Papers and Proceedings

The 16th

Federal Forecasters Conference 2008

Health Care Forecasting: Informing Future Choices
April 24, 2008
at the Bureau of Labor Statistics

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Announcement

The 17th
Federal Forecasters Conference
FFC/2009

Will be held

September 24, 2009

In

Washington, DC

More information will be available in the coming months

Federal Forecasters Conference – 2008

Papers and Proceedings

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Foreword

The 16th Federal Forecasters Conference (FFC/2008) was held April 24, 2008 in Washington, DC. This meeting continues a series of conferences that began in 1988 and have brought wide recognition to the importance of forecasting as a major statistical activity within the federal government and among its partner organizations. Over the years, these conferences have provided 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/2008, "Health Care Forecasting: Informing Future Choices," was addressed from a variety of perspectives by a distinguished panel. Elizabeth Arias, health scientist within the Mortality Statistics Branch at the National Center for Health Statistics, discussed implications of changing mortality patterns. Rima F. Khabbaz, Director of the National Center for Preparedness, Detection, and Control of Infectious Diseases within the Centers for Disease Control and Prevention, spoke about new approaches and ongoing challenges in controlling microbial threats. Finally, John Poisal, Deputy Director of the National Health Statistics Group at the Centers for Medicare and Medicaid Services, discussed health spending projections.

The papers and presentations in this FFC/2008 proceedings volume cover a range of topics. In addition to health care issues, these include: forecasting transportation trends; statistical methods; projections of education and training needs; forecasting impacts of government policy; evaluating policy forecasts; cycles, investment and prices; and international aspects of forecasting.

Acknowledgements

Many individuals contributed to the success of the 16th Federal Forecasters Conference (FFC/2008). First and foremost, without the support of the cosponsoring agencies and the dedication of the Federal Forecasters Consortium Governing Board, FFC/2008 would not have been possible.

Eric Figueroa of the Bureau of Labor Statistics (BLS) opened the morning program, introducing Keith Hall, Commissioner of BLS, who gave the welcoming remarks. Brian Sloboda of the United States Postal Service presented certificates to the winners of the FFC/2008 forecasting contest. Frederick L. Joutz of the George Washington University announced the FFC/2006 best conference paper awards. Jeff Busse of the U.S. Geological Survey made award presentations and took photos. Kathleen Sorensen of the U.S. Department of Veterans Affairs (VA) moderated the morning session's panel discussion, and Stephen MacDonald, Economic Research Service (ERS), U.S. Department of Agriculture, closed the morning session.

The afternoon sessions were organized by Kathryn Byun and Rose Woods, both of BLS; and Frederick L. Joutz and Jeff Busse. All the members of the Federal Forecasters Governing Board worked hard to provide support for the various aspects of the conference, making it the success it was.

Many thanks to the afternoon session chairs, who volunteered to organize and moderate the afternoon presentations. The session chairs are listed within these proceedings.

Special thanks go to Bryan Boulier, Tara Sinclair, Robert Trost, and Frederick L. Joutz of The George Washington University for reviewing the papers presented at the 15th Federal Forecasters Conference and selecting the winners of the Best Conference Paper awards for FFC/2006.

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 go to Wendy Davis and Kasmira Smarzo of BLS for assisting on the day of the conference.

Special thanks go to Marybeth Matthews and Cynthia Krauter of the VA for producing the conference program, and 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/2008 a successful conference.

2008 Federal Forecasters Conference

2008 Forecasting Contest Winners

Winners

Peter Rossi
U.S. Department of Defense
Office of the Actuary

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

First Runner-Up

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

Second Runners-Up

Ken Beckman
U.S. Department of the Interior
U.S. Geological Survey

John Golmant
Administrative Office of the U.S. Courts

2008 Federal Forecasters Conference

15th Federal Forecasters Conference

Best Paper Contest Winners

Winner

"Impacts of Aging on Health Care Spending"
By Sean Keehan, Aaron Catlin, and Micah Hartman
Centers for Medicare & Medicaid Services

Honorable Mention

"Aging and Bankruptcy"
By John Golmant and Tom Ulrich
Aministrative Office of the U.S. Courts

"Forecasting Mortality Using Bayesian Vector Autoregressive Methods"
By Javier Messeguer
Social Security Administration

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 on an annual basis.

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.

Contents

Panel Discussion

Panel Discussion

Health Care Forecasting: Informing Future Choices

Forecasting health care costs and health care demand will be critical in the coming decades. Both costs and demand for health care are rising, forcing public policy to address important trade-offs. New technologies and treatments, preparedness concerns, and shortages of clinicians are among the many forces expected to increase costs. At the same time, demographic changes and emerging diseases are among the factors expected to increase demand. All of these changes highlight the uncertainty forecasters face as they attempt to guide policy-makers through the crucial economic choices of the coming decades. The 2008 Federal Forecasters Conference will examine the role of federal forecasters in the evolution of public policy to address the need for sustainable, high-quality health care in a time of change.

Moderator
Kathleen Sorensen
National Cemetery Administration
U.S. Department of Veterans Affairs

Panel Discussants

Elizabeth Arias, Ph.D.
Health Scientist
Mortality Statistics Branch
Division of Vital Statistics
National Center for Health Statistics

Implications for the Future Health Status and Health Care of the US Population of Changes in Population Composition and Attendant Mortality Patterns

This presentation will explore the role of historical, current, and projected changes in population composition and attendant mortality patterns on the future health status and health care of the US population. It will present historical, current and projected changes in population composition, predominantly the aging of the population; changes in related survival trends, life expectancy trends, and changes in leading causes of death. The presentation will elaborate on the relationship between changing population composition and mortality regimes and address the possible consequences to the health status and health care of the US population that may result from the aging of the population and its concomitant mortality regime.

Rima F. Khabbaz, M.D.
Director, National Center for Preparedness,
Detection, and Control of Infectious Diseases
Centers for Disease Control and Prevention

Controlling Microbial Threats: New Approaches and Ongoing Challenges

Infectious diseases continue to cause tremendous morbidity and mortality worldwide. Unprecedented social, industrial, environmental, and ecological changes in today's globalized world have given highly adaptable microbes ready access to new geographic areas and populations and spurred a host of newly recognized zoonotic diseases. Political and economic factors also continue to affect the vulnerability of populations to infectious threats--both naturally occurring and intentionally caused. This presentation will describe recent challenges and opportunities in our efforts to prevent and control infectious diseases, including the increasing problem of antimicrobial resistance. It will also describe important lessons learned from our response efforts, including the critical role of preparedness planning, the importance of multidisciplinary partnerships, and the need to contain local outbreaks at their source.

John Poisal, MBA
Deputy Director,
National Health Statistics Group
Centers for Medicare and Medicaid Services

National Health Spending Projections Through 2017: Divergent Trends Ahead

Growth in National Health Expenditures (NHE) is expected to be 6.7 percent in 2007 and remain near that same rate over the full projection period (2007-2017). The health share of Gross Domestic Product (GDP) is expected to increase slightly to 16.3 percent in 2007 and then climb to 19.5 percent of GDP by 2017. The leading edge of the "Baby Boom" generation will begin enrolling in the Medicare program in 2011. As a result, a divergence in trends is expected as this shift in coverage is anticipated to contribute to an acceleration in public spending growth and a deceleration in private spending growth. Finally, dissimilar growth rate trends are expected at the sector level, as well. Beginning in 2008 and running through 2017, hospital spending growth is anticipated to slow while prescription drug expenditure growth is expected to accelerate.

Concurrent Sessions I

Health Care Issues

Session Chair: Dan Culver, U.S. Department of Veterans Affairs

Rescinding Community Mitigation Strategies in an Influenza Pandemic: An Agent-Based Modeling Approach (http://www.cdc.gov/EID/content/14/3/365.htm)

Victoria J. Davey, U.S. Department of Veteran Affairs and Robert J. Glass, National Infrastructure Simulation and Analysis Center

Using a networked, agent-based computational model of a stylized community, we evaluated thresholds for rescinding 2 community mitigation strategies after an influenza pandemic. We ended child sequestering or all-community sequestering when illness incidence waned to thresholds of 0, 1, 2, or 3 cases in 7 days in 2 levels of pandemic severity. An unmitigated epidemic or strategy continuation for the epidemic duration served as control scenarios. The 0-case per 7-day rescinding threshold was comparable to the continuation strategy on infection and illness rates but reduced the number of days strategies would be needed by 6% to 32% in mild or severe pandemics. If cases recurred, strategies were resumed at a predefined 10-case trigger, and epidemic recurrence was thwarted. Strategies were most effective when used with high compliance and when combined with stringent rescinding thresholds. The need for strategies implemented for control of an influenza pandemic was reduced, without increasing illness rates.

Labor Market Effects of Employer Provided Health Insurance

Rose A. Woods, Bureau of Labor Statistics, U.S. Department of Labor

The relatively high cost of employer provided health insurance has many effects in the labor market. Wages, employment, and hours worked are all thought to respond to increases in the cost of providing health insurance. This paper examines the relationship between employer provided health insurance, wages, hours and employment at an industry level. These results are then incorporated into the existing models used by the Office of Employment Projections at the Bureau of Labor Statistics to project future industry employment. The results suggest that projections for employment for most industries are not largely affected by the expected rise in employer health care costs.

Department of Veterans Affairs Nursing Recruitment and Retention Efforts
Estimating the Impact of Clinical Training and Other Factors

Dilpreet Singh, MS, MPA, Marla Weston, Ph D, RN, Linda Johnson, Ph D, RN, Malcolm Cox, MD, Karen Sanders, MD, and Robert Zeiss, Ph D, U.S. Department of Veteran Affairs

The Department of Veterans Affairs (VA) employs over 50,000 registered and licensed practical nurses. However, there is a shortage of nurses partially contributed by aging of nursing workforce who are eligible to retire. A high percent of all VA nurses receive a part or all of their training at VA. Nursing students can be a great source of future recruits at VA. A VA Nurse Recruitment and Retention Survey was conducted to assist in estimating number of nursing students who may seek employment with VA. This paper presents results of the Survey including factors that impact seeking employment with VA.

Labor Market Effects of Employer Provided Health Insurance

Rose A. Woods, Bureau of Labor Statistics
Bureau of Labor Statistics, 2 Massachusetts Ave. NE, Room 2135, Washington, DC 20212

Introduction

In recent testimony before the Committee on the Budget of the United States Senate, Peter Orszag, Director of the Congressional Budget Office, stated that no other single factor will exert as much influence over the federal government's long-term fiscal balance as the future growth rate of costs in the health care sector. He went on to say that the effects of rising health care costs are not limited to public programs and that the rising cost of health benefits can limit the growth of cash earnings for workers with employer-based coverage.[1]

Employer health care costs are rising and are widely believed to have many effects on labor market outcomes. Research[2] has shown increasing health premiums have affected the probability of employment negatively, increased the likelihood of part-time employment, reduced hours worked, and reduced wages. This study extends the current industry models used at the Bureau of Labor Statistics (BLS) to project employment 10 years in the future, by adding to the models the rising health insurance costs faced by employers. The results suggest that the employment levels are not affected significantly for the industries analyzed, although this may be due in part to offsetting effects. Specifically, wages are affected negatively as are the average weekly hours. However, all else the same, these declines can be such that there is a positive effect on total number of jobs, albeit at relatively lower wages and fewer hours per week.

Background

Within the Bureau of Labor Statistics (BLS), the Office of Occupational Statistics and Employment Projections (OOSEP) is charged with developing 10-year projections of employment by industry and occupation. These projections are developed to facilitate understanding of current and future labor market conditions and are disseminated for use in career guidance and public policy planning that is related to employment issues. A system of several component models is used by OOSEP to develop these projections.

[1] CBO Testimony, Growth in Health Care Costs, January 31, 2008.

[2] Baicker and Chandra

This study presents the industry level labor model that is currently used, and extends it to take into account the rising health care costs faced by employers. The next section discusses the current labor model and the modifications for this study. This is followed by a discussion of the regression results. Using the results from both the modified models and the models currently utilized, projections of employment through 2016 are performed and compared.

