	#
2003–04	100	2	12	23	28	32	4	#
Private-actual								
1987–88	100	4	15	33	30	12	4	2
1990–91	100	3	13	28	34	15	4	3
1993–94	100	4	13	25	35	17	3	2
1999–2000	100	7	13	22	29	23	4	2
2003–04	100	6	13	22	25	26	5	3
Private-projections[2]								
1999–2000	100	4	15	24	29	24	4	#
2003–04	100	4	15	25	27	24	5	#

Rounds to zero.

[1] Projections of the age distribution of public school teachers correspond to the projections of newly hired teachers presented in scenario 1 of table 7 of *Predicting the Need for Newly Hired Teachers in the United States to 2008–09.*

[2] Projections of the age distribution of private school teachers correspond of the projections of newly hired teachers presented scenario 1 of table 9 of *Predicting the Need for Newly Hired Teachers in the United States to 2008–09.*

NOTE: Detail may not sum to totals because of rounding. These projections were produced using the 1993–94 to 1994–95 continuation rates and the 1993–94 age distributions of newly hired teachers.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey (SASS), "Public School Teacher Questionnaire," 1987–88 through 2003–04 and "Private School Teacher Questionnaire," 1987–88 through 2003–04; *Predicting the Need for Newly Hired Teachers in the United States to 2008–09;* and unpublished tabulations.

Occupational Changes During the 20th Century

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Professional, managerial, clerical, sales, and service workers (except private household service workers) grew from one-quarter to three-quarters of total employment between 1910 and 2000; laborers (except mine laborers), private household service workers, and farmers lost the most jobs over the period

With occupation data from the 2000 census now available, it is an appropriate time to analyze occupational employment trends over the 20th century. The shift from a workforce composed mostly of manual workers to one comprising mostly white-collar and service workers is generally known. This article reveals just how radical that shift has been. It also shows that many of the projected employment changes over the 2004–14 period[1] are continuations of trends that began in the previous century.

The article analyzes changes in occupational staffing patterns—occupations and occupation groups as a percent of total employment in the economy—rather than numeric changes.[2] This methodology indexes employment growth to the average for all occupations over the period. Occupations and occupational groups growing faster than average appear as an increasing proportion of total employment, those growing as fast as average as a constant percent, and slower growing or declining ones as a declining percent.[3] For clarity, however, numeric employment data also are given.

Data and methodology

Occupational data presented in this article are from decennial censuses, adjusted by the Integrated Public Use Microdata Series (IPUMS) from the University of Minnesota's Minnesota Population Center.[4] Every census taken in the 20th century used a different system to classify occupations, so data between censuses are not necessarily comparable. IPUMS used the 1950 Index of Occupations and Industries to impose an occupational scheme on data from each census. Because of definitional changes and because some occupations in the 1950 index were components of broader occupations in other years, it was difficult to determine some decade-to-decade employment changes. That is, while the broad trends shown for larger occupation groups and many individual occupations are believed to be relatively accurate, some decade-to-decade changes may reflect data comparability problems between surveys rather than indicating actual changes in employment.[5] Nevertheless, data estimates are shown to the closest thousand; readers should be aware that actual employment may have been somewhat different.

The 1950 census classified all workers into 269 occupation categories, hereafter referred to as occupations;[6] the same census also gives employment estimates for each occupation. In its effort to create a consistent time series, IPUMS reduced the number of occupations to 230. The 1950 census arranged all occupations into 11 major groups, as shown in chart 1, but, with a few exceptions, no subgroups—all occupations were just listed alphabetically.[7] To better analyze growth patterns within these 11 major groups, this article classifies the majority of occupations into subgroups, closely corresponding to 2000 Standard Occupational Classification (SOC) major or minor groups.[8]

Some 1950 occupation and group names are gender specific or differ in other ways from those in current use, and their coverage of occupations also may differ. In addition, in 1950, some occupations were classified into major groups different from those they were classified into in 2000. For example, cashiers, judged a sales occupation in 2000, constituted a clerical occupation in 1950, and the category of farmers and farm managers, which formed a minor occupation group within management occupations in the 2000 census, was one of the 11 major occupation groups in the 1950 classification. Therefore, the 2000 employment levels shown in this article for certain occupations or occupation groups may not match the employment levels listed in the 2000 census for those same occupations or occupation groups.

The 1900 and 1930 data sets were unavailable from IPUMS at the time the research that led to this article was being carried out. Therefore, the time series begins with 1910 and covers eight additional data points: the year 1920 and the years 1940 through 2000. An employment status filter was applied to the 1940–2000 samples, eliminating those who were not actively employed. During that period, the census asked these people what the last occupation they held was if it was within the previous 5 or 10 years (depending upon which census year was in question). Including those employed within the previous 5 or 10 years would create some distortions, and the data obtained would not match other publicly available data. By contrast, no filter was applied to the 1910 or 1920 data. In both of these censuses, the question on occupation was restricted to those who were either employed or actively looking for work. Those who were retired or out of the labor force for any other reason were not included. When the employment filter was applied to the 1910 sample, certain occupations nearly disappeared. Applying an employment filter to the 1920 survey was not possible, because that census did not ask any question about the respondent's employment status. Therefore, the 1910 and 1920 data include some persons not employed in those years. Altogether, the census data show that employment increased 2.3 times over the 9 decades, from 39.2 million to 129.7 million.

Occupation categories

Occupational staffing patterns changed radically over the 1910–2000 period in response to changes in the mix of goods and services produced and the methods used to produce them. Of the 11 major occupation groups listed in the 1950 census, professional, technical, and kindred workers had the largest percent (and numeric) increase, while the farmer and farm laborer groups had the largest percent (and numeric) decreases. (See chart 1.) Professional, technical, and kindred workers rose from ninth largest to the largest occupation group, while the two farm groups dropped from largest and third largest, respectively, to the smallest, except for private household workers.[9]

Five of the major occupation groups increased as a share of the total, while six declined. All of the ones that declined, except for private household workers, consist of occupations that produce, repair, or transport goods and are concentrated in the agriculture, mining, construction, manufacturing, and transportation industries. The five that increased are the so-called white-collar occupations, plus service workers, except private household. The four major groups that are white-collar occupations include mostly occupations having to do with information, ideas, or people (many in the service group also work with people); are more concentrated in services-producing industries; and, at least for professional and managerial occupations, have higher-than-average education requirements. In aggregate, the five groups that increased went from 24 percent to 75 percent of total employment, while the six groups that declined went from 76 percent to 25 percent over the 90-year period.[10]

The analysis that follows presents charts and discusses decade-by-decade trends for

- the aforementioned 11 major occupation groups;
- selected occupation subgroups, generally corresponding to major or minor groups in the 2000 SOC system; and
- individual occupations that are large, that help explain group trends, or that run counter to group trends.

Occupations and occupation groups are discussed in the order of their staffing pattern changes, from the largest increase to the largest decrease. Those which increased as a proportion of the total tend to be concentrated in industries that grew more rapidly than average or that were a growing proportion of employment in their industries. For example, attendants in hospitals and in medical and dental offices grew particularly fast, because they were employed in rapidly growing health services industries and, over the century, they assumed many routine duties formerly performed by physicians, nurses, and other healthcare workers. In contrast, rail-road brakemen and switchmen declined very sharply, both because demand for railroad services grew much more slowly than average and because their work became increasingly mechanized.

Changes in the mix of goods and services produced, in technology, and in business practices, as well as broad economic and social trends, are discussed to the extent that they explain changes in occupational staffing patterns. For example, the mechanization of the production of goods and services and the development of technology are discussed in the sections on production operatives and engineers, respectively; the spread of motor vehicle use is discussed in the context of road vehicle operators, mechanics and repairers, and police; and the growth of large bureaucratic organizations is examined in the discussion of accountants, clerical workers, and managers.

Some occupation groups exhibited sharp, steady growth as a percent of total employment over the entire period.[11] These occupations include professional occupations overall and several professional subgroups, such as accountants, college teachers, and healthcare workers except for physicians, as well as protective service workers. Computer specialists had especially sharp growth from 1960, when data on that occupation were first collected. Managers, officials, and proprietors also grew, but more slowly. Other groups grew rapidly after 1910, but slowed some time after midcentury. Among these groups are engineers; teachers, except college; and food service workers. Sales workers, mechanics and repairers, and road vehicle operators stopped growing altogether. Judges and lawyers' and physicians and surgeons' employment showed no growth through 1970, but rose—particularly sharply for lawyers—after 1970. For both groups, the early lack of growth was due, at least in part, to artificial limits on supply. (See the discussion on pages 10–11.)

Both operatives and clerical workers rose as a proportion of employment for a number of decades, but then declined. Production and other craftsmen, laborers, mine operatives, and farmers and farm managers all rose from 1910 to 1920, but then declined for the rest of the century, some sharply. Construction workers declined slowly throughout the period.

Farm laborers and foremen, as well as private household workers, dropped sharply after 1910. As a result, the occupational staffing patterns in 2000 were vastly different from those in 1910.

Professional, technical, and kindred workers

Between 1910 and 2000, the employment of professional, technical, and kindred workers increased more than fourfold as a proportion of total employment, from 4.4 percent to 23.3 percent. (See chart 2.) Numerically, employment grew from 1.7 million to 30.2 million. Industrialization, technological development, and the growing size and complexity of organizations; rapid growth in healthcare, education, and social services; and the expanded role of government all contributed to the increase. Charts 3–5 show occupational detail for this major group. The occupation groups correspond to two- and three-digit 2000 SOC categories included in the professional and related occupations aggregation.[12]

Computer specialists did not exist in 1910, and there were few, if any, in 1950, so they do not appear in the 1950 census or the IPUMS classification system. The first commercial electronic computer was delivered in 1951, and employment data on computer specialists were first collected in the 1960 Census.[13]

Computer specialists grew 95 times as a proportion of total employment between 1960 and 2000, from 0.02 percent to 1.92 percent. (See chart 3, top panel.) Employment grew from 12,000 to 2,496,000.[14] The rapid development of computer technology—both more advanced hardware and software and the growth of networks, including the Internet—plus sharply falling computer prices led to the spread of computer use to almost all areas of the economy.

Accountants and auditors grew 13 times as a proportion of total employment between 1910 and 2000, from 0.1 percent to 1.4 percent. (See chart 3, second panel.) Employment grew from 39,000 to 1,795,000.[15] The increasing complexity of business and government operations; more sophisticated management techniques that required more accounting data; greater government regulation regarding financial disclosure, mergers, pensions, and other issues; and the development of complex tax laws all contributed to the growth of this occupation.

College presidents, professors, and instructors grew 12 times as a proportion of total employment between 1910 and 2000, from 0.07 percent to 0.87 percent. (See chart 3, third panel.) The number grew 43 times, from 26,000 to 1,132,000. Over the 9 decades, college enrollments also grew 43 times, from 355,000 to 14,979,000, while the proportion of the population aged 25 and older with 4 or more years of college grew 9.5 times, from 2.7 percent to 25.6 percent.

The more rapid growth from 1960 to 1970 reflects the attendance of the 1946–64 baby-boom generation. From fall 1959 to fall 1969, enrollments in degree-granting institutions more than doubled, from 3.64 million to 8 million. The sharp increase from 1990 to 2000 reflects a sharp rise in enrollments, as well as growth in the proportion of part-time professors and instructors. The latter growth may have spread the teaching load over more teachers.

Engineers increased 9 times as a proportion of total employment between 1910 and 2000, from 0.2 percent to 1.8 percent. (See chart 3, bottom panel.) Their number grew from 74,000 to 2,276,000. Rapid industrialization and growing technological sophistication, which increasingly depended on the work of engineers, fueled the growth. Prior to 1910, much innovation was carried out by self-taught inventors, such as Thomas Edison, but it increasingly began to be carried out by engineers, many in research-and-development laboratories. A rapid growth of manufacturing, including the new motor vehicle and aircraft industries; the development of a vast infrastructure of roads, bridges, and electric power and other utilities; the growth of telephone and broadcast communications and the development of computers; more commercial buildings; and sharp increases in defense spending after 1940 all fueled the growth.[16] Slower growth after 1970 reflects the slower growth of manufacturing, in which engineers are concentrated, and the use of computers in design work, which increased engineers' productivity.[17] The 1990–2000 trend also reflects a drop in defense spending with the end of the Cold War.

Healthcare workers grew 5 times as a proportion of total employment between 1910 and 2000, from 1.2 percent to 7.0 percent. (See chart 4, top panel.) Employment grew from 453,000 to 9,056,000. In 1950, some occupations included in healthcare were not part of professional and technical employment. In order to encompass all healthcare workers within the same category, attendants in hospitals and other institutions and practical nurses, both of which were classified as service occupations in the 1950 census, and attendants in physicians' and dentists' offices, classified as a clerical occupation in 1950, are included among healthcare workers in this article.[18]

Growth occurred as improved medical technology permitted many more medical problems to be treated, or to be treated more aggressively, greater wealth and the spread of health insurance made healthcare more affordable, and a more long-lived population increased the need for healthcare. In 1910, most healthcare was provided in the home, with basic tasks performed by family members. Over the century, more and more healthcare began to be provided by healthcare workers in hospitals, nursing homes, and offices of medical practitioners.[19] For example, there was a large increase in the proportion of childbirths in hospitals between 1920 and 1940.[20]

The expansion of health insurance played a key role in the growth of healthcare after 1940. By shifting the responsibility for payment from the consumer to third-party payers such as insurance companies and the government, health insurance encouraged consumers to use more and costlier healthcare services. Health insurance also encouraged the development of new programs and technologies with little concern for their true cost.[21] In 1939, only 6 percent of workers had hospital insurance; by 1950, 51 percent of workers were covered.[22] Growth was stimulated during World War II, as wage controls encouraged employers to offer benefits, such as hospital insurance, to recruit and retain workers.[23] Gradually, hospital insurance was expanded from simply covering hospital care to covering a wide range of healthcare, whereupon it became health insurance in general. In 1965, with the creation of Medicare and Medicaid, insurance expanded further to cover the elderly and the poor. By 1970, 86 percent of Americans had some form of health insurance,[24] and that percentage remained about the same through 2000.[25]

Despite growth in the proportion of healthcare workers, overall the proportion of physicians and surgeons dropped between 1910 and 1970, from 0.40 percent to 0.36 percent of total employment. (See chart 4, bottom panel.) The drop was caused by changes in healthcare delivery that increased the productivity of physicians and surgeons and by restrictions on medical school enrollments that limited the supply of those professionals. Physicians' productivity increased because some duties were shifted to other healthcare workers and because doctors stopped making house calls. The expansion of medical schools and the admission of more foreign-trained physicians and surgeons to the Nation helped raise the proportion of physicians and surgeons to 0.55 percent by 2000.[26] Employment grew from 155,000 in 1910 to 279,000 in 1970 and 709,000 in 2000.

The expansion of hospitals, nursing homes, and other healthcare services and the increasing specialization in health-care increased the proportional employment of most other healthcare workers. Professional nurses grew from 0.3 percent to 2.1 percent of total employment, and therapists and healers grew from 0.02 percent to 0.37 percent. (See chart 4, bottom panel.) Attendants in hospitals and other institutions and attendants in physicians' and dentists' offices grew from 0.1 percent to 2.2 percent of total employment from 1920 to 2000 (no data were available for 1910), as they assumed more routine tasks formerly done by physicians, nurses, and other higher paid workers. (See chart 4, bottom panel.) Medical and dental technicians grew from 0.14 percent to 0.99 percent of total employment between 1950 and 2000. (See chart 4, bottom panel; no data were available before 1950.)

Lawyers and judges increased one-and-a-half times as a proportion of total employment between 1910 and 2000, with almost all growth coming since 1970. (See chart 5, top panel.) Between 1910 and 1970, lawyers and judges grew from 0.29 percent to 0.35 percent of employment (reaching a peak of 0.36 percent in 1940), after which they jumped to 0.71 percent by 2000.[27] Employment grew from 112,000 in 1910 to 272,000 in 1970 and 927,000 in 2000. Stiff licensing requirements (for both individuals and law schools) and other restrictions on supply limited growth through 1970, but as these restrictions weakened or disappeared, the number of law graduates grew.[28] At the same time, demand for lawyers increased, as many more laws were enacted, business activities became more complex, and society became more litigious. Civil rights legislation for minorities, women, and older and disabled persons; laws regarding the environment, employer-employee relations, product safety, and consumer protection; and higher crime and divorce rates all contributed to the growth of lawyers and judges.[29] Several Supreme Court decisions expanded the right to a court-appointed counsel for criminal defendants, which in turn led to increased funds for public-defenders' offices and a sharp increase in the number of court-appointed defense attorneys.

Teachers below the college level[30] increased 1.4 times as a proportion of total employment between 1910 and 2000, from 1.6 percent to 3.8 percent. (See chart 5, bottom panel.) Their number rose sevenfold, from 624,000 to 4,972,000. Decreasing class size, as measured by pupil-to-teacher ratios, and greater enrollments drove the growth of schoolteachers. The sharp growth in the number of adults taking self-enrichment classes, in subjects such as cooking, dancing, and creative writing, as well as those taking remedial education, adult literacy, and English as a second language, drove the growth of adult education teachers.

The elementary and secondary school pupil-to-teacher ratio dropped by more than half, from about 35 in 1910 to 16.4 in 2000.[31] Elementary and secondary school enrollments grew 1.7 times, from 19,372,000 to 52,989,000, between 1910 and 2000, while total U.S. population grew more than twofold, from 92,000,000[32] to 281,000,000.[33] The number of 5- to 18-year-olds increased 1.3 times, from 24,361,000 in 1910 to 61,298,000 (5- to 19-year-olds) in 2000.[34] Enrollments increased even faster than the 5- to 18-year-old population, because students remained in school for more years, on average, in 2000 than in 1910. Much of the increase in educational attainment occurred during the middle of the century. Between 1940 and 1980, the percentage of 25- to 29-year-olds with a high school diploma increased from 38.1 percent to 85.4 percent. (The percentage of black 25- to 29-year-oldswith a high school diploma increased from 12.3 percent to 76.7 percent.) Growth slowed after 1980, but reached 88.1percent in 2000.[35] The increase in the number of teachers below the college level was more pronounced among secondary school teachers than among elementary school teachers.

The drop in teachers as a proportion of the total employed in 1950 reflects lower enrollments as the smaller age cohort of those born during the 1930s moved through the education system. The increases in 1960 and 1970 reflect higher enrollments as the baby-boom generation, born between 1946 and 1964, moved through the system. After 1970, lower enrollments, together with a continued drop in pupil-teacher ratios, led to more modest growth in teachers as a proportion of the total employed.

Clergy (trend not charted), one of the larger professional occupations in 1910, decreased slightly as a proportion of total employment between 1910 and 2000, from 0.32 percent to 0.29 percent. Employment of clergy grew from 125,000 to 379,000.[36]

Service workers, except private household

Service workers, except private household, increased 2.7 times as a proportion of total employment between 1910 and 2000, from 3.5 percent to 13 percent. (See chart 6.) Employment increased from 1,363,000 to 16,897,000.[37] Subgroups analyzed correspond to 2000 SOC major group (two-digit) categories: building and grounds cleaning and maintenance service, food preparation and serving, protective service, and personal care and service occupations. (Health service, a fifth SOC major group within the service occupations, which includes attendants at hospitals and other institutions, as well as practical nurses, was discussed earlier with professional healthcare workers.[38])

Building and grounds cleaning and maintenance occupations grew 5.3 times as a proportion of total employment between 1910 and 2000, from 0.4 percent to 2.4 percent.[39] (See chart 7, top panel.) Employment grew from 150,000 in 1910 to 2,676,000 in 1980 and 3,158,000 in 2000. Rapid growth in the number of office buildings, hotels, stores, healthcare facilities, apartment buildings, schools, and other structures requiring cleaning and maintenance spurred the increase in employment. It is not clear why the proportion dropped after 1980, but the numbers may reflect problems with the data.

Workers in food preparation and serving related occupations are employed in eating and drinking places, in stores selling food prepared on the premises, and in schools, health care, and other facilities providing prepared meals. Their employment grew 3.4 times as a proportion of total employment between 1910 and 2000, from 0.8 percent to 3.7 percent of total employment. (See chart 7, bottom panel.) In numbers, their employment grew from 323,000 to 4,758,000.

Bartenders, however, declined slightly, from 0.29 percent to 0.24 percent, with a temporary drop to 0.06 percent in 1920 as a result of prohibition.[40] (See chart 7, bottom panel.)

Greater income made food prepared away from home more affordable; the advent of automobiles, improved roads, and greater urbanization made food and drink purveyors more accessible; and an increasing percentage of women working outside of the home intensified the need for prepared meals.[41] More nursing home and assisted-living facility residents and an expansion of school lunch programs also stimulated growth. The number of meals that Americans eat away from home has grown from 16 percent in 1977–78 to 29 percent in 1995.[42]

Protective service workers increased 2.5 times as a percent of total employment between 1910 and 2000, from 0.53 percent to 1.85 percent. (See chart 8, top panel.) Their employment grew from 205,000 to 2,395,000. Most growth was in police, sheriffs, guards, and marshals. (See chart 8, top panel.) Increased urbanization, more motor vehicle traffic, higher crime and incarceration rates, more properties and other assets to protect, and more laws to enforce all contributed to the growth. The faster growth since 1960 may reflect, at least in part, a response to the sharp increase in homicide and robbery rates.[43] The proportion of firemen doubled between 1910 and 1950, due to urbanization and the replacement of volunteers with paid firefighters, but remained level thereafter. (See chart 8, top panel.)

Personal care and service occupations grew 77 percent as a proportion of employment between 1910 and 2000, from 1.3 percent to 2.4 percent. (See chart 8, bottom panel.) Employment grew from 515,000 to 3,054,000. Most of the growth took place after 1970 and was among professional and personal services attendants, an occupation that includes teachers' aides and childcare workers. Over the 90-year period, employment of barbers, beauticians, and manicurists showed little growth, while that of porters and elevator operators declined.

Clerical and kindred workers

Clerical and kindred workers grew 2.7 times as a proportion of employment between 1910 and 1980, but by 2000 their proportion had declined to 2.3 times the 1910 level. The proportion went from 5.2 percent in 1910 to 19.3 percent in 1980 and 17.4 percent in 2000. (See chart 9, top panel.) Employment grew from 2,026,000 in 1910 to 18,758,000 in 1980 and 22,591,000 in 2000. The greater number, size, and complexity of business, government, and nonprofit organizations, with more reports, transactions, records, correspondence, and telephone calls to handle and more clients and customers to deal with all contributed to the growth of clerical occupations. In addition, the spread of retail self-service, as opposed to asking a sales worker for goods stored behind a counter and then having the worker ring up the sale, caused cashiers, classified as a clerical occupation in 1950, to grow rapidly, replacing sales workers.[44]

The growing use of computers and other electronic devices, which simplified or eliminated many clerical activities, caused the post-1980 decline. Automated switching and voice messaging affected telephone operators; personal computers, word-processing software, optical scanners, electronic mail, and voice messaging, secretaries and typists; accounting and database software, bookkeepers; ATM's and telephone and online banking, tellers; and computerized checkout terminals, cashiers.[45] The proportion of telephone operators declined after 1950; stenographers, typists, and secretaries, as well as bookkeepers, after 1970; bank tellers after 1980; and cashiers after 1990. (See chart 9, panel 2.) However, occupations requiring personal contact, such as bill and account collectors; vehicle dispatchers and starters; attendants in physicians' and dentists' offices; and receptionists, increased as a percent of employment through 2000.[46]

Managers, officials, and proprietors

Managers, officials, and proprietors, except farm, grew 1.2 times as a proportion of total employment between 1910 and 2000, from 6.5 percent to 14.2 percent of all employment. (See chart 10.) Their number grew from 2,503,000 to 18,392,000. More and larger bureaucratic organizations, some with many layers of managers, as well as the development of more sophisticated management techniques, spurred growth. The proportional drop between 1950 and 1970 is due to a sharp decline in the number of self-employed managers, as small owner-operated establishments were replaced by larger corporate-owned ones operated by salaried managers. Employment of self-employed managers, officials, and proprietors, n.e.c, declined 22 percent between 1950 and 1960, from 2,528,000 to 1,968,000, and employment of self-employed managers and administrators, n.e.c., declined 49 percent between 1960 and 1970, from 1,764,000 to 902,000.[47] Most of those employed within the major SOC group of managers, officials, and proprietors, except farm, are classified in the census as managers, officials, and proprietors (not elsewhere classified), limiting more detailed analysis.

Sales workers

Sales workers grew 69 percent as a proportion of total employment between 1910 and 1970, but then dropped. In 2000, the occupation was 56 percent above the 1910 level. Sales workers went from 4.4 percent of total employment in 1910 to 7.4 percent in 1970 and 6.8 percent in 2000. (See chart 11.)Employment of sales workers grew from 1,695,000 in 1910 to 5,677,000 in 1970 and 8,855,000 in 2000. A rapid increase in the volume of goods and services sold kindled the growth. The leveling after midcentury occurred as self-service retailing became widespread, reducing the need for sales workers and spurring the growth of cashiers, a clerical occupation in the 1950 census.[48] Computerized sales terminals, introduced toward the end of the century, also limited growth by raising retail sales workers' productivity.