Data and Methodology

Four equations are used to model and estimate employment, average hourly wages and average weekly hours by industry. Total annual hours for each industry are currently modeled as follows:

$$\ln L = a_0 + a_1 t + a_2 \ln Y + a_3 \ln\left(\frac{w}{p}\right)$$

Average hourly wages are:

$$AHW = a_0 + a_1 EC_t + a_2 UR_t$$

The average weekly hours for each industry:

$$AWH = a_0 + a_1 t + a_3 ur$$

The price index for each industry is estimated with the following equation:

$$\ln(p) = a_0 + a_1 \ln(P)$$

Where:

L	labor, measured as annual wage and salary hours
t	time measured as the year
Y	Real output
ur	aggregate unemployment rate
a_n	constants/coefficients
w	nominal wages
p	Industry output price
P	GDP chain weighted price index

For the purposes of this study, these four equations were amended to take into account the effects of employer provided health care costs by adding an additional variable, HI, to each equation. In either case, the total employment in each industry is determined by an identity:

$$E_i = \left(L_i \middle/ AWH_i \right) \frac{1}{52}$$

Data

The data used in these equations come from a variety of sources, and were aggregated such that there were nine 2-digit NAICS sectors on an annual basis from 1990 to 2007. The most detailed industry level at which the employer health care cost data were available was 2 digits. Consequently, all the industry data were aggregated to that level, rather than working at the more detailed level that the OOSEP publishes its results. The historical data used to estimate the equations come from the following sources.

- **Industry Output** – The data for industry output come from various surveys, censuses, BEA NIPA and benchmark IO data. They are developed in the context of the Input-Output model used by OOSEP.
- **Employment Compensation** – The data for employment compensation are taken from the Macroeconomic Advisors (MA) Employment Compensation series. This series is developed using the BLS Employment Compensation Index and the Employer Costs for Employment Compensation.
- **Price Data** – BLS Producer Price Index using the industry classification and the BEA GDP price index
- **Wage Data** – The detailed industry wages data are taken from the BLS Quarterly Census of Employment and Wages.
- **Employment, hours, and unemployment data** – The BLS Current Population Statistics (CPS) and Current Employment Statistics (CES) programs publish employment levels from both establishment and household surveys.
- **Employer Health Cost** – Data from the Kaiser Family Foundation, Employer Health Benefits, Annual Survey 1999-2007 were used for the employer health costs. This is an establishment survey. Because the most detailed industry level data in the survey is 2-digit NAICS, the data were aggregated to 2-digit NAICS summary levels. The data were transformed to measure average hourly health insurance cost per worker, paid by the employer. This cost measures the cost per worker employed, not per worker employed with health insurance. To the extent that some establishments don't offer many of their employees health insurance, or that their employees are not likely to choose the health insurance benefit offered, health premiums may not have as much of an effect on overall employment at that establishment, as they would an establishment with a high take-up rate.

In addition to estimating the four equations for each industry, the models are used to project future employment, hours, and wages. The exogenous data used to forecast the data come from the following sources.

- **Industry Output** – The output data used for the projections come from the Input Output model used in the OOSEP; the model predicts output based on projections of Gross Domestic Product, and detailed industry structure of the economy.
- **Employment Compensation –** The MA econometric model which is used to project GDP also projects employment compensation as one of its variables.
- The chain-weighted **GDP price** index and the **unemployment rate** are also provided by the Macro Model
- **Employer Health Insurance Costs** are projected into the future using National Health Expenditure projections[3] for spending on private insurance. Specifically, the history and projections data from the CMS health expenditures for the private insurance component were used to predict the industry specific health insurance costs per worker – average hourly health insurance cost per employee.

These four equations and their counterparts which include the health insurance cost component are estimated using ordinary least squares regression for each of the nine industries separately. The nine industries are mining, construction, manufacturing, transportation, wholesale trade, retail trade, financial, healthcare, and other service industries.

Results

The results from the regression analysis are shown in Tables 1 through 3.

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[3] Centers for Medicare & Medicare Services, Office of the Actuary. National Health Expenditure (NHE) Amounts by Type of Expenditure and Source of Funds: Calendar Years 1965-2017 in PROJECTIONS format

The effect rising health insurance costs to employers (Table 1) on total hours demanded was negative for all industries, however it was significant in only 3 of the 9 industries studied. Transportation, retail trade, and healthcare industries varied from a 1.3 percent to a 4.8 percent decrease in total hours demanded given a 10 percent increase in health insurance costs for employees. The coefficient on wages was negative and significant for all industries except retail trade; output was positive and significant for all the industries. The coefficient for year, which is meant to capture increases in productivity through technological change, was negative for all industries except construction and the financial sector.

The results for the wage equations are shown in Table 2. The employee compensation coefficient was positive and highly significant for all industries. The values ranged from .37 in retail trade to 1.36 in the financial sector, indicating that for a 1 dollar increase in the general level of compensation, wages, on average, are expected to increase anywhere from 37 cents to $1.36, depending on the industry. The unemployment coefficient was negative in all industries, although it was significant in only 7 of the 9 industries analyzed. The coefficient on employer health cost was negative for 7 of the 9 industries analyzed, but only significant in three industries: transportation and utilities, retail trade, and the healthcare industry. The magnitude of the coefficients was larger than expected: -7.33 in transportation, -4.26 in retail trade, and -1.93 in healthcare. This would imply a much larger decrease in wages for a $1 increase in average hourly health insurance paid by the employer. One possible explanation is that the health insurance cost variable measures the actual dollars paid by the employers, not the dollars that could have been paid, had the take-up rate been higher. In addition, the average hourly wages are much higher than the average hourly health insurance costs – in excess of tenfold for all industries. The equations were not estimated in a log-log form because they are not done so in the basic OOSEP labor model, but had they been, the coefficient would most likely be much less than one.

Average weekly hours were affected negatively by rising health care costs for all industries except mining, financial, and healthcare (see table 3). However, it was only significant in two industries: wholesale trade and retail trade. It's not clear what the expected sign of this coefficient should be. One theory suggests that rising health care costs should create incentives for employers to increase hours by having the existing employees work more hours, and avoid hiring additional workers, who would come with additional fixed costs. Another theory is that the firms would hire more temporary and part-time workers, who typically don't receive health benefits, resulting in a reduction in the average hours worked. To the extent that retail and wholesale trade are more likely to fall into the latter category, the results seem plausible.

Performance statistics for these equations are shown in tables 3 through 6. The R-squared statistic is relatively high for the nearly all the industry equations estimated, for both the total hours equations and the average hourly wage equation. Most were in excess of 0.90, and the addition of the health insurance cost variable bumped up this goodness-of-fit statistic by at least 0.01 for most industries. The exception was transportation and utilities and wholesale trade for the total hours equation. Wholesale trade had an R-squared of 0.86 and 0.85 for the equations with and without the health cost variable; transportation and utilities was slightly lower with estimates of 0.82 and 0.75, with and without the health insurance variable. The average weekly hours equations had somewhat smaller R-squared statistics (see Table 6); however the addition of the health insurance cost variable increased the fit statistic substantially in the cases of mining and retail trade.

The F-statistic shown in these tables indicates whether the addition of the health insurance cost variable can be statistically justified. For the total hours equations, the F-statistic for transportation and utilities, retail trade, and the healthcare industry indicate that health insurance variable should be included in the model. The same is true of these industries in the wage equations. The average weekly hours equations show that the health variable should only be included in the wholesale and retail trade industries. An in-sample estimate of the Theil U-statistic was computed for the three equations across all the industries. Because it is an in-sample estimate, the results are consistent with the other fit statistics discussed. A better measure of the models ability to predict future employment, wages, and average weekly hours would have been to do an out-of-sample Theil U-statistic. To the extent that OOSEP is interested in how these models may help project industry employment, future research will include this type of analysis.

The estimates from these equations were however used to project what employment would be in the year 2016. All parameter estimates are used in the projections of total hours, wages, and average weekly hours; this is true of the current methods employed in the OOSEP industry projections. Charts 1 through 9 show the industry employment results (in terms of jobs) of the projections for both the current model and the extended model. The current published OOSEP results are also shown in these charts for comparison. The results from the models without the health insurance cost variable are not the same as the published results, as one might expect. This occurs for several reasons. In the actual process, detailed industries are estimated, and the results are aggregated to get 2-digit sector level results. Secondly, the process requires that the employment adds up to certain controls supplied by the macro model. And finally, distributional adjustments may be made such that add factors are employed at the detailed industry levels.

In the case of mining, the addition of the health insurance costs estimates a higher level of employment than the current model. Construction jobs are predicted to be virtually the same regardless of the inclusion of the health insurance cost variable. Jobs in transportation and utilities are substantially higher, and show a sharper increase when employer health care costs are factored in. Manufacturing jobs too are predicted to result in more jobs, when the effects from health insurances costs are a part of the equations. Transportation and utilities are projected to grow faster over the period with the extended model. The published BLS employment figures for wholesale and retail trade result in higher levels of employment in 2016 than either of the two models presented here. In the case of wholesale trade, employment is projected to grow only slightly under either model (basic or extended). Jobs in retail trade are predicted to grow faster when the health cost variable is included, although it does not reach the level of the jobs for retail trade that are projected in the published data. Financial services results in virtually the same outcome, whether health costs are included as variable or not. The growth rate, and resulting jobs, however, are estimated to be somewhat higher than the published projections for this sector. Other services and the healthcare sector both result in more jobs in 2016 when projected health costs are included.

One possible explanation for this overall positive effect on jobs is the negative effect rising health premiums have on wages and average weekly hours. The estimates of the effect increased employer health insurances costs have on wages seem relatively large. These may be sufficient to provide enough of an offset to the direct effect of any increase in health insurance on total hours demanded. The coefficients in the total hours equations are negative for both health insurance cost and wages, although the magnitude is much larger for wages than it is for health costs. To the extent that wages are driven down (perhaps excessively so), total hours may be expected to increase. In addition, the negative effect on average weekly hours is also contributing to an increase in total jobs. The decline of average weekly hours may be due in part to rising health care costs, in addition to a general trend, further increasing the number of part-time jobs relative to full-time jobs.

Concluding remarks

While not conclusive, the results from this paper show labor market effects from rising health care costs faced by employers. Given these data, some sectors appear to be more affected than others. In particular, the transportation and utilities, retail trade, and healthcare industries have shown a significant negative effect in terms of both total hours demanded and wages paid. The wage response appears to be very strong, and may overcome any increases in rising health care costs, to the point where *more* labor is demanded. The increased proportion of part-time jobs, some of which may be due to rising health costs faced by employers, further strengthens this tendency. In both the retail and wholesale trade industries, employer health care costs had significant negative effects on the average weekly hours.

Further research, ideally at the establishment level, could provide a better understanding of these outcomes. In particular, the likelihood of offering insurance, the effects on wages for different occupations within industries, and the tendency to hire more temporary or part-time workers, should be of interest to planners, forecasters, and policy makers, in characterizing and shaping future labors.

$$\ln L = a_0 + a_1 t + a_2 \ln Y + a_3 \ln\left(\frac{w}{p}\right) \qquad \ln L = a_0 + a_1 t + a_2 \ln Y + a_3 \ln\left(\frac{w}{p}\right) + a_4 \ln\left(\frac{HI}{p}\right)$$

Table 1. Regression Results for Total Hours Demanded Equations

Industry		Intercept	Year	Ln Output	Ln wage/price	Ln HI/price
Mining	**old**	28.674 **	-0.019 **	1.407	-0.200 **	
	new	26.699 *	-0.018 **	1.374 **	**-0.174**	**-0.038**
Construction	**old -**	**6.483**	**0**	1.201 **	**-0.303**	
	new -	**8.810**	**0.002**	1.178 **	**-0.272 -**	**0.044**
Manufacturing	**old**	63.588 **	-0.035 **	1.043 **	0.031 **	
	new	42.403 **	-0.023 **	0.877 **	**0.194**	**-0.194**
Transportation	**old 18.**	**187**	**-0.013**	1.282 **	**-0.263**	
	new -	**46.009**	**0.0187**	1.302 **	**-0.0514**	-0.485 *
Wholesale	**old**	33.606 **	-0.017 **	0.919 **	-0.588 **	
	new 27.	**744**	**-0.014**	0.835 **	**-0.489**	**-0.043**
Retail	**old 27.**	**743**	**-0.011**	**0.251**	0.587 **	
	new -	**12.499**	**0.010**	**0.087**	0.561 **	-0.131 **
Financial	**old -**	**1.086**	**0.002**	0.516 **	**-0.159**	
	new -	**1.732**	**0.002**	0.511 **	**-0.154**	**-0.006**
Service other	**old**	17.885 **	-0.011 **	1.237 **	-0.871 **	
	new 6.	**001**	**-0.005**	1.117 **	-0.669 **	**-0.098**
Healthcare	**old**	-48.485 **	0.030 **	**-0.023**	-0.537 **	
	new	-52.962 **	0.030 **	0.350 *	-0.387 **	-0.163 **