Craftsmen, foremen, and kindred workers

Craftsmen, foremen, and kindred workers grew 27 percent as a proportion of total employment between 1910 and 1920, but by 2000 the group was 10 percent below the 1910 level. The occupation grew from 10.9 percent in 1910 to 13.8 percent in 1920, dipped below 12 percent in 1940, recovered to almost 14 percent by 1950, remained above 13 percent through 1970, and then declined to 9.8 percent in 2000. (See chart 12.) The drop in 1940 reflects, at least in part, the Great Depression, which may have affected craftsmen more than other occupation groups.[49] Employment grew from 4,223,000 in 1910 to 12,769,000 in 2000. The occupation of craftsmen, foremen, and kindred workers is divided into three subgroups for this article, roughly corresponding to the 2000 SOC major occupation groups of construction workers, mechanics and repairers, and production and other craftsmen.[50]

Mechanics and repairers grew 10.9 times as a proportion of total employment between 1910 and 1950, but by 2000 the occupation had dropped to 9.9 times the 1910 proportion. It grew from 0.32 percent to 3.91 percent in 1960 and then slipped to 3.58 percent in 2000. (See chart 13, top panel.) Employment of mechanics and repairers grew from 140,000 in 1910 to 2,520,000 in 1960 and 4,642,000 in 2000. A vast increase in the amount of machinery, all requiring maintenance and repair, drove the growth. There was greater mechanization of factories, farms, offices, mines, service industries, and homes, all made possible by the spread of a network of electric power lines and generating facilities. The number of motor vehicles and aircraft in use grew exponentially, as did machinery related to central heating and air-conditioning, telephone and broadcast communications, computers, and many other technologies. The proportion of mechanics and repairers declined slightly after 1960 as the pace of mechanization slowed and as machinery and equipment became more reliable and easier to repair.

Construction workers declined 31 percent as a proportion of total employment between 1910 and 2000, from 4.3 percent to 3.0 percent. (see chart 13, middle panel.) Employment grew from 1,663,000 in 1910 to 3,837,000 in 2000. Most of the relative decline in construction workers' share of employment was among carpenters. Electricians, the second-largest construction occupation after carpenters in 2000, grew from 0.34 percent of total employment in 1910 to 0.57 percent in 2000, with most growth between 1910 and 1920. (See chart 13, middle panel.)

Production and other craftsmen grew 26 percent as a proportion of total employment from 1910 to 1920, but then declined, dropping to 65 percent below the 1910 level. The category grew from 5.5 percent in 1910 to 6.9 percent in 1920, but fell to 1.9 percent by 2000. (See chart 13, bottom panel.) Employment grew from 2,125,000 in 1910 to 3,435,000 in 1970, but slipped to 2,515,000 by 2000. Mechanization and automation in the manufacturing and railroad industries, as well as in other industries; more efficient management; and, in the later decades, greater imports caused the decline.

Operatives

Operatives and kindred workers include operators of motor vehicles and fixed machinery; assemblers, inspectors, packers, and related workers; and apprentices to craft workers. In the early years of the 20th century, the occupation also included many operators of horse-drawn vehicles. Operatives grew 28 percent as a proportion of total employment between 1910 and 1950, but by 2000 their proportion had fallen to 33 percent below the 1910 level. Operatives grew from 15.7 percent of total employment in 1910 to 20.1 percent in 1950, but then declined to 10.4 percent in 2000. (See chart 14.) Employment grew from 6,079,000 in 1910 to 11,518,000 in 1950, peaked at 14,346,000 in 1980, and declined to 13,544,000 by 2000. The group is divided into three components for analysis: road (motor and horse-drawn) vehicle operators, mine operatives and laborers, and production and other operatives.

Road vehicle operators grew 88 percent as a proportion of total employment between 1910 and 1960, but by 2000 the category was only 59 percent above the 1910 level.[51] Road vehicle operators grew from 1.9 percent of total employment in 1910 to 3.6 percent in 1960, but then settled at about 3.0 percent for the rest of the century. (See chart 14.) Employment grew from 735,000 in 1910 to 3,917,000 by 2000. The increase was due to growth in the volume of goods moved by road and in the distances the goods were shipped.

The employment drop to 641,000 and 1.5 percent of total employment in 1920 reflects the shift from horse-drawn to motorized vehicles, which greatly increased driver productivity.[52] (The 1910 and 1920 censuses did not distinguish clearly between operators of horse-drawn and motorized vehicles.) The growth of truck registrations from 10,000 in 1910 to 1.1 million in 1920 indicates the magnitude of the shift. So does the drop in employment of livery stable keepers and managers from 35,000 to 11,000 over the same period.[53]

Mine operatives and laborers declined 95 percent as a proportion of total employment between 1910 and 2000, from 2.4 percent in the former year to 0.1 in the latter (see chart 14), while employment fell from 917,000 to 158,000. The sharp decline was due to advances in mining technology and mechanization and to the slower-than-average growth of mining industry output.

Production and other operatives grew 32 percent as a proportion of total employment from 1910 to 1950, but by 2000 was 53 percent below the 1910 level. (See chart 14.) Employment grew from 4,265,000 in 1910 to 8,829,000 in 1950, peaked at 11,010,000 in 1980, and dropped to 9,412,000 by 2000. The trend largely reflects developments in mass production in manufacturing. In the early decades of the 20th century, mass production, which relied on considerable mechanization and the splitting of complex tasks into simple ones, required large numbers of operatives.[54] Operatives tended the machines used in rapidly growing continuous-process industries such as steel, paper, and chemicals; operated metal-fabricating, sewing, printing, textile, and other machinery; and assembled and inspected motor vehicles and, later, refrigerators, radios, televisions, and many other products.[55] In nonmanufacturing industries, they operated laundry and drycleaning machinery and railroad switches and brakes, made and altered dresses and suits, and parked cars. The proportional decline of operatives after 1950 reflects automation in manufacturing, laundries, railroads, and other industries; more efficient management; and, in the later decades of the 20th century, greater imports.

Laborers, except farm and mine

Laborers other than farm and mine laborers declined by 64 percent as a proportion of total employment between 1910 and 2000. During that span, these laborers' share of employment went from 10.4 percent to 3.7 percent, although the proportion peaked at 11.4 percent in 1920. (See chart 15.) Employment of the group grew from 4,035,000 in 1910 to 4,972,000 in 1990, but dropped to 4,851,000 in 2000. Both more efficient management and the mechanization of production, construction, and material-handling activities led to the decline. However, the proportion of gardeners, except farm, and groundskeepers nearly tripled, from 0.26 percent to 0.7 percent, with most growth occurring after 1980. (See chart 15.) Employment grew from 100,000 to 903,000. More public and commercial buildings, highways, and recreation facilities requiring gardening services, plus more extensive landscaping, stimulated the growth. Rising incomes also permitted homeowners to do more extensive landscaping and lawn care and to hire workers for tasks formerly done by household members. Employment of laborers, excluding gardeners, was 3,900,000 in 2000, the same level as in 1910.

Private household workers

Private household workers fell 92 percent as a proportion of total employment, from 6.0 percent in 1910 to 0.45 percent in 1990. (See chart 16.) Employment of these workers declined from 2,319,000 to 523,000. (Due to changes in the occupational classification system used in the 2000 census, data for 2000 are not available.[56]) The decline reflects changes in both demand and supply. The need for private household workers decreased over the period as home production of goods and services shifted to manufacturing and service industries and as housework became more mechanized. A greater proportion of food was prepared in food-processing plants, grocery stores, and restaurants; clothing increasingly was produced in manufacturing industries and cleaned in service industries; and more and more children were cared for in daycare centers. At the same time, labor-saving technologies such as hot and cold running water, central heating, gas and electric stoves, refrigerators and freezers, clothes washers and dryers, vacuum cleaners, dishwashers, and wash-and-wear clothing made housekeeping easier to perform.[57] The supply of workers to this occupation also became more limited, particularly in the early part of the century, as outside employment opportunities for women—most of these workers were women—broadened, chiefly in clerical and service occupations.[58]

Farmers and farm laborers

The two occupation groups of farmers (including farm managers) and farm laborers (including foremen) combined declined 96 percent as a proportion of total employment between 1910 and 2000, from 33 percent to 1.2 percent. (See chart 17.) Employment declined from 12,809,000 to 1,598,000 between the 2 years.[59] Sharply rising farm productivity, together with limited appetites for farm products, caused the decline. In addition, rapid growth in demand for workers in other occupations, as well as higher earnings, encouraged the shift out of farming.

Farm mechanization, most notably the replacement of horses and mules with gasoline-powered tractors of growing power and efficiency, greatly increased farm workers' productivity. So did improved fertilizers and pesticides, higher yield varieties of plants and breeds of animals, improved irrigation practices, more efficient farm management, and farm consolidation. Near the end of the century, genetically modified crops increased yields, reduced pesticide usage, and increased resistance to many pests and fungi. The proportion of farm laborers dropped especially sharply from 1910 to 1920, as people left for military service or factory work during World War I and did not return. In addition, the 1920 census was conducted on January 1; had it been conducted on April 15, a time of greater farm activity, a greater number of seasonal farm laborers would have been reported.[60]

Despite declining farm employment over the 1910–2000 period, agricultural output grew. Wheat production increased 2.6 times, from 625 million bushels to 2,228 million bushels, and yield per acre tripled, from 13.7 bushels to 42.0 bushels. Corn production grew 2.5 times, from 2,852 million bushels to 9,915 million bushels, with yield per acre growing 4 times, from 27.9 bushels to 136.9 bushels.[61] However, these increases in output, while substantial, were much more modest than increases in output in other sectors, such as manufacturing and services. Still, from 1900 to 1997, the time required to cultivate an acre of wheat decreased from more than 2 weeks to about 2 hours, while for an acre of corn, it declined from 38 hours to 2 hours.

EVERY 2 YEARS, THE BUREAU ANALYZES historic employment trends as part of its program of 10-year occupation and industry employment projections. The Bureau projects that many of the long-term trends described in this article will continue into the 21st century.62 Professional and related occupations and health service workers are projected to increase their share of total employment between 2004 and 2014. Construction occupations and installation, maintenance, and repair occupations are expected to remain about the same proportion of total employment, while production occupations (roughly equivalent to production craftsmen and production-related operatives), office and administrative support occupations (roughly equivalent to clerical occupations), and agricultural managers and agricultural workers are projected to decline.

Notes

1 See the November 2005 *Review*.

2 In the Bureau's biennial projections, an industry-occupation matrix is used to analyze occupations as a percentage of total employment in each industry. (See *Occupational Outlook Handbook, 2004– 05*, Bulletin 2570 (Bureau of Labor Statistics, March 2004), pp. 663– 64; and *Occupational Projections and Training Data, 2004–05*, Bulletin 2572 (Bureau of Labor Statistics, March 2004), pp. 42–43; on the Internet at http://www.bls.gov/emp).

3 Those with a numeric decline in employment have a staffing pattern decline of 70 percent or more.

4 On the Internet at http://www.ipums.org/. (See Steven Ruggles, Matthew Sobek, Trent Alexander, Catherine A. Fitch, Ronald Goeken, Patricia Kelly Hall, Miriam King, and Chad Ronnander, *Integrated Public Use Microdata Series: Version 3.0 (*Minneapolis, Minnesota Population Center, 2004.)) IPUMS provides Census Bureau microdata dating back to 1850. The size of the microdata sample is either 1 percent or 5 percent, depending upon the year.

5 In addition, the original Census Bureau data have both sampling and nonsampling errors.

6 An occupation category consists of a homogeneous group of occupation titles. (See *Alphabetical index of occupations and industries, 1950 Census of Population*, rev. ed. (U.S. Bureau of the Census, 1950), p. vi.)

7 The 1950 census did include three subgroups: engineers, natural scientists, and mechanics and repairers.

8 See *Standard Occupational Classification Manual, 2000* (Executive Office of the President, Office of Management and Budget, 2000).

9 Data in chart 1 on private household workers are for 1990, rather than 2000. In the 2000 census, the employment of private household workers cannot be determined, because those workers are included with workers having similar duties in cleaning, childcare, food preparation, or other service worker occupations. Therefore, the change in private household workers' employment over the 90-year period cannot be calculated.

10 Of course, these shifts began well before 1910. For example, employment in the agricultural sector, roughly equivalent to farm occupation employment, declined

from 64.5 percent in 1850 to 32.1 percent in 1910. Over the same period, employment in the goods-producing sector increased from 17.7 percent to 32.1 percent, and that in the service-producing sector increased from 17.8 percent to 35.9 percent. (See Michael Urquhart, "The employment shift to services: where did it come from?" *Monthly Labor Review*, April 1984, pp. 15–22, especially table 1, p. 16.)

[11] That is, their growth appears as a straight line in the charts that are presented. Obviously, growth rates over the period need not be steady.

[12] The group included SOC numbers 15–29–0000 in 2000. (See *Standard Occupational Classification Manual, 2000*, p. xvi.) Accountants and auditors, however, a category classified as a business and financial operations occupation in the 2000 SOC, also is discussed here because it was classified as a professional, technical, and kindred occupation in 1950.

[13] See *Greatest Engineering Achievements of the 20th Century* (Washington, DC, National Academy of Engineering, 2006), on the Internet at http://www.greatachievements.org/.

[14] Data are from the 1960–90 censuses and the 2000 Current Population Survey (CPS). Computer programmers; computer systems analysts; and computer specialists, not elsewhere classified (n.e.c.), first appeared as titles of occupations in the 1960 census, within professional, technical, and kindred workers, n.e.c., and as Bureau of the Census occupations (with employment data) in 1970. Special tabulations provide employment data for 1960. (See Constance Bogh DiCesare, "Changes in the occupational structure of U.S. jobs," *Monthly Labor Review*, March 1975, pp. 24–34, especially Table 2, p. 26; and John A. Priebe, Joan Heinkel, and Stanley Greene, *1970 Occupation and Industry Classification Systems in Terms of Their 1960 Occupation and Industry Elements*, Technical Paper 26 (U.S. Department of Commerce, Bureau of the Census, 1972), especially table 1, p. 19.)

[15] Data on accountants for the 1910–40 period are from *Historical Statistics of the United States, Colonial Times to 1970*, Bicentennial Edition, part 1 (U.S. Department of Commerce, Bureau of the Census, 1975). Accountants and auditors are classified with business and financial operations occupations in 2000.

[16] *Greatest Engineering Achievements.*

[17] William C. Goodman, "The software and engineering industries: threatened by technological change?" *Monthly Labor Review*, August 1996, pp. 37–45.

[18] Healthcare workers, excluding attendants and practical nurses, increased 4.6 times, from 0.8 percent to 4.4 percent.

[19] In the latter part of the century, home healthcare provided by healthcare workers also grew rapidly.

[20] David E. Kyvig, *Daily Life in the United States, 1920–1940* (Chicago, Ivan R. Dee, 2002).

[21] See Anne Kahl and Donald Clark, "Employment in health services: long term trends and projections," *Monthly Labor Review*, August 1986, pp. 17–36; and David Hiles, "Health services: the real jobs machine," *Monthly Labor Review*, November 1992, pp. 3–16.

[22] Theodore Caplow, Louis Hicks, and Ben J. Wattenberg, *The First Measured Century: An Illustrated Guide to Trends in America, 1900– 2000* (Washington, DC, AEI Press, 2001).

[23] Personal interview with Dale C. Smith, Ph. D., chairman, Department of Medical History, U.S. University of the Health Services, Dec. 8, 2004.

[24] Caplow, Hicks, and Wattenberg, *The First Measured Century*.

[25] *Statistical Abstract of the United States: 2003* (U.S. Census Bureau, 2003). Data are based on the CPS.

[26] At 9.1 percent, physicians and surgeons were the second-largest professional and technical occupation in 1910, but by 2000 they had dropped to 2.4 percent of all professional workers. Dentists and pharmacists remained a fairly steady proportion of total employment throughout the century.

[27] The higher 1940 ratio may reflect the smaller-than-average impact of the Great Depression on the employment levels of lawyers. In 1940, the overall unemployment rate was 14.6 percent (Statistical *Abstract of the United States, 1961* (U.S. Census Bureau, 1961).)

[28] Richard L. Abel, *American Lawyers* (New York, Oxford University Press, 1989); see especially pp. 123–26.

[29] Federal laws include the Civil Rights Act of 1964, the Age Discrimination in Employment Act of 1967, the National Environmental Policy Act of 1969, and the Occupational Safety and Health Act of 1970.

[30] In the census, teachers, n.e.c. The only other category of teachers is college presidents, professors, and instructors. Teachers, n.e.c., made up by far the largest professional occupation in 1910, at 36.4 percent of all professional workers. By 2000, it was still the largest, but was only 16.4 percent of professional workers.

[31] Thomas D. Snyder, ed., *120 Years of American*

Education: A Statistical Portrait (Washington, DC, National Center for Education Statistics, 1993); see also IES/NCES, "Youth Indicators, 2005: Trends in the Well-being of American Youth, Indicator 11: Pupil/Teacher Ratios and Expenditures per Student," table 11, on the Internet at http://nces.ed.gov/programs/youthindicators/.asp?PubPageNumber=11&ShowTablePage=TablesHTML/11.asp.

32 *United States Summary: Population and Housing Unit Counts*

(U.S. Census Bureau, August 1993), table 2, on the Internet at:

http:// www.census.gov/population/censusdata/table-2.pdf.

33 *National and State Population Estimates: Annual Population Estimates 2000–2005* (U.S. Census Bureau, Dec. 21, 2005), on the Internet at http://www.census.gov/popest/states/NST-ann-est.html.

34 The percent change here is based on data for 5- to 19- year-olds, prorated for 5- to 18-year-olds.

35 *Digest of Education Statistics Tables and Figures* (National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education, 2001), table 8, on the Internet at http:// nces.ed.gov/programs/digest/d01/dt008.asp. Between 1910 and 1940, the proportion of people aged 25 years and older with a high school diploma increased from 13.5 percent to 24.5 percent.

36 Clergy declined from 7.3 percent to 1.3 percent of professionals over the period.

37 The 2000 data include some workers classified as private household workers in earlier years.

38 Health service workers grew 4 times as a percent of total employment, from 0.39 percent to 1.95 percent. Their numbers grew from 97,000 to 3,513,000. Practical nurses are classified with service workers in the 1950 census, but with healthcare practitioners and technical occupations in the SOC. Data for service workers, n.e.c., are not included in the components.

39 Gardeners, except farm, and groundskeepers are included within laborers, just as they are in the 1950 census classification.

40 Nationwide prohibition began on January 16, 1920, with the 18th amendment to the Constitution, but State and local laws had already significantly affected the drinking of alcoholic beverages. The amendment was repealed in 1934. (See Kyvig, *Daily Life in the United States*, pp. 3, 24, and 25.)

41 John A. Jakle and Keith A. Sculle, *Fast food: roadside restaurants in the automobile age* (Baltimore, Johns Hopkins University Press, 1999).

42 http://www.fns.usda.gov/cga/PressReleases/1999/PR-0060.htm.

43 Caplow, Hicks, and Wattenberg, *The First Measured Century*, pp. 214–17.

44 In the 2000 SOC, cashiers are classified as sales workers.

45 See Teresa L. Morisi, "Commercial banking transformed by computer technology," *Monthly Labor Review*, August 1996, pp. 30– 36; and Michael J. Pilot, " *Occupational Outlook Handbook*: a review of 50 years of change," *Monthly Labor Review*, May 1999, pp. 8–26.

46 Data on attendants in physicians' and dentists' offices also are included in data on healthcare workers.

47 John Priebe, *Changes between the 1950 and 1960 Occupational and Industry Classifications* (U.S. Bureau of the Census, July 1969). DiCesare, "Occupational structure of U.S. jobs," cautions that part of the 1960–70 decline could be attributed to definitional changes.

48 See note 44.

49 See, for example, note 27.

50 Data for these three categories do not include foremen, n.e.c. The Census Bureau aggregated data for all foremen, so there was no way to allocate their employment to each of the categories. Craftsmen and kindred workers, n.e.c., also were not allocated. The occupation of mechanics and repairers is a 1950 census group, roughly equivalent to installation, maintenance, and repair occupations in the 2000 SOC.

51 This group corresponds to motor vehicle operators in the 2000 SOC.

52 Fourteenth Census of the United States taken in the Year 1920, Volume IV, Population 1920, Occupations (U.S. Bureau of the Census), p. 16.

53 *Ibid.*, p. 39.

54 See Harold F. Williamson, *The Growth of the American Economy* (New York: Prentice-Hall, Inc., 1944), especially pp. 499–519.

55 See Kyvig, *Daily Life in the United States*, pp. 35–37, for a discussion of Henry Ford's role in developing mass production.

56 See *Standard Occupational Classification Manual, 2000*.

57 *The First Measured Century*, pp. 36–37, 98–99. The greater labor force participation rate of women in the latter part of the century did not appear to affect the

decline in the number and proportion of private household service workers.

[58] Between 1910 and 1950, the number of women employed in clerical occupations increased 5.5 times (by 3.8 million), while male clerical workers increased 1.1 times. (See *Historical Statistics of the United States*, pp. 139, 140).

[59] Employment of farmers declined from 15.6 percent of all employment to 0.6 percent, from a level of 6,048,000 to 775,000. Employment of farm laborers declined from 17.4 percent to 0.6 percent, or, numerically, from 6,761,000 to 823,000.

[60] See *Fourteenth Census*, pp. 12, 13, 22–24. The 1910 census was conducted on April 15. The *Fourteenth Census* also discusses the possible overcount in the 1910 census of children aged 10–15 years reported as farm laborers. In the early years of the 20th century, a large proportion of farm laborers were unpaid family workers.

[61] See *Track Records: United States Crop Production* (U.S. Department of Agriculture, National Agricultural Statistics Service, April 2003), on the Internet at http://usda.mannlib.cornell.edu/data-sets/crops/96120/track03c.htm#all; and 2002 Census of Agriculture—State Data: New York (U.S. Department of Agriculture, National Agricultural Statistics Service, no date), table 33, on the Internet at http://www.nass.usda.gov/census/census02/volume1/ny/st36_1_033_033.pdf.

[62] Daniel E. Hecker, "Occupational employment projections to 2014," *Monthly Labor Review*, November 2005, pp. 70–101.

Chart 1. Proportional employment in occupational categories, 1910 and 2000

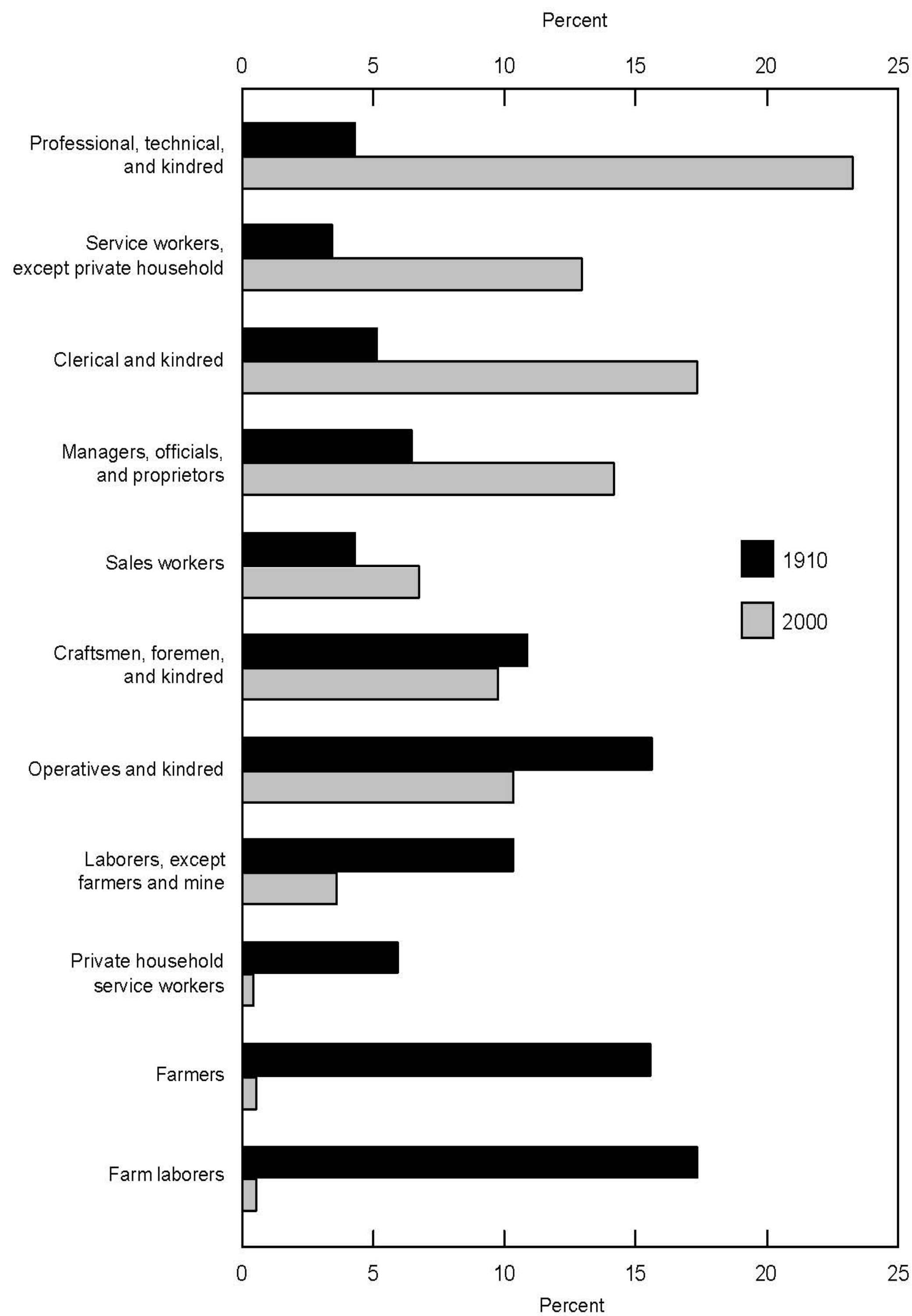


Chart 2: Professional, technical and kindred occupations grew to become the largest occupational group