** indicates statistical significance at 5% level * indicates statistical significance at 10% level.

$$AHW = a_0 + a_1 EC + a_2 UR \qquad AHW = a_0 + a_1 EC + a_2 UR + a_3 HI$$

Table 2. Regression Results for Industry Wage Equation

Industry		Intercept	Employee Compensation Unem	ployment Rate	Employer Health Insurance
Mining	**old**	2.346 **	1.000 **	-0.440 **	
	new 2.	**158**	1.015 **	-0.438 **	**-0.207**
Construction	**old**	4.350 **	0.575 **	-0.196 *	
	new	4.455 **	0.559 **	-0.199 *	**0.457**
Manufacturing	**old**	6.042 **	0.626 **	-0.423 **	
	new	4.880 *	0.714 **	-0.395 **	**-1.416**
Transportation & Utilities	**old**	4.347 **	0.685 **	**-0.137**	
	new -	**2.868**	1.221 **	**-0.105**	-7.328 **
Wholesale	**old**	1.441	0.921 **	-0.306 **	
	new 2.	**140**	0.874 **	-0.336 **	**0.839**
Retail	**old**	6.289 **	0.371 **	**-0.363** **	
	new 2.	**889**	0.554 **	**-0.262** **	-4.261 *
Financial	**old 0.**	**187**	1.250 **	-0.715 **	
	new -	**1.119**	1.360 **	-0.692 **	**-1.763**
Service other	**old**	2.319 *	0.840 **	-0.389 **	
	new -	**1.873**	1.149 **	**-0.276**	**-5.658**
Healthcare	**old**	4.830 **	0.449 **	**-0.087**	
	new 2.	**493**	0.592 **	**-0.385**	-1.933 *

** indicates statistical significance at 5% level * indicates statistical significance at 10% level.

$$AWH_i = a_0 + a_1 t + a_3 ur \quad AWH_i = a_0 + a_1 t + a_3 ur + a_4 HI$$

Table 3. Regression Results for Average Weekly Hours equation

Industry		Intercept Year		Unemployment Rate	Employer Health Insurance
Mining	**old 102.**	**170**	**-0.029**	**-0.209**	
	new 258.	**511**	**-0.107**	**-0.264**	**1.159**
Construction	**old**	56.481 **	**-0.008**	-0.236 **	
	new -	**50.422**	**0.046**	-0.197 **	**-1.619**
Manufacturing	**old**	128.542 **	-0.043 **	-0.189 *	
	new -	**149.509**	**0.096**	**-0.072**	**-2.296**
Transportation & Utilities	**old**	213.880 **	-0.087 *	**-0.358**	
	new -	**117.379**	**0.079**	**-0.265**	**-2.352**
Wholesale	**old**	185.790 **	-0.073 **	-0.235 **	
	new -	**37.390**	0.0389	-0.103	-2.025 **
Retail	**old**	31.243 *	-0.000	**-0.006**	
	new	-138.58 **	0.086 **	0.085 *	-2.043 **
Financial	**old**	125.236 **	-0.044 **	-0.180 **	
	new 184.	**894**	-0.074	-0.202 **	**0.498**
Service other	**old**	86.961 **	-0.027 **	-0.132 **	
	new 14.	**686**	0.010	-0.100 **	**-0.681**
Healthcare	**old**	-122.860 **	0.077 **	0.071 **	
	new	-86.302 **	0.059 **	**0.056**	**0.256**

** indicates statistical significance at 5% level * indicates statistical significance at 10% level.

Table 4. Performance Statistics – Total Hours Equations

Industry		**R squared**	**F stat**	**MAE**	**Theil U**
Mining	**old 0.**	**87**	**0.03**	**34.16**	**0.62**
	new 0.	**87**		**34.07**	**0.61**
Construction	**old 0.**	**99**	**0.07**	**221.55**	**0.49**
	new 0.	**99**		**222.45**	**0.48**
Manufacturing	**old 0.**	**96**	**1.55**	**393.32**	**0.53**
	new 0.	**97**		**374.96**	**0.51**
Transportation & Utilities	**old 0.**	**75**		**217.88**	**1.19**
	new 0.	**82**	4.60 *	**162.06**	**1.03**
Wholesale	**old 0.**	**85**		**159.13**	**0.81**
	new 0.	**86**	**0.10**	**161.49**	**0.81**
Retail	**old 0.**	**91**		**362.73**	**1.06**
	new 0.	**94**	5.26 **	**325.32**	**0.87**
Financial	**old 0.**	**98**		**112.60**	**0.51**
	new 0.	**98**	**0.01**	**111.80**	**0.51**
Service other	**old 0.**	**99**		**527.49**	**0.38**
	new 0.	**99**	**1.24**	**535.62**	**0.36**
Healthcare	**old 0.**	**99**		**135.28**	**0.22**
	new 0.	**99**	7.38 **	**99.43**	**0.18**

** indicates statistical significance at 5% level * indicates statistical significance at 10% level.

Table 5. Performance Statistics – Wage Equations

Industry		R squared	F stat	MAE	Theil U
Mining	**old 0.**	**99**		**0.43**	**0.46**
	new 0.	**99**	**0.03**	**0.24**	**0.26**
Construction	**old 0.**	**99**		**0.11**	**0.40**
	new 0.	**99**	**0.03**	**0.23**	**0.43**
Manufacturing	**old 0.**	**99**		**0.23**	**0.42**
	new 0.	**99**	**0.25**	**0.28**	**0.44**
Transportation & Utilities	**old 0.**	**96**		**0.58**	**0.59**
	new 0.	**97**	4.79 **	**0.46**	**0.59**
Wholesale	**old 0.**	**98**		**0.13**	**0.54**
	new 0.	**99**	**0.23**	**0.22**	**0.23**
Retail	**old 0.**	**98**		**0.10**	**0.51**
	new 0.	**98**	3.23 **	**0.18**	**0.45**
Financial	**old 0.**	**99**		**0.19**	**0.43**
	new 0.	**99**	**0.20**	**0.58**	**0.45**
Service other	**old 0.**	**99**		**0.07**	**0.40**
	new 0.	**99**	**1.48**	**0.28**	**0.33**
Healthcare	**old 0.**	**99**		**0.08**	**0.16**
	new 0.	**99**	**3.22**	**0.18**	**0.48**

** indicates statistical significance at 5% level * indicates statistical significance at 10% level.

Table 6. Performance Statistics – Average Weekly Hours Equations

Industry		R squared	F stat	MAE	Theil U
Mining	**old 0.**	**10**		**0.43**	**1.07**
	new 0.	**62**	**0.64**	**0.42**	**1.05**
Construction	**old 0.**	**62**		**0.13**	**0.77**
	new 0.	**67**	**2.12**	**0.12**	**0.07**
Manufacturing	**old 0.**	**24**		**0.26**	**1.15**
	new 0.	**36**	**2.25**	**0.24**	**1.04**
Transportation & Utilities	**old 0.**	**23**		**0.60**	**1.40**
	new 0.	**28**	**0.99**	**0.60**	**1.30**
Wholesale	**old 0.**	**70**		**0.14**	**1.01**
	new 0.	**81**	7.17 **	**0.13**	**0.82**
Retail	**old 0.**	**002**		**0.11**	**0.94**
	new 0.	**45**	10.76 **	**0.09**	**0.72**
Financial	**old 0.**	**41**		**0.20**	**0.77**
	new 0.	**42**	**0.28**	**0.20**	**0.78**
Service other	**old 0.**	**71**		**0.06**	**0.72**
	new 0.	**75**	**2.21**	**0.06**	**0.66**
Healthcare	**old 0.**	**94**		**0.08**	**0.56**
	new 0.	**94**	**0.81**	**0.08**	**0.55**