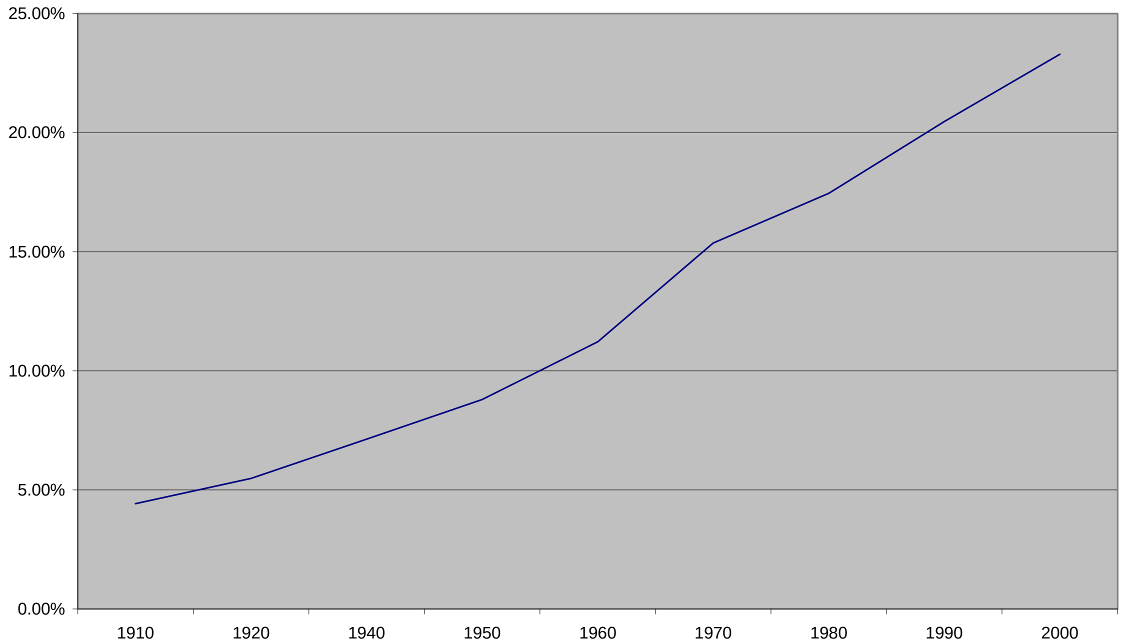
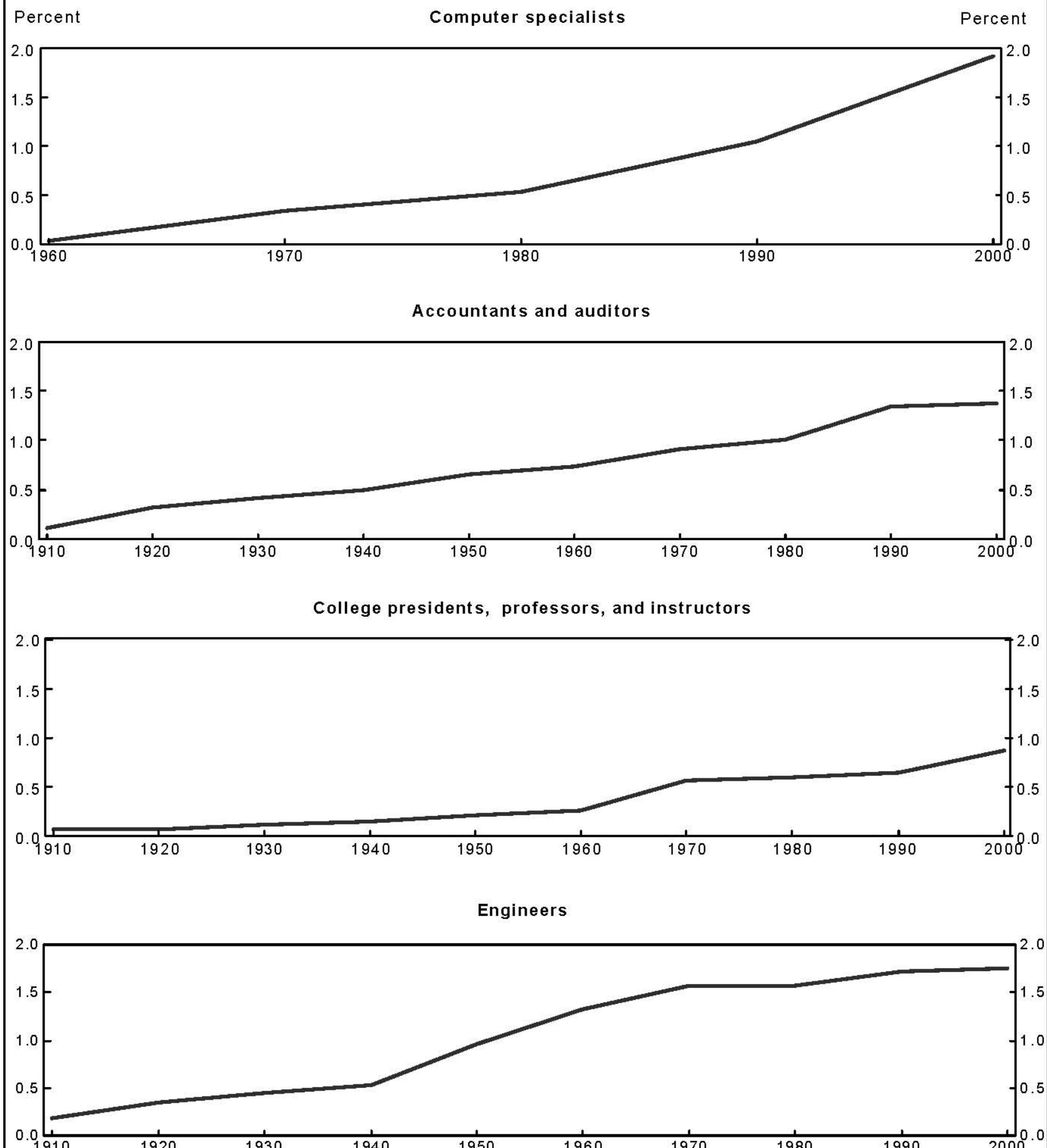
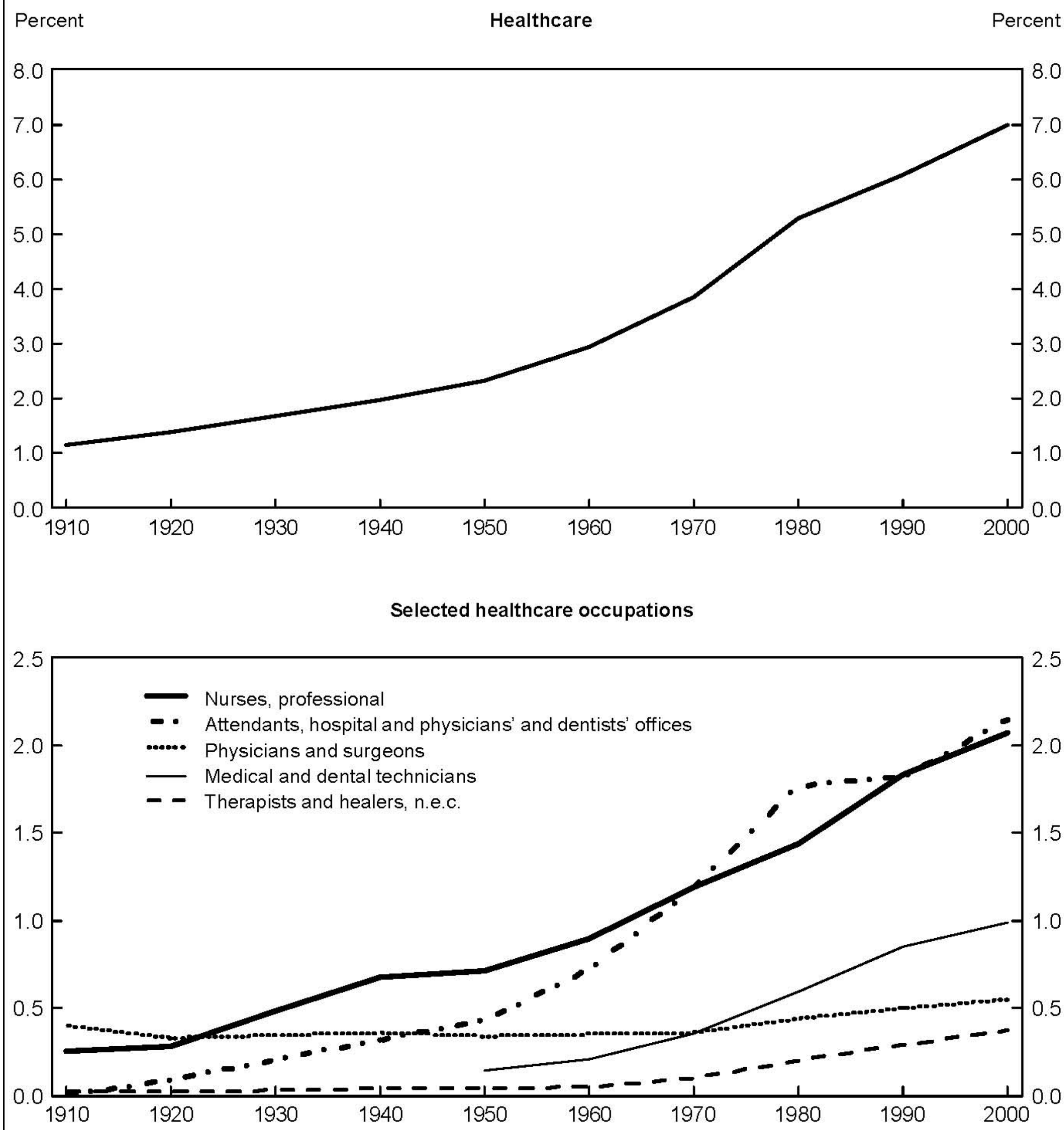


Chart 3. **Proportion of total employment of computer specialists; accountants and auditors; college presidents, professors, and instructors; and engineers, 1910–2000**



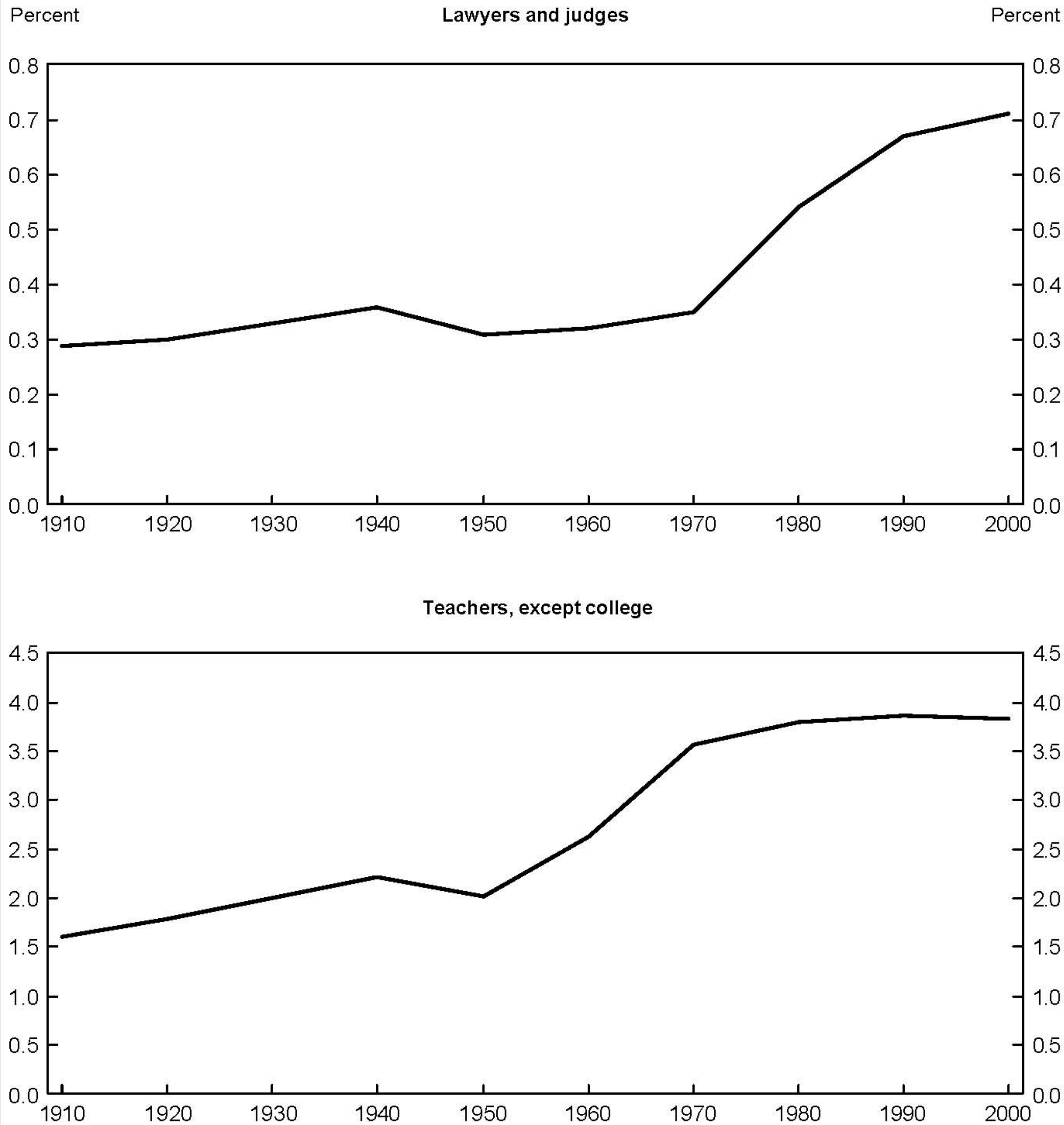
NOTE: Employment of computer specialists was first included as an occupation in 1960. Data for 1930 are an average of 1920 and 1940 data because 1930 data were unavailable when this article was written.

Chart 4. Proportion of total employment in healthcare and proportion of total employment of selected healthcare occupations, 1910–2000



NOTE: Data for 1930 are an average of 1920 and 1940 data because 1930 data were unavailable when this article was written.

Chart 5. **Proportion of total employment of lawyers and judges and of teachers, except college, 1910–2000**



NOTE: Data for 1930 are an average of 1920 and 1940 data because 1930 data were unavailable when this article was written.

Chart 6

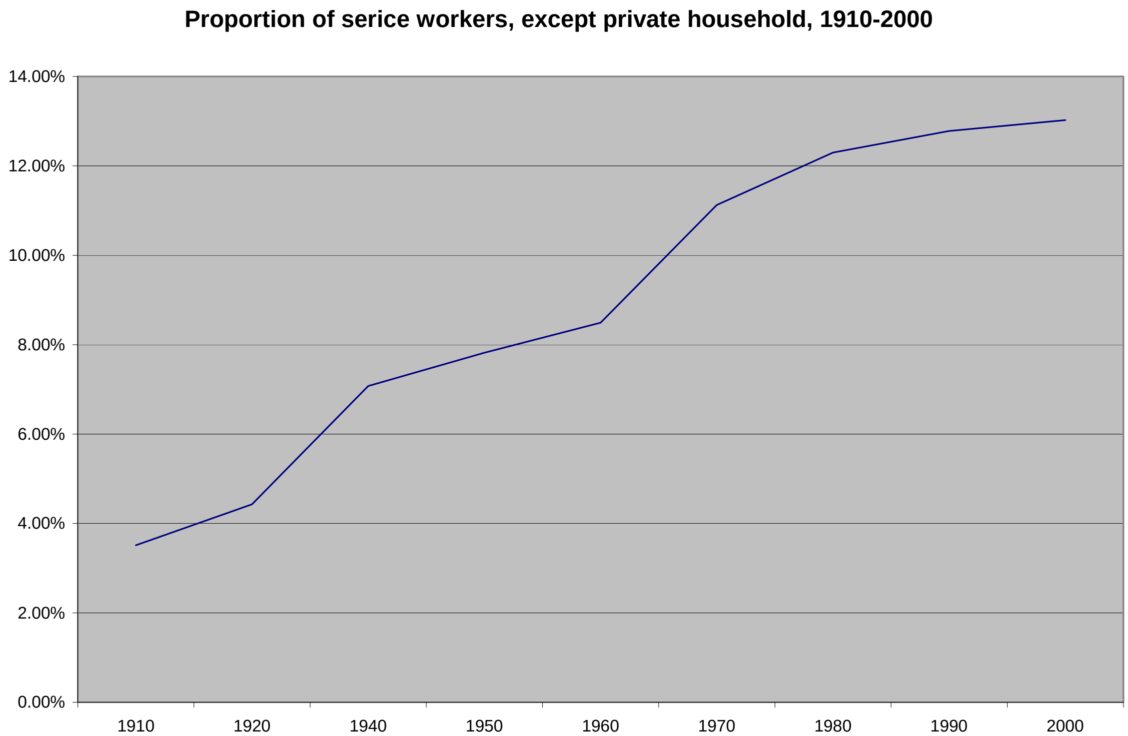
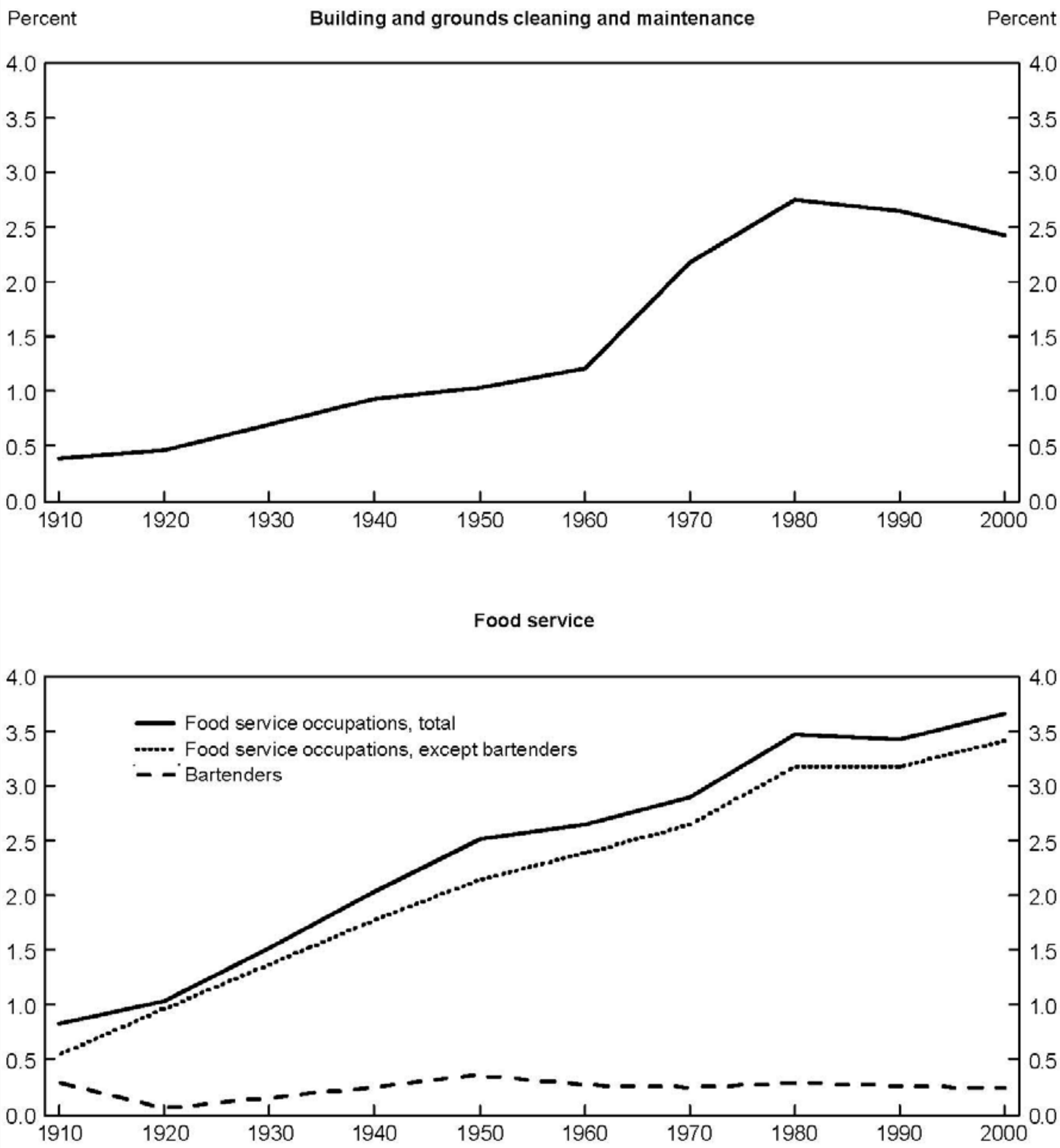
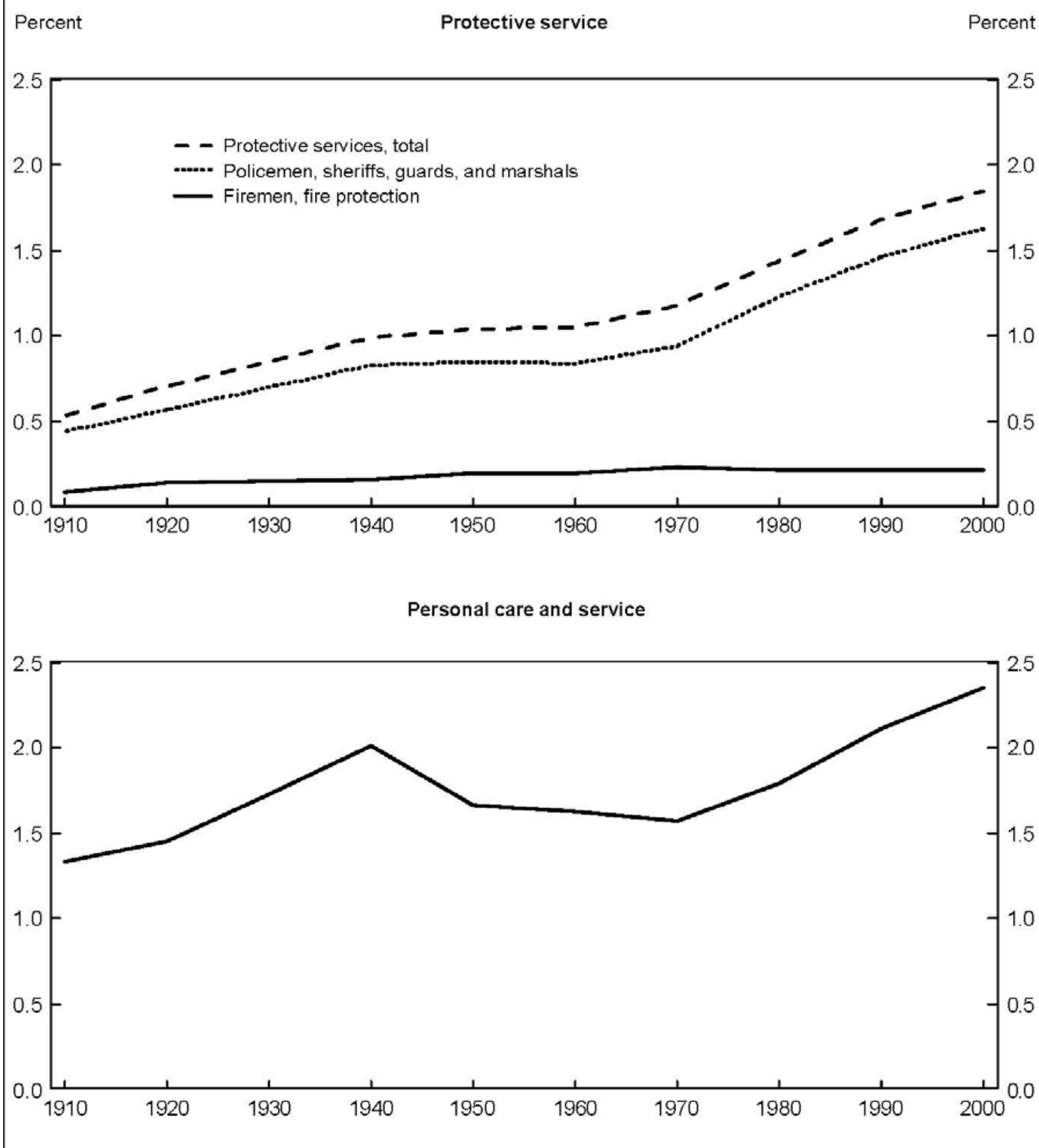

Proportion of serice workers, except private household, 1910-2000
14.00%
12.00%
10.00%
8.00%
6.00%
4.00%
2.00%
0.00%
1910
1920
1940
1950
1960
1970
1980
1990
2000

Chart 7. Proportion of total employment in building and grounds cleaning and maintenance occupations and proportion of total employment in food service occupations, 1910–2000