** indicates statistical significance at 5% level * indicates statistical significance at 10% level.

Chart 1. Mining Jobs Projections through 2016

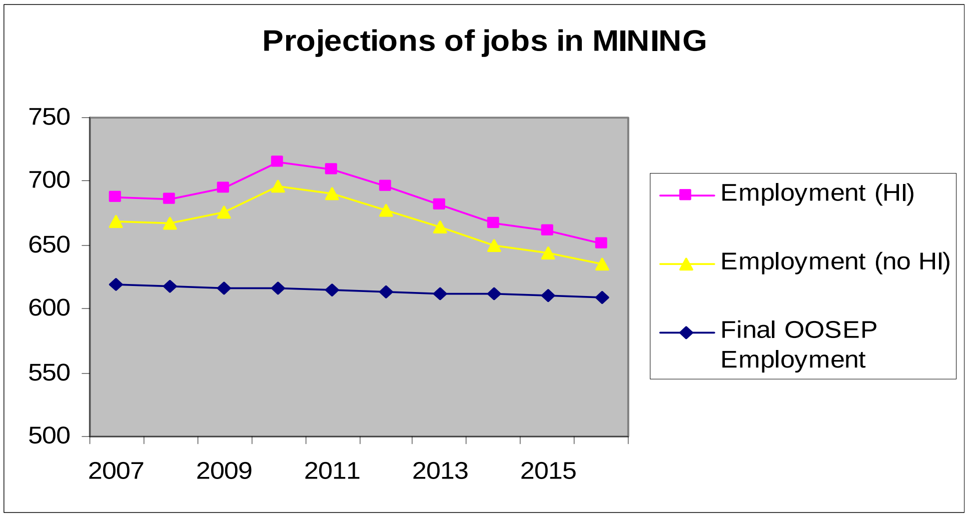


Chart 2 Construction Jobs Projections through 2016

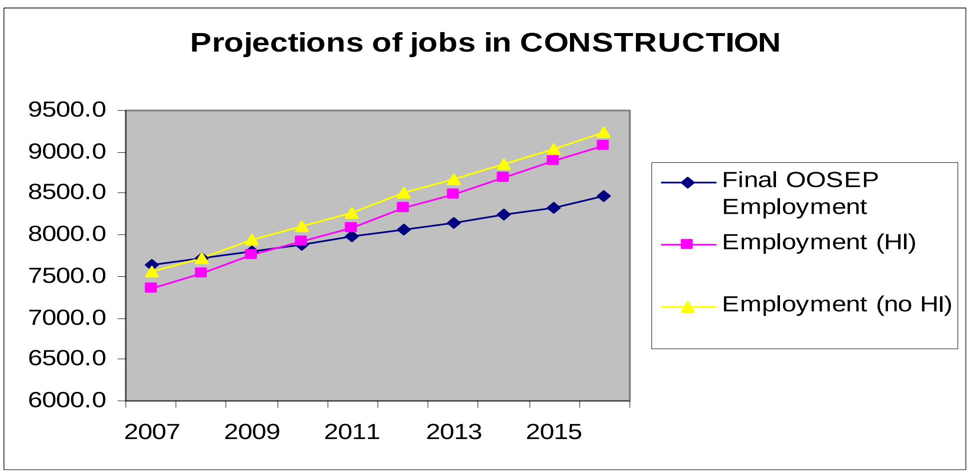


Chart 3 Manufacturing Jobs through 2016

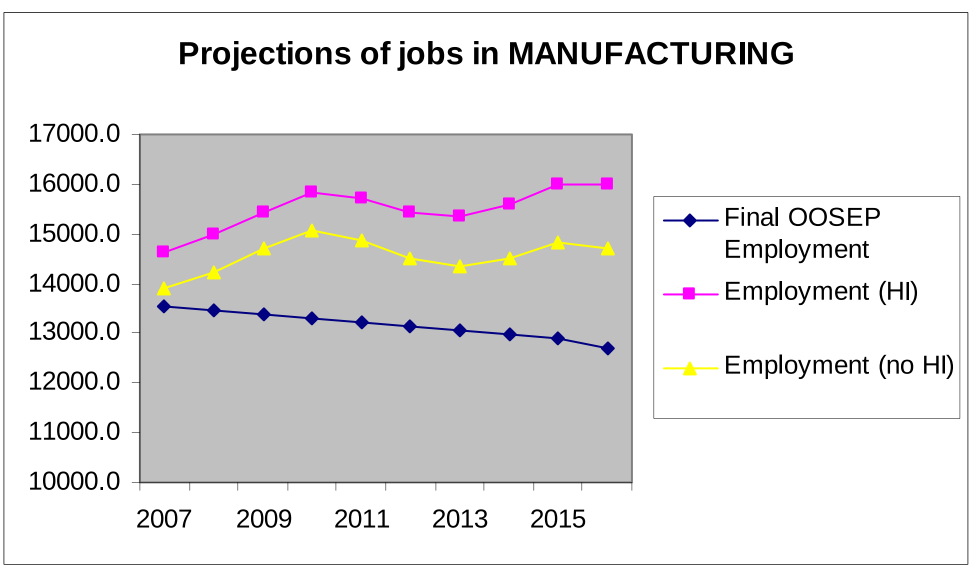


Chart 4. Transportation Jobs through 2016

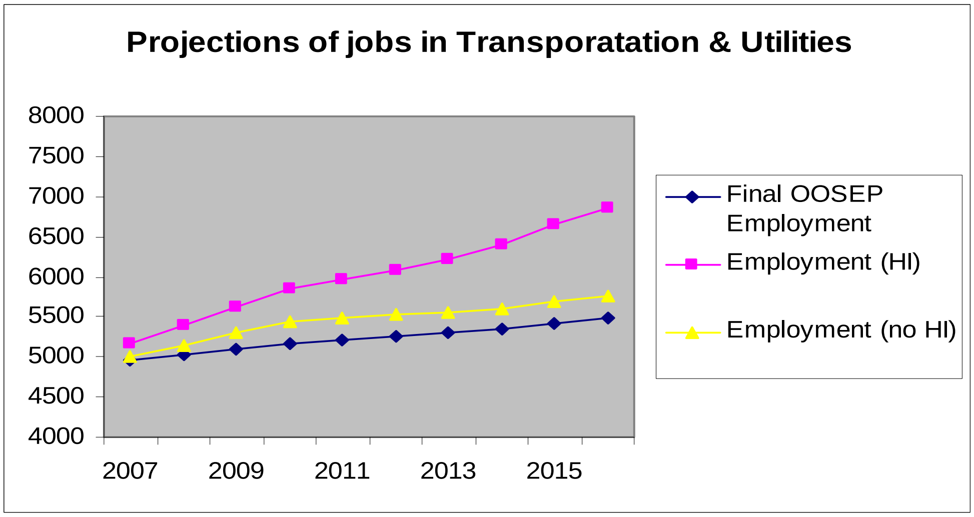


Chart 5. Wholesale Trade Jobs through 2016

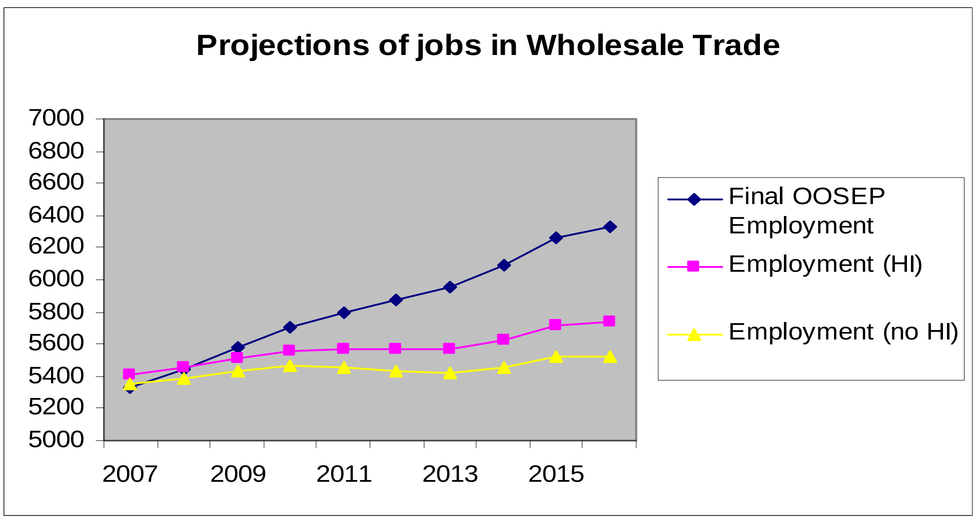


Chart 6. Retail Trade Jobs through 2016

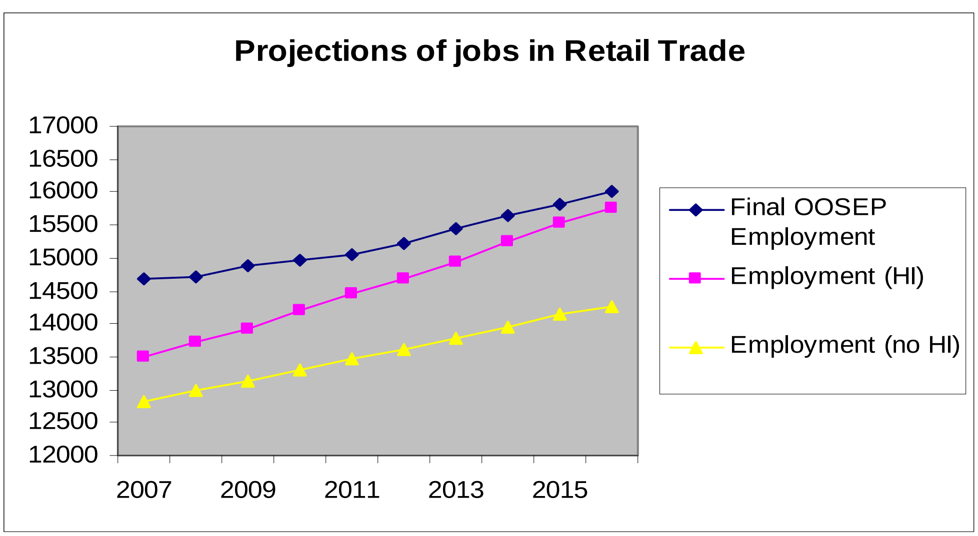


Chart 7. Financial Services Jobs through 2016

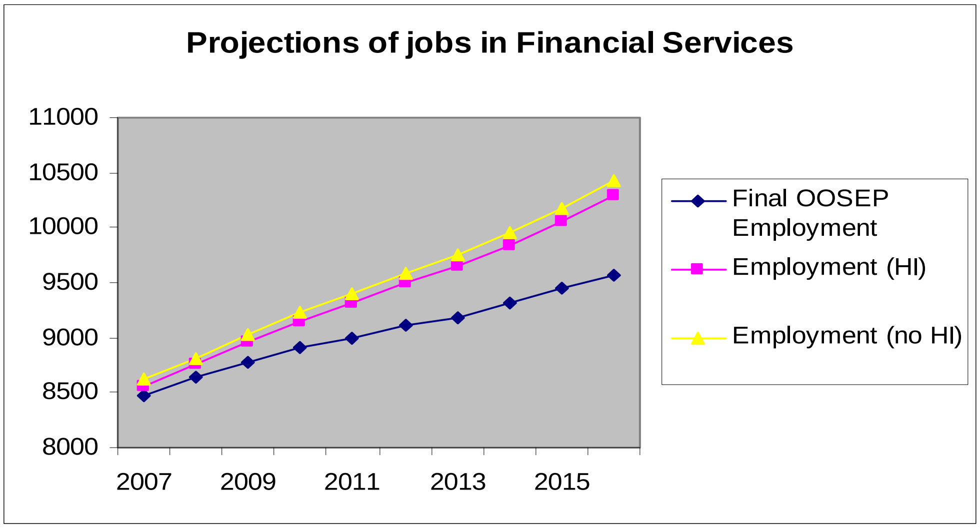


Chart 8. Other Services Jobs through 2016

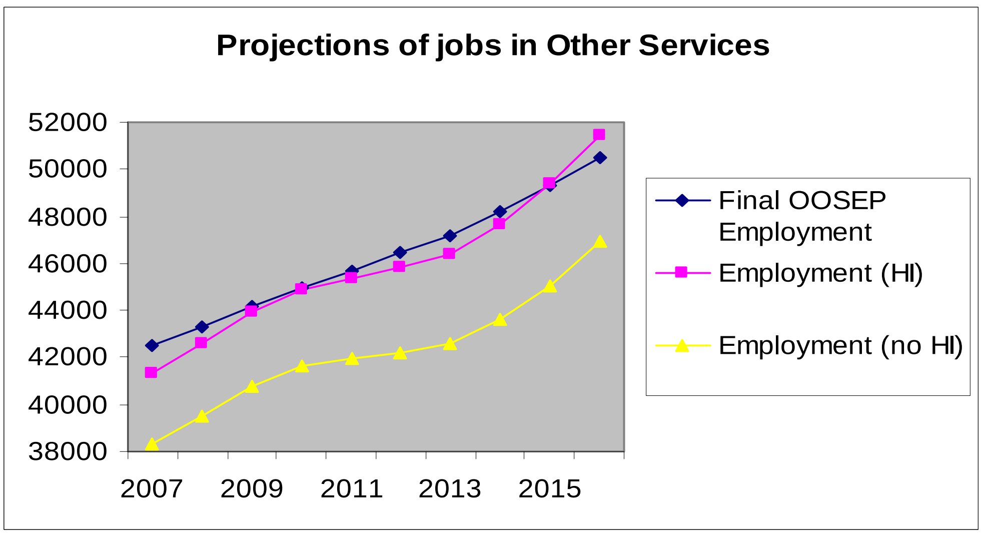
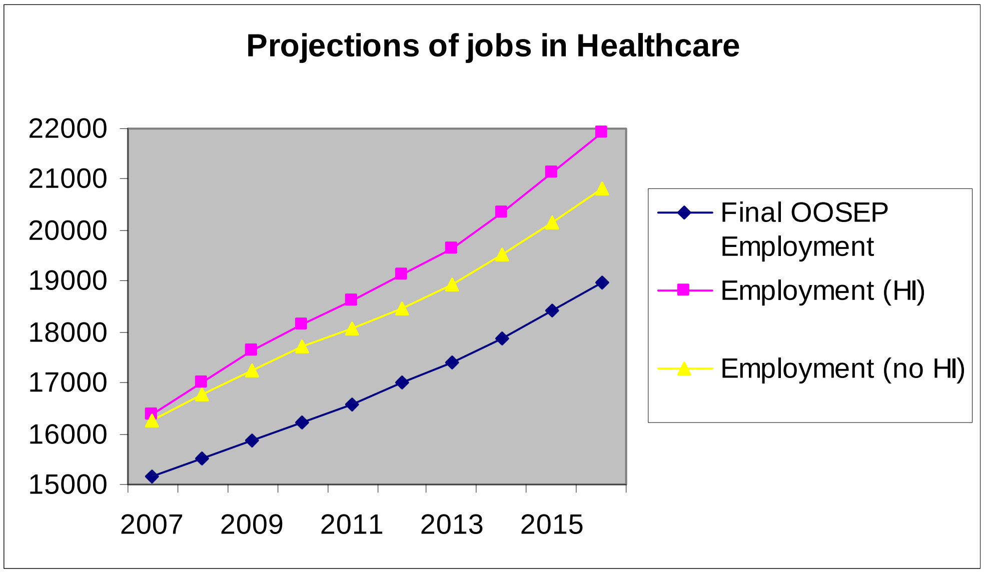


Chart 9. Heatlthcare Jobs through 2016


Projections of jobs in Healthcare
22000
21000
20000
19000
18000
17000
16000
15000
2007
2009
2011
2013
2015
Final OOSEP Employment
Employment (HI)
Employment (no HI)

Department of Veterans Affairs
Nursing Recruitment and Retention Efforts
Estimating the Impact of Clinical Training and Other Factors

Dilpreet Singh, MS, MPA, Marla Weston, PhD, RN, Linda Johnson, PhD, RN, Malcolm Cox, MD, Karen Sanders, MD, and Robert Zeiss, PhD.

1. INTRODUCTION

Registered nurses (RNs) are the largest group of health care professionals in the United States. However, a critical shortage of RNs exists in the U.S. and this shortage is expected to worsen due to an aging workforce and lack of capacity in nursing schools to meet current demands. According to the American Association of Colleges of Nursing's (AACN) report on 2007-2008 Enrollment and Graduations in Baccalaureate and Graduate Programs in Nursing, "U.S. nursing schools turned away 40,285 qualified applicants from baccalaureate and graduate nursing programs in 2007 due to insufficient number of faculty, clinical sites, classroom space, clinical preceptors, and budget constraints."

The Department of Veterans Affairs (VA) faces similar nursing shortages partially due to an aging workforce, resulting in retirements. According to the 2008-2012 Veterans Health Administration (VHA) Workforce Succession Plan, by FY 2013 20% of the approximately 50,000 VA nurses will be eligible for voluntary retirement. [1]

The Office of Academic Affiliations (OAA) in VHA conducts an education and training program for health care professionals through affiliations with educational institutions. In FY 2007, of the 49,000 associated health trainees who received training at VA, over half (28,000) were nursing students. These students form a substantial potential recruitment pool at the associate, baccalaureate, master's, and doctoral levels.

To further understand the impact of "clinical training at VA" and "other factors", on nurse recruitment and retention efforts, a survey was conducted. This paper presents results of that survey.