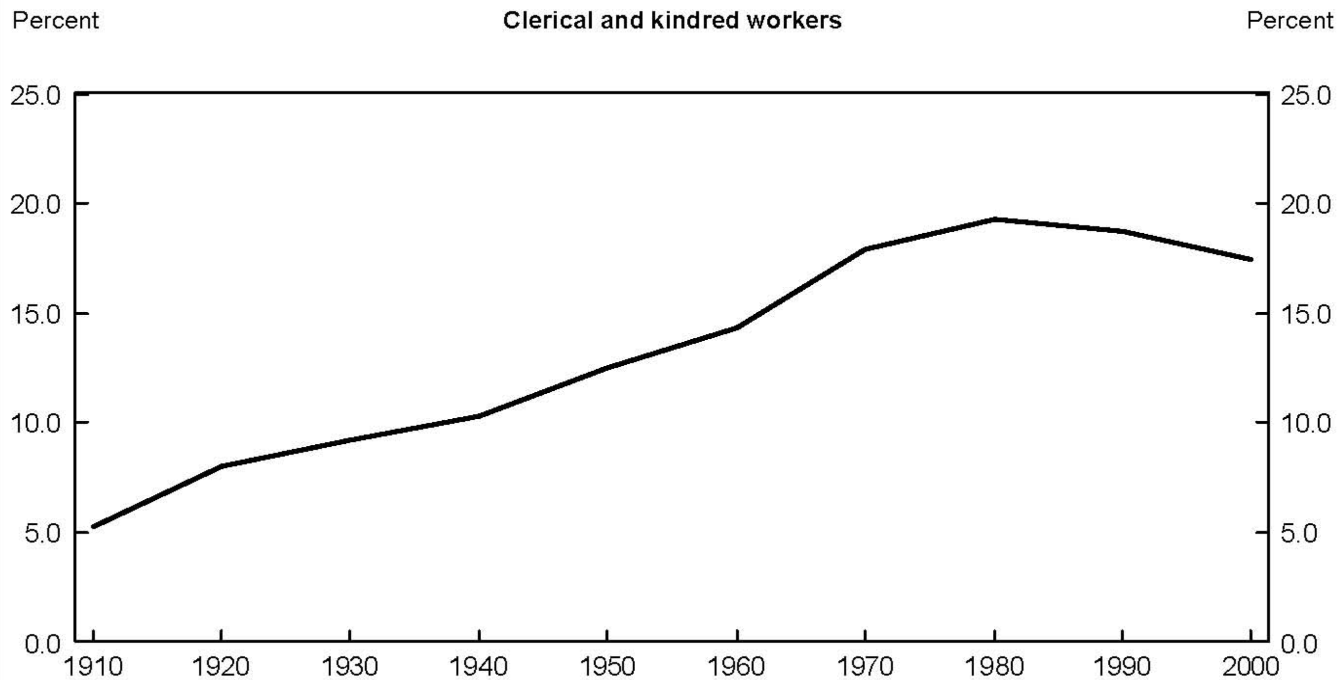
NOTE: Data for 1930 are an average of 1920 and 1940 data because 1930 data were unavailable when this article was written.

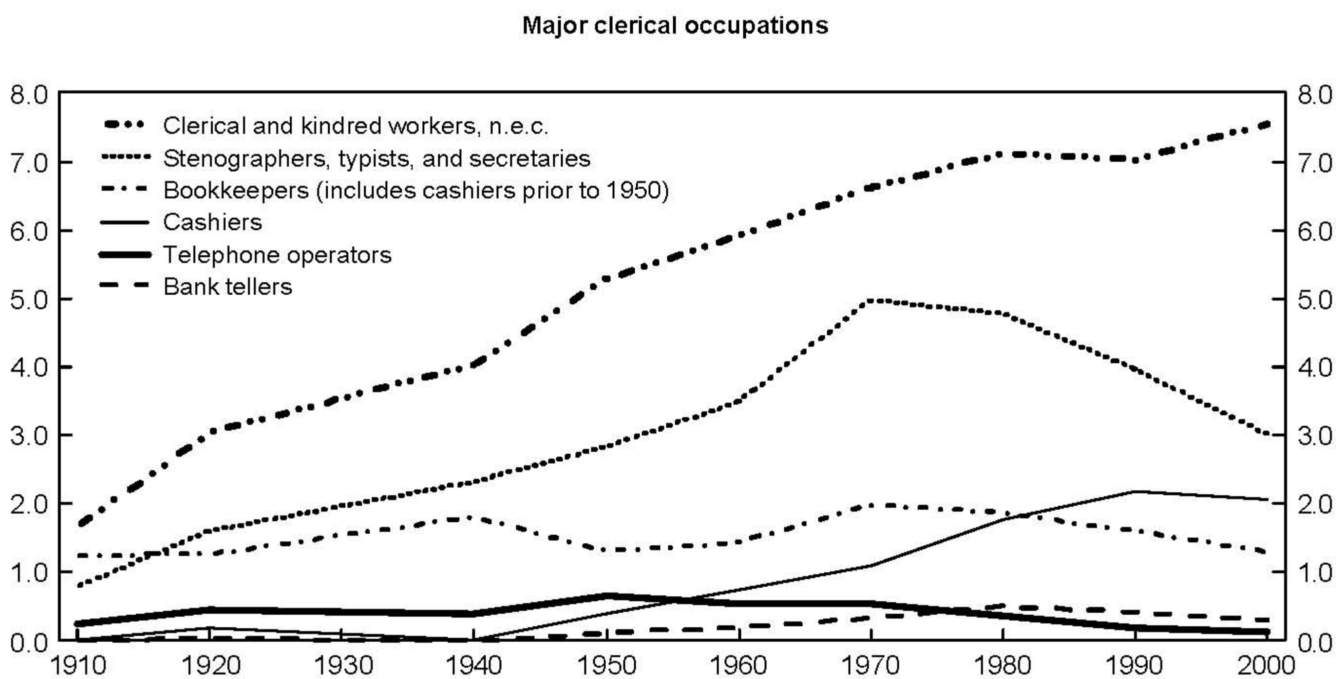
Chart 8. **Proportion of total employment in protective service occupations and in personal care and service occupations, 1910–2000**



NOTE: Data for 1930 are an average of 1920 and 1940 data because 1930 data were unavailable when this article was written.

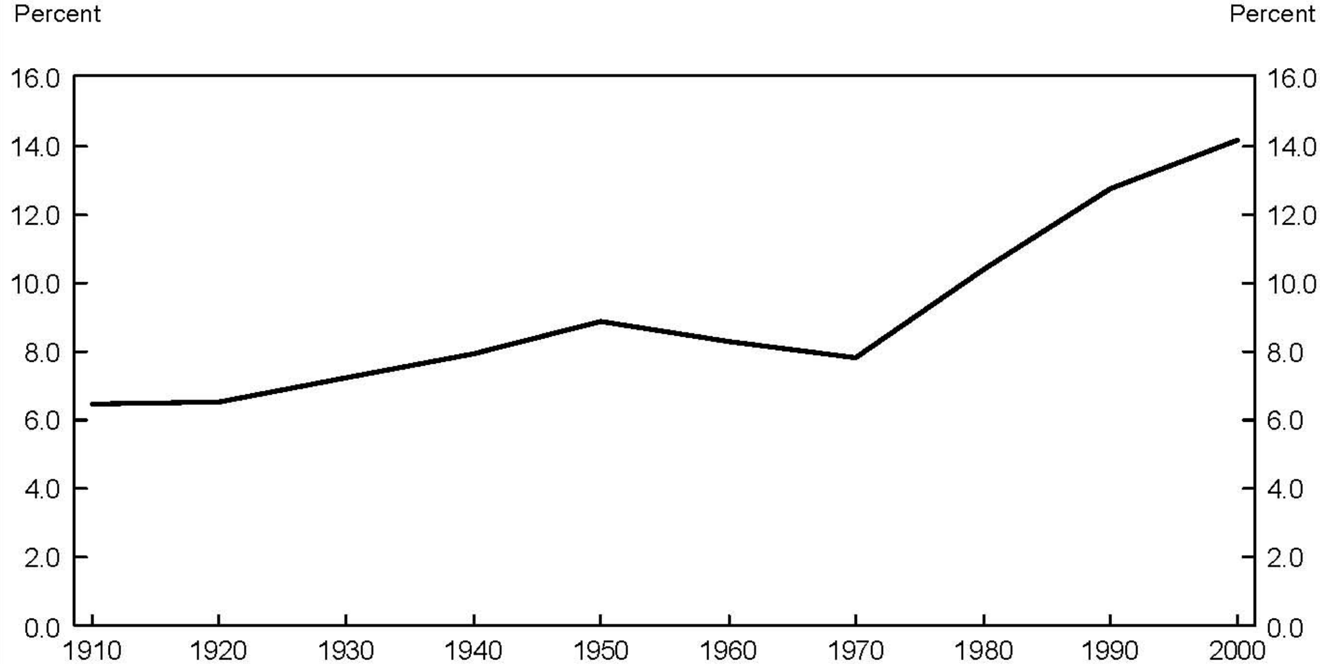
Chart 9. Proportion of total employment of clerical and kindred workers and proportion of total employment in major clerical occupations, 1910–2000





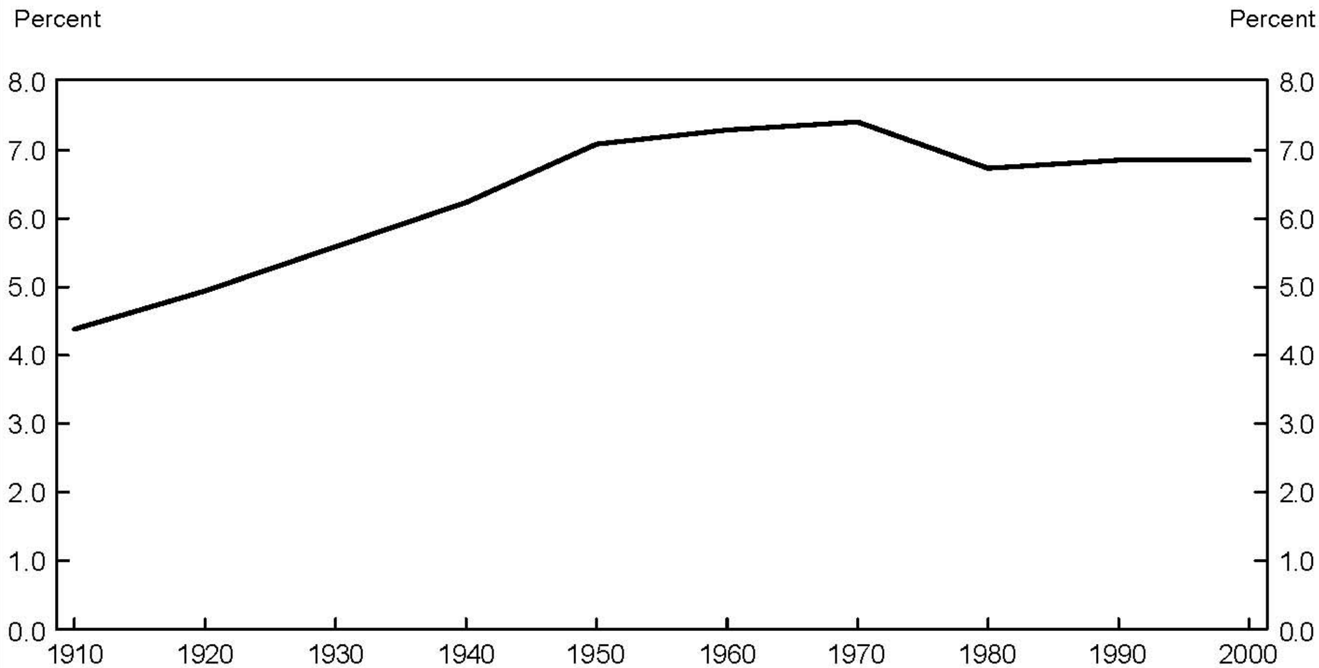
Note: Data for 1930 are an average of 1920 and 1940 data because 1930 data were unavailable when this article was written.

Chart 10. **Proportion of total employment of managers, officials, and proprietors, 1910–2000**



NOTE: Data for 1930 are an average of 1920 and 1940 data because 1930 data were unavailable when this article was written.

Chart 11. **Proportion of total employment of sales workers, 1910–2000**



NOTE: Data for 1930 are an average of 1920 and 1940 data because 1930 data were unavailable when this article was written.