2. VHA NURSE RECRUITMENT AND RETENTION SURVEY

a. Survey Methodology: OAA, in collaboration with the Office of Nursing Services, the Healthcare Retention and Recruitment Office, and the Office of Human Resources and Labor Relations established a work group of subject matter experts who oversaw the study and provided guidance regarding the content of the questionnaire, the sample to be surveyed, survey methodology, and data analysis.

A literature review provided initial content for the survey questionnaire. The draft questionnaire was further refined based on input from four focus groups of recently hired nurses at VA Medical Centers in Baltimore, MD, Salisbury, NC, Salt Lake City, UT, and Martinez, CA. Focus groups' comments were useful for content validation of the draft survey questionnaire and for identification of less relevant items.

The survey was conducted during a three week period from October 3 to October 23, 2006. Approximately 6,850 VA nurses hired during the previous three years, were contacted by mail and asked to complete a web-based survey. The initial letter was followed by two reminders to improve the response rate. Participation in the survey was voluntary and required only 10-15 minutes.

To maintain confidentiality of individual respondents, only aggregated data were released. Some respondents did not answer all questions; as a result, data are presented as percentages of nurses responding to each question. In addition, for some questions, nurses were asked to select any number of options that apply, thus, the total percents may not sum to 100 percent.

b. Response Rate: Of the 6,850 nurses contacted, 3,330 completed the web-based survey, giving a response rate of 48.6 percent. Responses were received from 165 sites, representing a wide geographic distribution.

c. Demographics: Recently, VA's new hires have been an older population. Based on this survey, only two percent were younger than 25 years, 12 percent were age 25-34, 28 percent were age 35-44 years, 41 percent were age 45-54, 18 percent were age 55-64 years, and one percent were age 65 or older. Thus, a

[1] Department of Veterans Affairs, Veterans Health Administration Workforce Succession Plan (2008-2012).

majority (60%) of the nurses were 45 years of age or older. Eighty three percent were female.

d. Factors that Impact Recruitment Efforts: This section covers factors that could impact nurses' decision to seek employment with VA. Specifically, the focus is on the impact of 1) receiving training at VA, 2) sources of information about VA job opportunities, and 3) important factors about the job itself.

1) VA Training: Almost one third (32%) of recently hired nurses received some clinical training at VA. Over half (57%) of those trained at VA considered their training at VA "Very or Moderately Important" in their decision to accept employment with VA. (Figure #1) Similarly, a high percentage (82%) of survey participants said they would be "Very or Somewhat Likely" to recommend VA training to others. (Figure #2)

The quality of training at VA was considered equivalent to that of non-VA training in the three areas surveyed: Personal Mentoring (54% VA vs. 56% Non-VA), Quality of Preceptors (56% VA vs. 57% Non-VA), and Orientation Program (51% VA vs. 53% Non-VA).

2) Learning about VA Job Opportunities: In order to reach the maximum number of prospective nursing applicants, it is important to know how nurses learned about VA job opportunities. The top three sources identified were VA Employees (42%), Friend or Family (30%), and Newspapers, Journals or other Advertisement Media (15%).

3) Important Factors about the Job Itself: Nurses were asked to identify factors considered important when looking for their current job. These factors were considered "Very Important" by 50 percent or more of the respondents: Other Benefits (vacation and sick leave), Salary, Working Environment (morale, workspace, interdisciplinary care, access to specialty expertise, opportunities for learning, etc.), Career Opportunities, Desired Work Schedule, Continuing Education Opportunities, Choice of Specialty, and Flexible Work Schedule. (Figure #3).

e. Factors that Impact Retention Efforts: Since there is a critical shortage of nurses, it is important to retain employees as well as to maximize recruitment success. The survey provided the following information regarding employee retention.

1) Plan to stay with VA for the next five years: The participants were asked if they planned to be employed at a VA medical facility for the next five years. Seventy five percent responded " Yes Definitely" or "Yes Probably". (Figure #4).

2) Reasons for not planning to stay with VA: Those participants whose response was "Not Sure", "Probably Not", or "Definitely Not" (Figure #4) were asked to provide reasons for not planning to be with VA for the next 5 years. The top five reasons cited were: Compensation (amount of pay, infrequent salary increases, or lack of bonuses) (47%), Poor Management/Supervision (unfair treatment, complaints not acted upon) (46%), Obstacles to Getting Work done (lack of cooperation, red tape, or disorganization) (45%), Work Stress (35%), and Lack of Advancement Opportunities (33%).

3) Job satisfaction: According to a 2001 study, job satisfaction can be a key variable associated with turnover.[2] For this survey, job satisfaction was measured using a 5-point Likert scale. The results show that 78% of respondents were "Very or Somewhat Satisfied" with VA employment. (Figure #5).

A variety of factors influence job satisfaction. This survey identified the most frequently endorsed factors related to job satisfaction (responses of "Very Satisfied") as: Relationship with Patients (65 %), Work Schedule (49%), Relationship with Supervisor (43%), Relationship with Peers (43%), and Benefits Package (42%).

In contrast, the most frequently endorsed factors related to being " Very Dissatisfied" were: Adequacy of Ancillary/Support Staff (17 %), Monetary Awards (17%), Non-monetary Awards (16%), Adequacy of Nursing Staff (14 %), Opportunities for Promotion (14%), and Salary (13%).

Recommending employment to others may be another proxy for job satisfaction. When asked, how likely are you to recommend nursing employment at VA to others, 79% responded " Very Likely" or " Somewhat Likely". (Figure #6).

3. HIGHLIGHTS

- 32% of recently employed VA nurses received some of their clinical training at VA

[2] Lambert E.G., Hogan N. & Barton S.M. (2001), The impact of job satisfaction on turnover intent: a test of a structural measurement model using a national sample of workers. The Social Science Journal 38 (2), 233-250.

- 57% of VA nurses who trained at VA felt their training was important in the decision to seek VA employment
- 82% of those trained at VA are likely to recommend VA training to others
- 82% considered other benefits (vacation and sick leave) and 75% considered salary as "Very Important" factors in employment decisions
- 42% of the respondents learned of VA employment opportunities through VA employees
- 79% of current VA nurses are likely to recommend VA employment to others
- 75% of recently employed nurses are likely to remain employed in VA for the next 5 years

4. SUMMARY/CONCLUSIONS

The Nurse Recruitment and Retention Survey showed that VA clinical training programs play an important role in VA's nurse recruitment efforts. While only about one third of recently employed VA nurses had received some VA training, more than half of those who trained at VA felt that this training was important in their decision to seek employment with VA. This data suggests that clinical training programs have a clear impact on nurses' decisions to accept employment with VA.

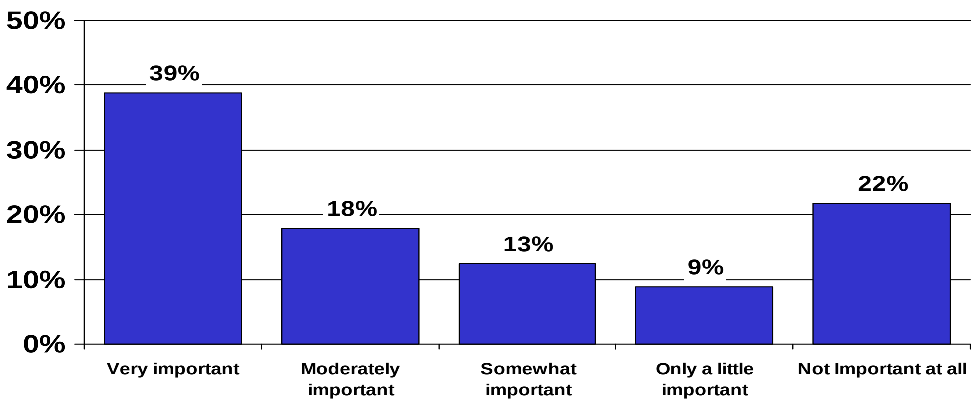
VA employees play a significant role in enhancing VA's recruitment efforts, as 42% of respondents heard about VA employment opportunities through VA employees. In addition, a majority of nurses were satisfied with VA employment and would likely recommend VA employment to others.

However, key variables of benefits, salary, and working environment are critical to recruitment success and may need to be enhanced to maintain VA as an attractive place to work. In addition, those factors that detract from retention of current employees, (such as, lack of compensation, poor management/supervision, and obstacles to getting work done) should be addressed.

Figure #1

Importance of VA Training in Seeking VA Employment

Among those who had VA training

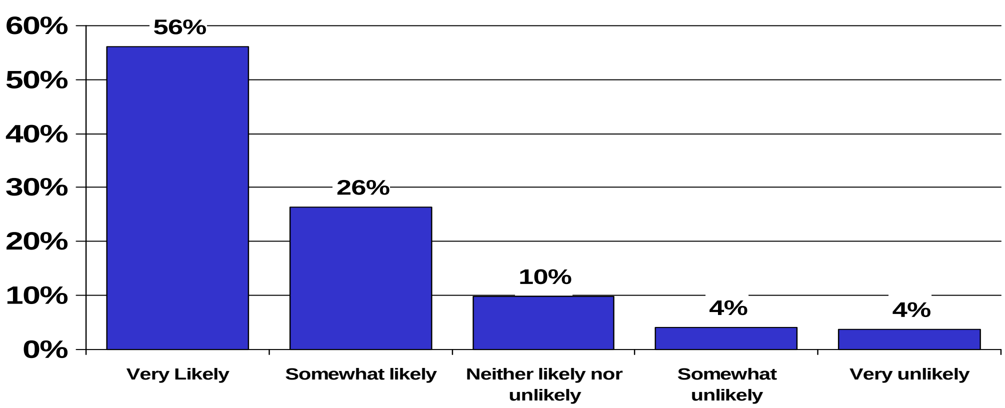


Q. How important was your VA training experience in your decision to accept current VA employment? N=1,004

Figure #2

Would Recommend VA Training

Among those who Trained at VA



Q. How likely are you to recommend training at a VA facility to others? N=1,004

Figure # 3

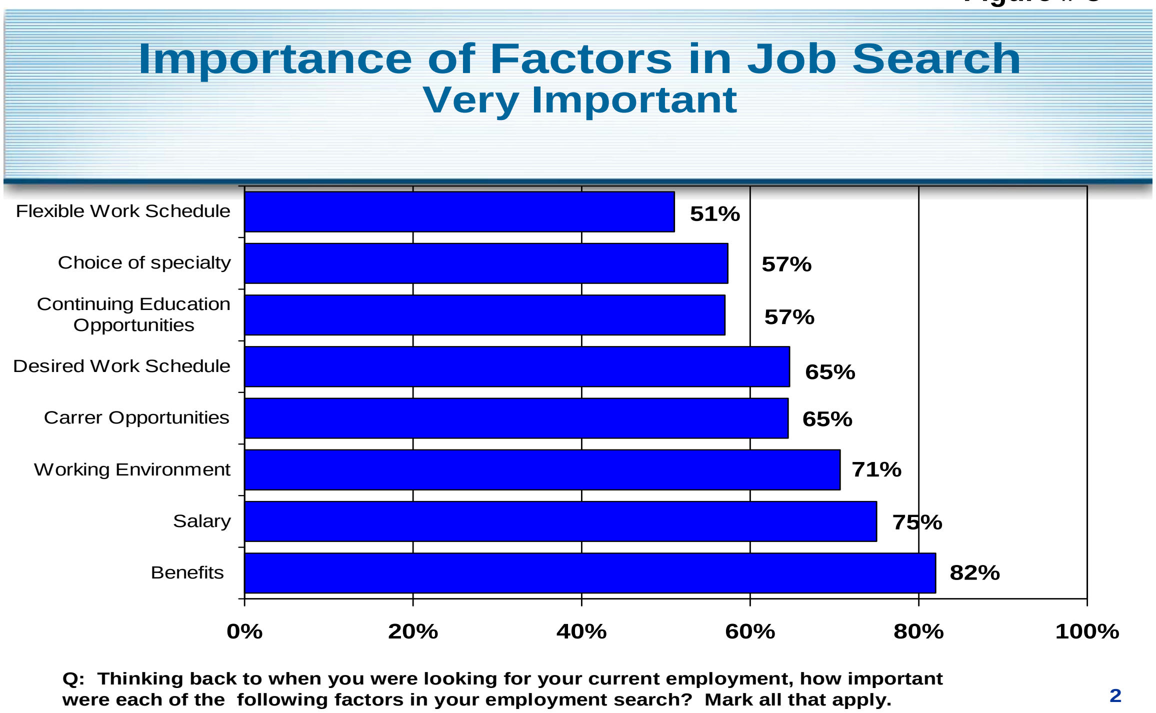
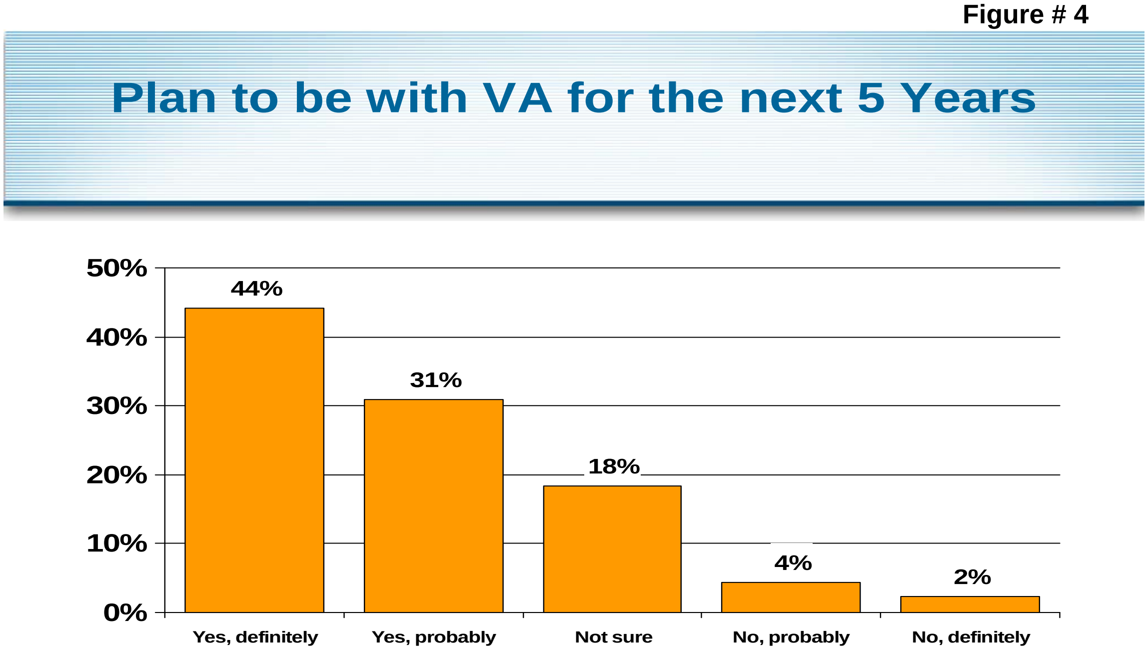
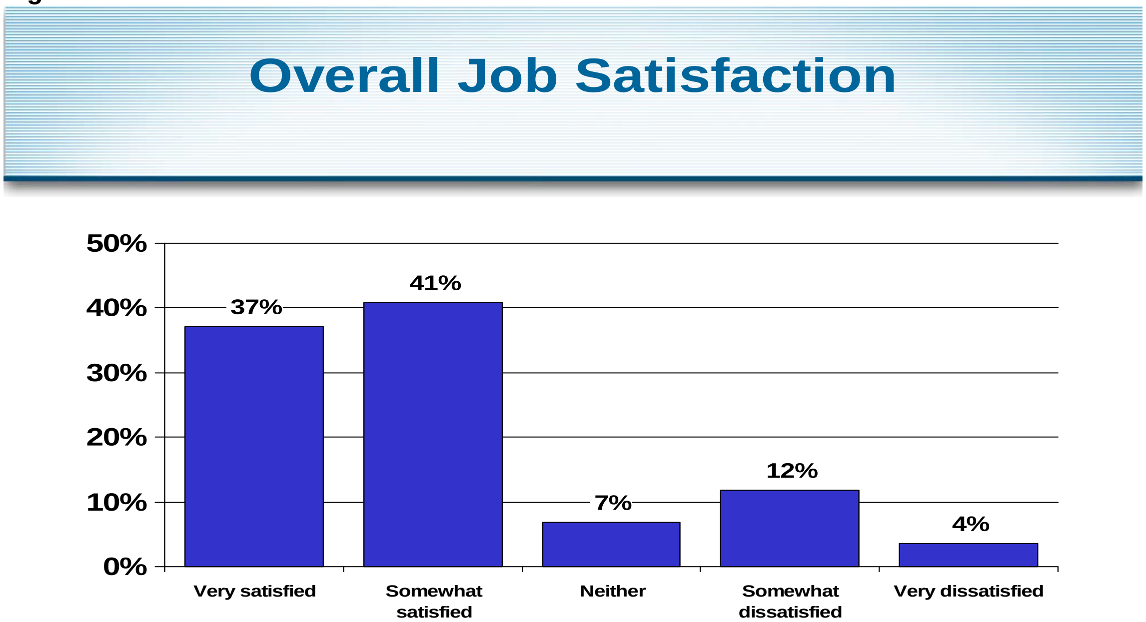


Figure # 4



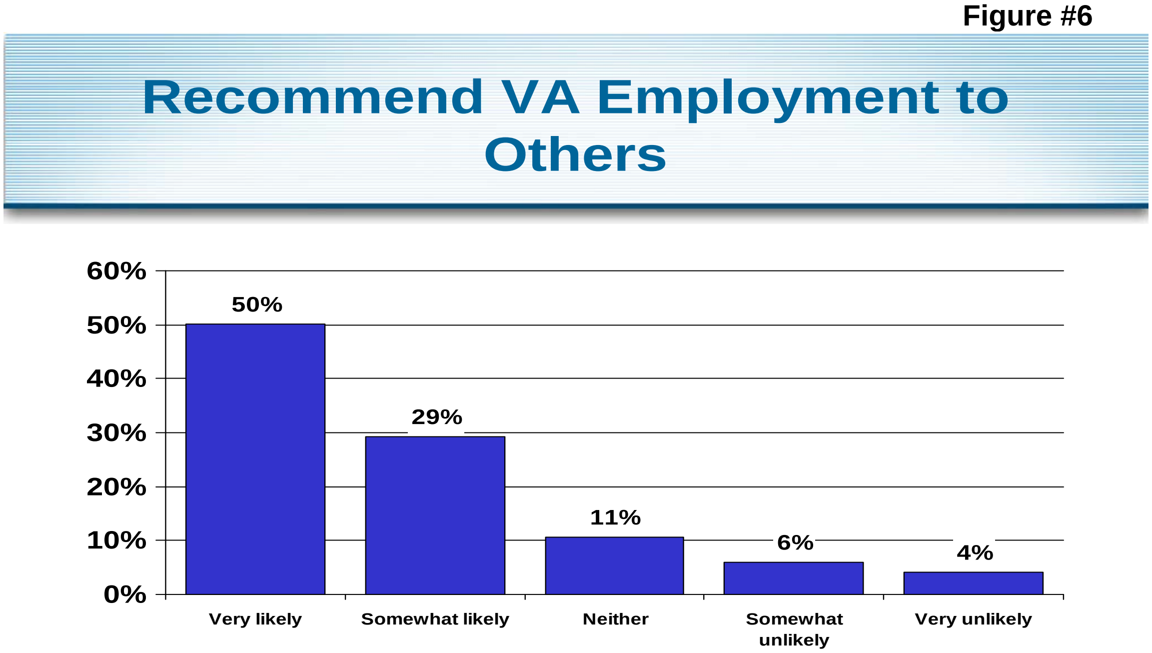
Q. Do you plan to be employed at a VA medical facility for the next 5 years?
N=2,984

Figure # 5



Q. Overall, how satisfied are you with your employment at this VA medical facility? N=2,984

Figure #6



Q. How likely are you to recommend nursing employment at a VA facility to others? N=2,957

Forecasting Transportation Trends

Session Chair: Fred Joutz, The George Washington University
Pheny Weidman, Bureau of Transportation Statistics

How the Seasons Impact Traffic Congestion: A Study of Three U.S. Cities

Peg Young, Bureau of Transportation Statistics

Congestion on our nation's highways has become a major issue facing many state and local agencies. At the national level, reducing congestion is one of the strategic goals of the U.S. Department of Transportation. Most urban areas of the country have experienced rising levels of congestion, as the increased volume of vehicular traffic exceeds the capacity of the transportation system being used. This report takes a unique view at congestion for three US cities, Chicago, Los Angeles, and Houston, by estimating the impact of seasons on congestion. By estimating how much more or less congestion is experienced monthly for each city, it can be shown how congestion in morning travel and evening travel differ through the year, as well as the differences occurring in weekend and weekday congestion.

Trends in Personal Income and Passenger Vehicle Miles Traveled (VMT)

Jeffery Memmott, Bureau of Transportation Statistics

For years, increasing income has been a principal factor contributing to the rapid growth of highway passenger travel. As incomes increased, the demand for additional transportation services manifested itself in a variety of ways: more individuals and households acquired personal vehicles; the proportion of multiple vehicle households grew; families moved to larger and more comfortable housing in the suburbs, thereby increasing commuting trip distances; and the number and length of discretionary trips increased. As a result, passenger highway travel, as reflected in vehicle miles of travel (VMT), increased rapidly. But there have been discussions since at least the early 1990s about whether the effects of rising incomes on travel demand would start to diminish. That speculation now appears to be a reality as recent data suggest the relationship has weakened—vehicle travel growth has started to slow in comparison to growth in real personal income. This presentation provides evidence on the relationship between VMT and personal income, along with factors affecting that relationship.

Time Series Analysis of Aviation Revenue Passenger Miles (RPMs)

Gary Feuerberg, Bureau of Transportation Statistics

Airline revenue passenger miles (RPMs) are one indicator of how the airline industry is performing. Two recent events caused significant declines in airline RPMs—the terrorist attacks of September 11th, 2001, and the SARS (Severe Acute Respiratory Syndrome) outbreak in Asia that followed in 2003. The effects of 9/11 are apparent even in the raw data, but the impact of the SARS scare is masked by seasonal fluctuations. This paper discusses the potential for analysis of time series data once seasonality has been removed. In October 2004, the Bureau of Transportation Statistics (BTS) began to seasonally adjust airline passenger data for use in its monthly Transportation Services Index, using X-12 ARIMA, release 0.2. Monthly RPM data fluctuate continually, making the underlying trend difficult to ascertain. Trend patterns in the data come into full view when the erratic seasonal factors are removed, revealing the airline RPM decline during the second quarter of 2003.

Statistical Methods in Forecasts

Session Chair: Charlie Hallahan, U.S. Department of Agriculture

Monitoring Processes with Changing Variances

J. Keith Ord, Georgetown University

Statistical process control (SPC) has evolved beyond its classical applications in manufacturing to monitoring economic and social phenomena. This extension requires consideration of auto-correlated and possibly non-stationary time series. Less attention has been paid to the possibility that the variance of the process may also change over time. In this paper we use the innovations state space modeling framework to develop conditionally heteroscedastic models. We provide examples to show that the incorrect use of homoscedastic models may lead to erroneous decisions about the nature of the process. The framework is extended to include counts data, when we also introduce a new type of chart, the P-value chart, to accommodate the changes in distributional form from one period to the next.

Improving Health Care Efficiency to Accommodate Increased Demand Due to Increased Access: A Case Study of a Washington D.C. Federally Qualified Health Center

Steven Kroll, Bureau of Labor Statistics, U.S. Department of Labor

Access to, and quality of, health care are two major criterion when evaluating health services. This paper is unique to health care forecasting in regards to its focus; the evaluation of primary health services to low-income and homeless residents. Using cycle time and clinic intake data collected from a non-profit health clinic, sampling theory, statistical imputation, and non-parametric testing are first applied to estimate provider service times by visit type. Queue theory and dynamic programming techniques are then implemented to calculate a capacity schedule. A discussion on the application of government data to improve the clinic's expectations, processes, and positioning concludes the report.

Improving Healthcare Predictive Modeling using NeuroSequences

Hung-Han Chen, BlueCross BlueShield and Michael T. Manry, University of Texas at Arlington

This paper presents a practical method to improve the performance of MLP neural networks on healthcare predictive modeling. By adding a layer of data exploration using SOM, the data is clustered, the topology property is preserved, and the task of predictive modeling is transformed to less complexity with the concept of "divide and conquer." The impacts of this new method are discussed and models of 3-month inpatient risk for 2.4 million insured members, an extreme unbalanced data, are compared to the result of a leading commercial risk score software.

Improving Health Care Efficiency to Accommodate Increased Demand:
A Case Study of a Washington D.C. Federally Qualified Health Center

Steven Kroll
Current Employment Statistics
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I. Introduction

Due to the uncertain and complicated nature of health care markets, the pricing for insurance and service has restricted access to care. In response to past market failures, non-profit organizations and the US federal government have worked in conjunction with one another to improve access to health care. Today in the US, Federal Qualified Health Centers (FQHCs) and non-profit "Look-a-likes" provide primary health services to low-income and homeless individuals. The guiding principles of these organizations have remained the same since FQHCs were appended to the Public Health Services Act (PHSA): 1) access to primary health care, regardless of a patient's ability to pay; and 2) that the health center is governed locally either by a created board or by the community served .