Chart 12: Proportion of total employment of craftsmen, foremen, and kindred workers, 1910-2000

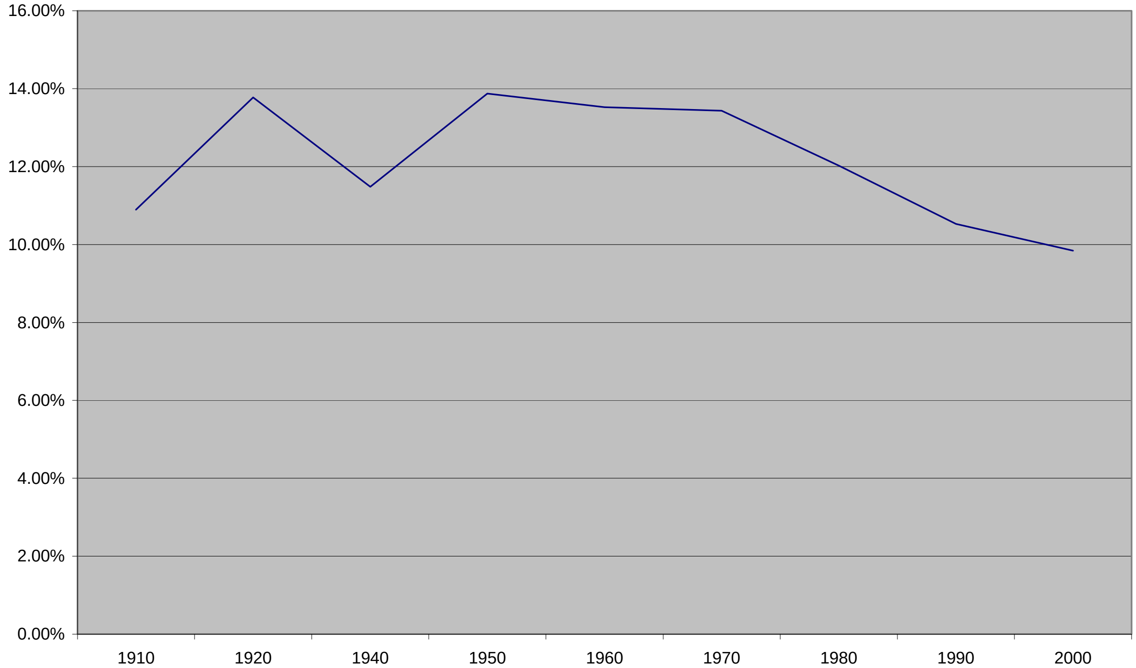
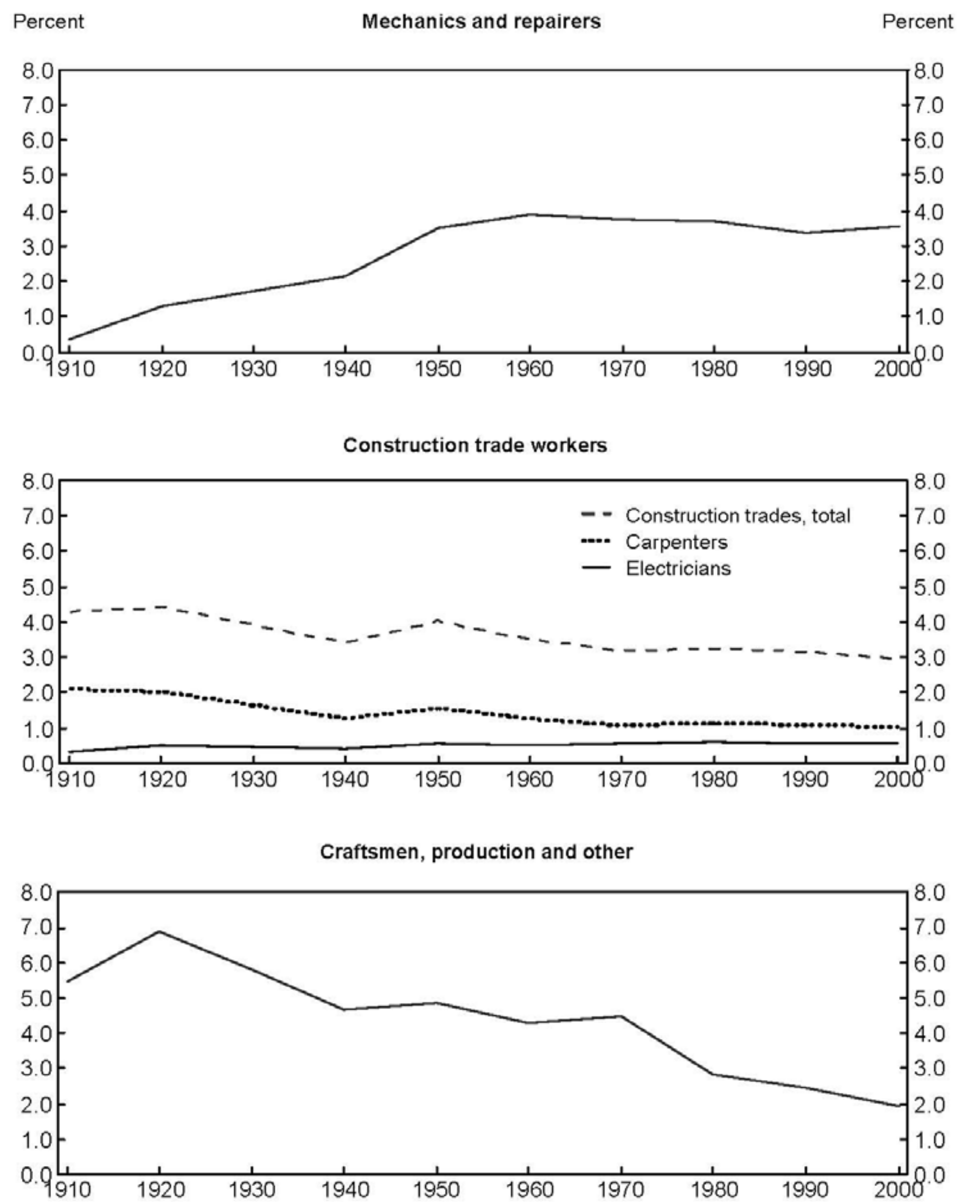
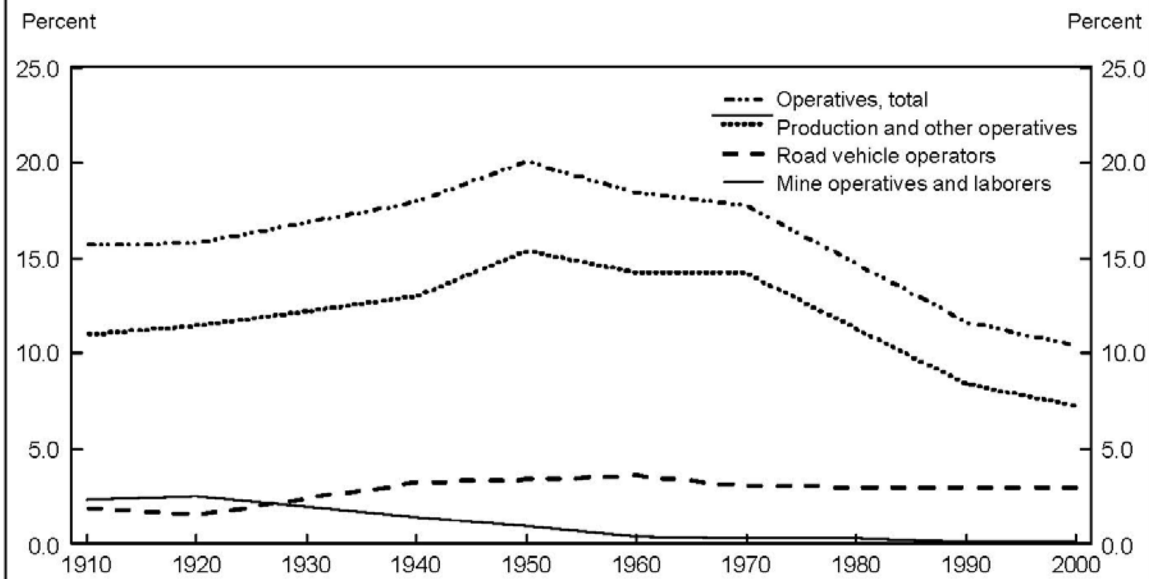


Chart 13. **Proportion of total employment of mechanics and repairers, construction trade workers, and production and other craftsmen, 1910–2000**



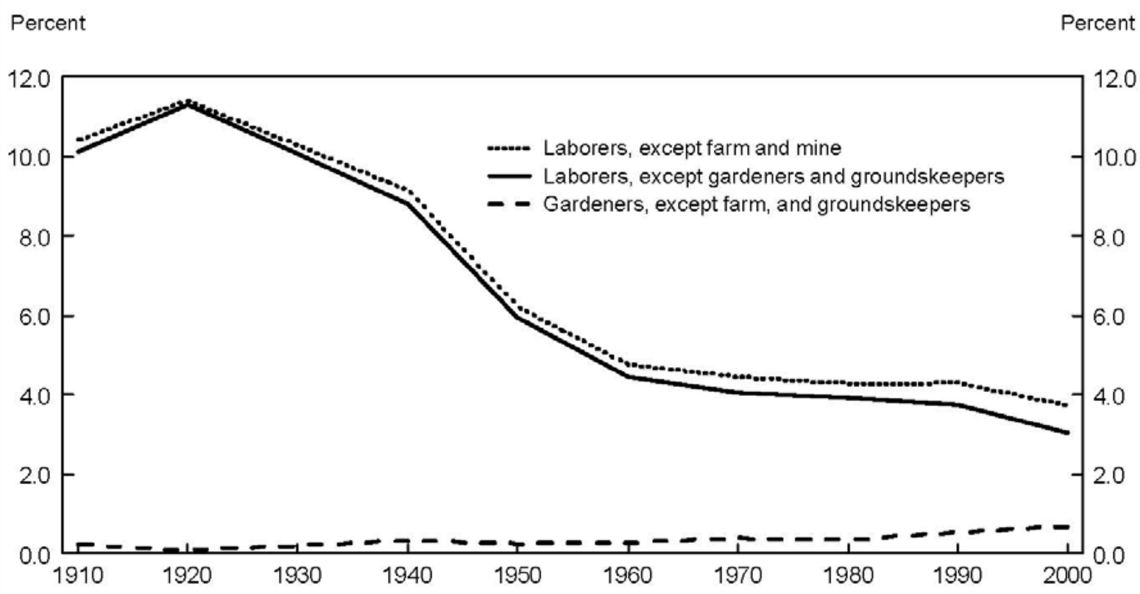
NOTE: Data for 1930 are an average of 1920 and 1940 data because 1930 data were unavailable when this article was written.

Chart 14. Proportion of total employment of operatives, 1910–2000



NOTE: Data for 1930 are an average of 1920 and 1940 data because 1930 data were unavailable when this article was written.

Chart 15. Proportion of total employment of laborers, except farm and mine, 1910–2000

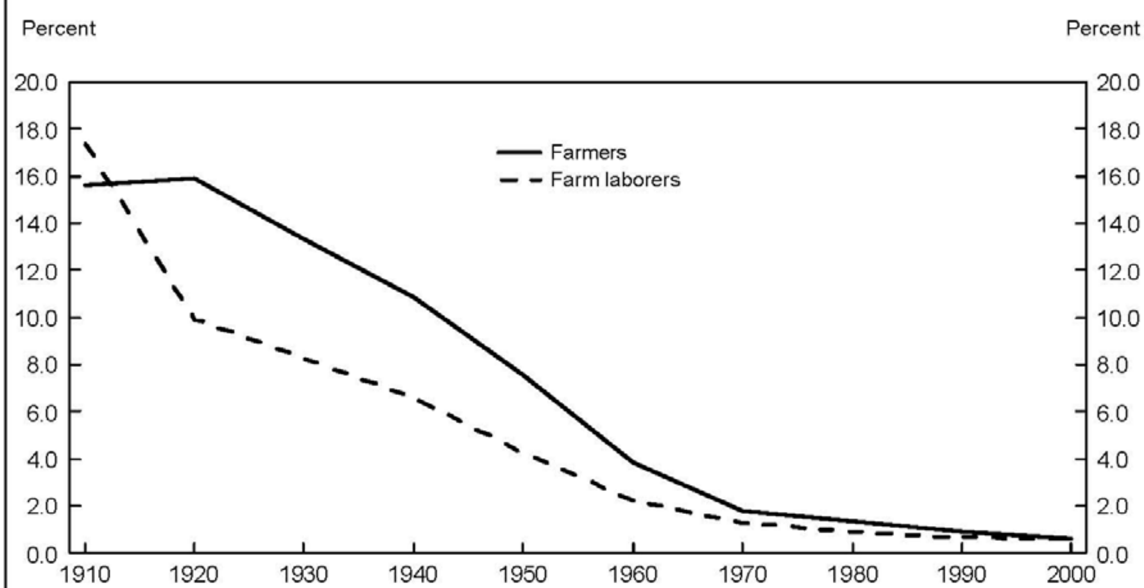


NOTE: Data for 1930 are an average of 1920 and 1940 data because 1930 data were unavailable when this article was written.

Chart 16. Proportion of total employment of private household service workers, 1910–1990

NOTE: Data for 1930 are an average of 1920 and 1940 data because 1930 data were unavailable when this article was written.

Chart 17. Proportion of total employment of farmers and of farm laborers, 1910–2000



NOTE: Data for 1930 are an average of 1920 and 1940 data because 1930 data were unavailable when this article was written.

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