FQHCs and their respective look-a-likes are currently funded either under Section 330 of the PHSA and/or by private donations. Unfortunately, anticipated increases in input costs and consumer demand are likely to further constrain current revenue streams. Subsequently, publicly funded health centers may be forced to become more productive with existent levels of capital to maintain current levels of access.

In the following report, statistical analysis and operations research are applied to develop operational benchmarks and improve patient flow. After providing a brief background on the study's clinic, the data collection process and statistical estimation of service times will be explained. Implications from this initial analysis will provide a framework for further investigation into operations improvement. Service time estimates are then used as inputs for a queuing model to generate average patient wait times at varying annual demand levels. After achieving a targeted demand level, visits are held constant, allowing the analysis of average wait times under decreasing service times.

After investigating facility capacity, recommendations to improve patient flow and facility capacity via forecasting and improved scheduling are then presented. Finally, applications of published data for mid-to-long term planning for primary health care are discussed.

II. Background

Community of Hope Health Services (COHHS) provides primary health care services to a portion of the 210,000 people in the District of Columbia who are uninsured, on Medicaid, Medicare, or enrolled in alliance-affiliated insurance programs. COHHS officially achieved FQHC status in 2006, stipulating an increase from 7,500 annual visits in 2006 to 14,000 in 2010. The clinic has responded by initiating a patient flow project to limit patient wait times with the projected increase in demand.

To establish benchmarks for current operations, COHHS developed a Patient Tracking Services Form (PTSF), detailing an eleven step process modeling all potential visits. Data on date, time, visit type, and process step were collected. PTSFs were completed for all patient visits during the first two weeks of December 2007.

Initial findings of the 10-day collection period revealed a number of key insights which can impede patient flow: 1) the distribution between patient type, walk-ins (WI) and appointments (APT), were relatively even and 50.8 percent and 49.2 percent, respectively. 2) A majority of patients, not including no-shows, were determined to be tardy or extremely early. 3) Daily demands for scheduled appointments were not distributed evenly. For example, for the time period studied, the clinic handled 45 percent more visits on Tuesday than they did on Thursday. 4) Arrival times for scheduled appointments appeared to be scheduled randomly. 5) Most outliers for cycle times occurred during heavy demand, when the number of patients within the queue exceeded the facility's capacity.

Each finding provokes further investigation into current processes. For example, is it best to maintain appointment/walk-in provider assignment ratio of 2 to 1? Understanding the relationship between service times with respect to visit distribution can help answer this question. Second, what is the capacity of the current facility? Will COHHS be able to meet future obligations within its current facility without losing patients due to increased wait times? Answers to these questions will assist COHHS in improving short-term operations while positioning themselves to meet their long-term goals.

Improving productivity for increased capacity within health care operations is difficult. For example, past health economic studies have measured the elasticity of substitution between labor and capital, and labor and materials, are close to zero. This finding suggests that process inputs possess a relatively complimentary nature to produce the process outputs. Second, due to FQHC guidelines and market conditions, COHHS cannot minimize costs by decreasing its service mix. Therefore, any increase in visits will be achieved primarily by increases in labor productivity due to improved processes.

III. Estimation of Service Times

To estimate service times, over 350 PTSFs were collected during the first two weeks of December 2007, accounting for 100 percent of patients visit for the respective time period. After excluding laboratory visits from the sample, service times were calculated by taking the difference between the time when the patient entered the exam room and the time the patient checked-out. Figure 1 illustrates the deconstruction for the purpose of service time estimation.

Figure 1. Changes in TSF for Cycle Time Analysis

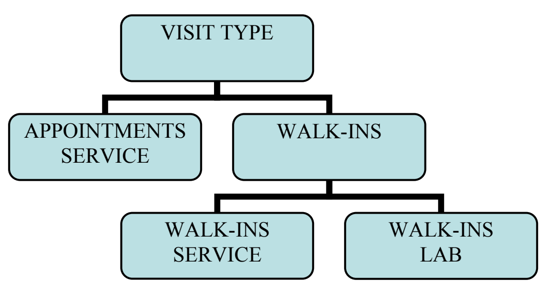
Time Arrived to Placed on Rack		1) Time Arrived to Placed on Rack (W)
Registration Completed		2) Placed on Rack to Triage (W)
Forwarded to Enrollment		3) Triage (I)
Completed by Enrollment	→	4) Triage to Exam Room (W)
Place on Rack		5) Exam Room (S)
Triaged		6) Lab Work (L)
Providers Office		7) Check-out
Exam Room		
Lab Work		
Check-out		

After compiling and cleaning the sample, a visual inspection of service times by visit type revealed that walk-in and appointment service times were generated by two different processes. To confirm this observation, thirty observations over the two week period were randomly selected by visit type. Under the assumption that neither WI nor APT service times were distributed normally, a large sample Mann-Whitney (MW) test was then implemented to test the following hypothesis:

H_o: The relative frequency distributions for WIs and APTs are identical. Service times for WIs and APTs should not be estimated separately.

H_a: The population relative frequency for WIs is shifted to the right of the relative frequency distribution for APTs. Therefore, service times should be estimated separately.

Figure 2. Taxonomy of Visit Type for Service Time estimation.



Setting the probability of Type I error to 5 percent (α =.05), the calculated MW test statistic of 2.07 exceeds the critical value of 1.67, rejecting the null hypothesis of identical service time distributions and their respective means. The primary implication from the Mann-Whitney test is that service times for WIs and APTs should be estimated separately.

The samples collected for the MW test were then used to derive initial sample estimates. Estimated service times for WIs were measured at 20 minutes, significantly less than patients with appointments, at 26 minutes. To validate the initial service time estimates, a second sample for each visit type was created by using the remaining complete, non-laboratory observations (missing observations were imputed to the mean). Invoking the central limit theorem, ANOVA was then performed between samples by visit type to verify initial sample estimates. Table 1 provides estimates for each sample by visit type and their respective F-statistics. The null hypotheses for both statistical tests, that service times are equal between first and second samples are not rejected, providing support that the population parameters for WIs and APTs are approximately 20 and 26 minutes, respectively.

Table1. Mean, Standard Deviation, and ANOVA by visit type

		MW	R	FV	CV
WI	mean	19.9	19.9	0.87	1.87
	s	11.0	11.4		
APT	mean	25.6	26.4	0.74	1.85
	s	12.4	11.8		

IV. Capacity

To estimate the facility's current capacity, an A/M/S queue model was applied to estimated service times under current provider assignment policy where:

A = arrival pattern
M = average service time
S = number of servers in system.

Before proceeding with capacity estimation, a short background on queue theory will be provided. Outcomes of queue theory are dependent upon the system's utilization factor. The utilization factor is defined as follows:

$$\rho = \lambda / s\mu \qquad (1)$$

where

ρ = utilization factor
λ = interarrival time
μ = average service time
s = number of servers in system.

Stability conditions dictate $\rho < 1$. If $\rho \geq 1$, patients arrive at a faster rate than the system can accommodate, resulting in infinite patient wait times. For capacity purposes, values of λ were used to calculate respective values for ρ, which were then used to generate a capacity schedule for the clinic. For benchmarking purposes, service quality was defined as the average patient waiting time, $W_{q,}$ defined by the following equation:

$$W_{wi} = \rho / (\mu - \lambda) \qquad (2)$$

The primary implications of Equation 2 are that increases in arrival rate and/or average service time result in longer patient wait times. Table 2 provides estimated patient wait times for three different annual demand levels by visit type using current respective service times. Visits restricted to the laboratory were assumed to represent 20 percent of WI visits. The facility's current capacity level is generated by summing the maximum level demands by visit type with the assumed visit level for laboratory work (5000+8000+1000=14000).

Table 2. Capacity estimation and average wait time for varying levels of annual demand

	MIN	Demand	λ	μ	WqMIN
WI	20	3000	1.5	3.0	20
	20	4000	2.0	3.0	40
	20	5000	2.5	3.0	100
APT	26	6000	3.0	4.6	25
	26	7000	3.5	4.6	44
	26	8000	4.0	4.6	91
LAB	10	1000	0.5	6.0	1
CAP		**14000**			

Clearly, it is feasible for the current facility to meet its 2010 goal of 14,000 visits. However, average patient wait times are far above the wait times at current demand levels. To ensure that the primary goal of the patient flow project is met, decreased wait times, average service times must be reduced.

Table 3. Average wait times for varying service times, holding capacity constant at 14000 visits.

	MIN	Demand	λ	μ	WqMIN
	20	5000	2.5	3.0	100
	18	5000	2.5	3.5	43
WI	16	5000	2.5	4.0	25
	14	5000	2.5	4.5	17
	12	5000	2.5	5.0	12
	26	8000	4.0	4.6	91
	24	8000	4.0	5.0	51
APT	22	8000	4.0	5.5	31
	20	8000	4.0	6.0	21
	18	8000	4.0	6.5	15

By holding the projected 2010 visit level at 14,000 constant, new estimates for average patient wait times were generated .Table 3 illustrates the reduction in average patient wait times resulting from increased provider productivity. A reduction in service times for WI's will reduce wait times by 75 percent, from 100 minutes to 25 minutes. A 20 percent reduction in service times for APTs will result in a patient wait of 31 minutes, roughly 67 percent less when compared to current service times. Therefore, it can be concluded that operations can be improved dramatically improving provider productivity.

V. Strategy

In the prior section, queue theory was applied to estimate the facility's capacity and develop operation benchmarks. Although means to measure and gauge performance are developed, it does not fully leverage available information to improve operations. This section suggests how internal data can improve patient scheduling. An introduction to publicly available data and its potential application to planning are then discussed.

Tables 4a and 4b present *actual* arrival times for scheduled appointments by hour over the entire two week period. A quick review of either table indicates that arrival times are fairly random. For example, 10 patients arrived during the 9 AM hour on Wednesday, December 12. On the following day, zero patients arrived during the same hour. As earlier analysis indicated, a primary cause to the random nature of scheduled arrivals is due to patient delinquency and no-shows. Without proper incentives (which have since been implemented) to encourage patient poignancy, random behavior for scheduled appointment arrivals will result in longer average patient wait times. A second cause for inconsistent arrival patterns is the clinic's approach to scheduling. Current information systems do not provide accurate service times for defined services. Second, information on the distribution of services is not considered during scheduling. Future research on each of these topics will provide the clinic with a demand management tool that will improve daily scheduling. Improved booking procedures will stabilize traffic intensity, resulting in decreased patient waiting time.

Publicly available government data can provide guidance in developing visit forecasts. Currently, the majority of COHHS cases utilizing exam rooms can be classified under three headings – pediatrics, well-being exams, and chronic disease treatment. The National Center for Health Statistics produces national statistic related to each of these headings. Research into how national aggregates relate to the clinic can result in improved forecasts and informed policy decisions.

Table 4a. Daily arrivals by hour for week of Dec.3, 2007, APT

TIME	M	T	W	H	F
8:30	4				1
9:00	4		1	2	**5**
10:00	1	3	**7**		1
11:00	3				
12:00		1	1		1
1:00	**5**	2	2	3	1
2:00	1	3	1	1	2
3:00	2	1		3	
4:00		2		1	
5:00		1			
6:00		2			
7:00					

Table 4b. Daily arrivals by hour for week of Dec.10 2007, APT

TIME	M	T	W	H	F
8:30	1		1		4
9:00	**6**	3	**10**		2
10:00	3	2	1	1	4
11:00	1	1	2	1	2
12:00			2	1	1
1:00	4	**7**	**5**	**5**	2
2:00	3	2	3	**6**	2
3:00	2	3		4	2
4:00				1	
5:00					
6:00		3			
7:00		1			

Pediatric care is one of the core services FQHCs provide. Although live births are not performed within the clinic, COHHS classifies different stages for scheduling – pre-natal, peri-natal, and post-partem. By studying data published by the NCHS, COHHS can gain further insight in regards to current and long-term relationships in birth and fertility rates between the clinic, the District, and the nation. Chart 3 in the appendix presents national and district birthrates from 1991 to 2005. From visual inspection, one may be able to infer that district birth rates have decreased steadily during the nineties, which has been followed by a steady increase that has occurring since 2001. The short-run relationship between the district and the nation (Chart 4) can be captured by measuring the changes in birthrates between nation and state. Regression analysis shows that the district's birthrate is more variable, with a with a 1 percent change at the national level resulting in a 1.5 percent change in the district. Managers can perform similar analyses using clinic data to determine how their facilities relate to overall aggregate trends. For example, if COHHS is experiencing a decline in pregnant patients similar to nation or district trend, managers adjust their inventories accordingly. If COHHS visit data does not resemble the national or district trend, COHHS can develop more customized forecasts from internal databases, optimal policies can be developed by using historical data.

Well-being exams also represent a significant portion of COHHS visit. NCHS has produced annual estimates from surveys conducted which can be used as a proxy to forecast well-being exams. Chart 2 provides visit levels for the period from 1995-1996 to 2003-2004, illustrating a yearly increase of 1.4 percent in visits to General/Family practitioner visits. Although clinic data has shown the rate of well-being exams increase at a greater rate than national figures, implications produced from analysis can be beneficial in assessing aggregate behavioral trends, improving utilization of the clinic's resources.

Chronic diseases, such as diabetes and hypertension, are also large contributors to the COHHS service mix. By transmitting insights provided by NHCS data, COHHS can improve their systematic knowledge, scheduling, and their long-term planning. Table 5a presents data by aggregate, race, age, and income, for the periods 1999 to 2001 and 2002 to 2004, on the percentage rate of diabetes within the US population. Further analysis shows there are a number of key insights to be gained. 1) The incidence rate of diabetes has increased from 9.4 percent for the 1999 to 2001 period 10.2 percent for the 2002-04, suggesting an annual upward trend of roughly 2.75 percent. 2) African-Americans are 65 percent likely to be diagnosed as diabetic when compared with the general population. 3) The likelihood of a "poor" individual of being diabetic is 40 percent greater than the general population. 4) Finally, the onset of diabetes is more likely to occur as an individual grows older. Table 5b presents data by population, race, age, and income for 1999-2001 and 2002-2003 on the percentage of the US population diagnosed with hypertension. Insights based on race, income, and age can also made to assist management and production workers within their decision-making. 1) The percentage of the populations being diagnosed with hypertension has remained relatively steady between the years for the six-year period within the table. 2) African-Americans are 40 percent more likely to have high blood pressure when compared with the general population 3) Income does appear to have a significant effect, as the likelihood of a poor individual being diagnosed as hypertensive is 11 percent greater than the average American. 4) And as with diabetes, the percentage of Americans over age 65 with hypertension is over 70 percent.

Finally, when NCHS data is used in conjunction with data published by the Census Bureau (CB), COHHS can better quantify their respective market potential. Using the US Census Bureau's American Fact Finder, a researcher can extract statistics concerning general demographic, social, economic, and housing characteristics by zip code, and compare these to national averages. For example, the analyst can estimate the number of diabetics near poverty within zip code 20009 (Table 6) by multiplying the CBs area population estimate and the number of those in poverty, by the NCHSs national percentage rate of diabetics, to determine overall market potential (46,561 x .132 x .124 = 762).

VI. Conclusion

This report has illustrated that statistical analysis, operations research, and secondary data sources can improve primary health clinic operation. Using sampling theory and non-parametric statistics, service times by visit type were estimated and subsequently verified. Service times were then implemented, under a specific provider assignment policy, into a queue model to generate average patient wait times for varying demand levels. After determining a specific demand level for the clinic, average patient wait times were then simulated using decreasing service times. After estimating capacity and setting facility benchmarks, suggestions for operations improvement are presented via improved scheduling and the application of government data. In conclusion, metrics to measure performance and tools to improve clinic forecasting are presented. Application of techniques and statistics presented can further prepare primary health clinics for the oncoming increase in health care demand.

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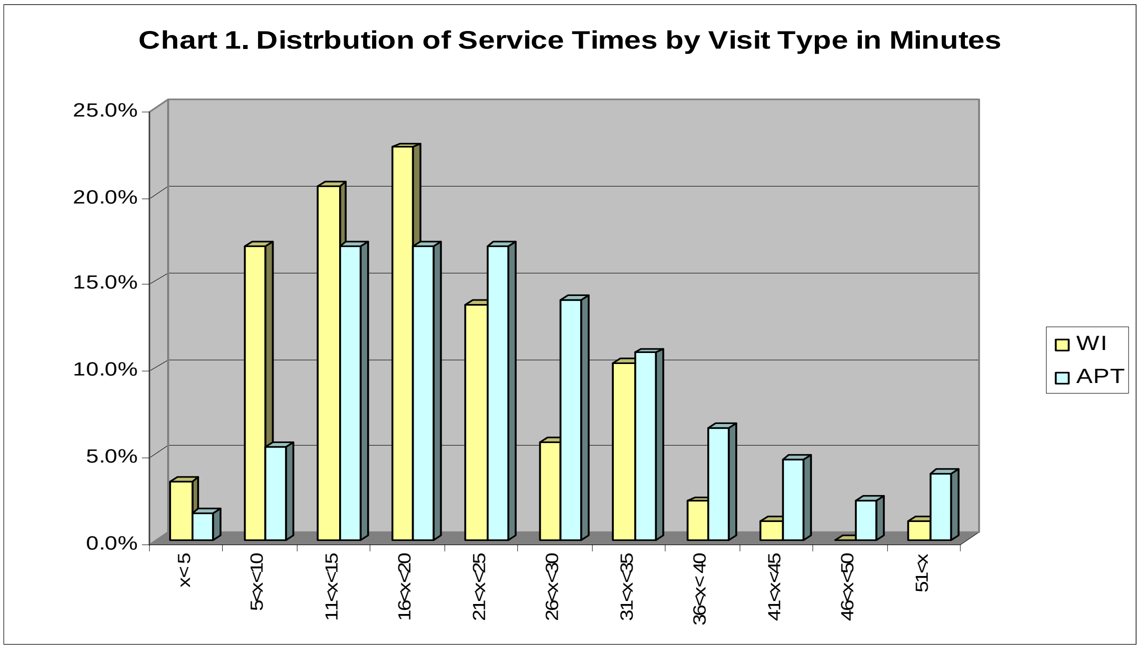
VIII. Appendix



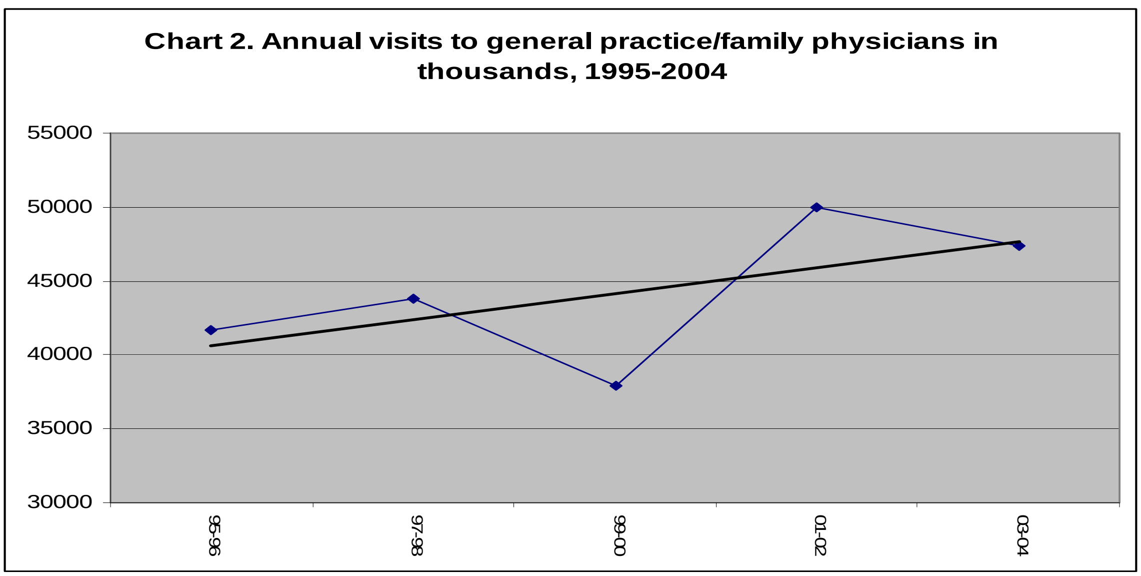


Chart 3. Birth Rate per 1,000 Population by Year, 1990-2005

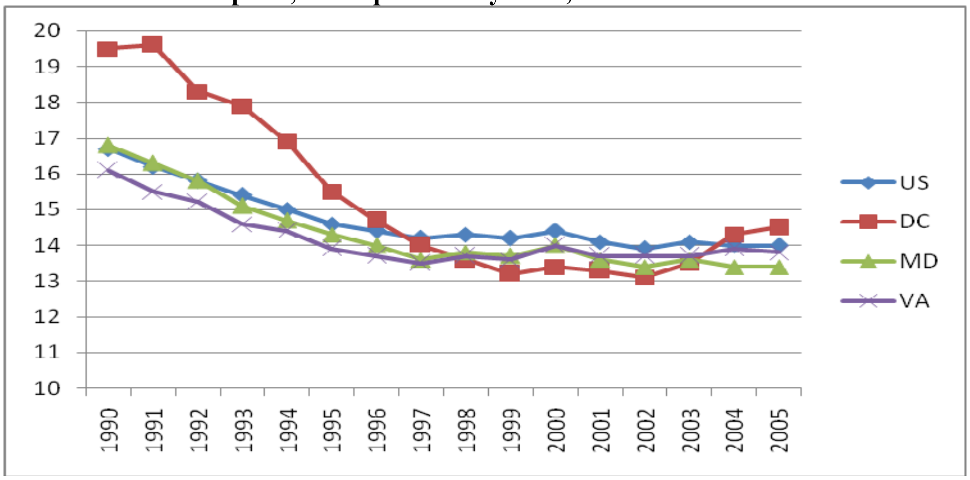


Chart 4. Changes in Birth Rate per 1,000 Population by Year, 1990-2005

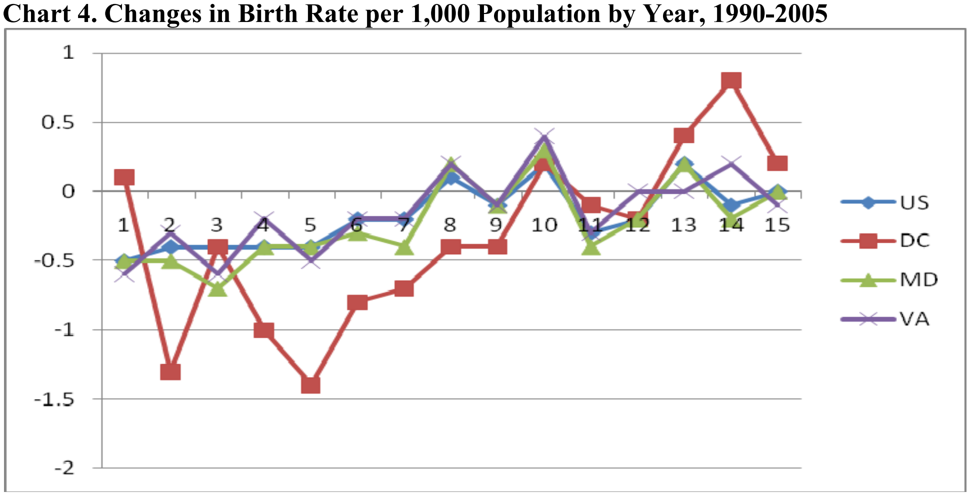


Table 5a. Diabetes among adults, age-adjusted: US, 1999-2004 by race and income

	Year	**1999-2002**				**2001-2004**			
	Poverty Status	All	Poor	Near poor	Nonpoor	All	Poor	Near poor	Nonpoor
Age	Race/Ethnicity								
20+	All	**9.4**	13.2	12.6	7.5	**10.2**	13.3	12.5	8.5
	Non-Hispanic White	8	11.6	11.2	6.5	8.8	12.7	11.9	7.2
	Non-Hispanic Black	15.5	20.7	17.6	12.9	14.2	15.1	13.7	12.9
	Mexican-American	13.1	16	13	12.3	14.7	18.2	11.7	14.5

Table 5b. Hypertension among adults, age-adjusted: US, 1999-2004 by race and income

	Year	**1999-2002**				**2001-2004**			
	Poverty Status	All	Poor	Near Poor	Nonpoor	All	Poor	Near Poor	Nonpoor
Age	Race/Ethnicity								
20+	All	**29.9**	32.6	32.9	28.4	**30.7**	34.2	33.2	29.5
	Non-Hispanic White	28.4	29.5	31.7	27.3	29.4	33.8	31.7	28.4
	Non-Hispanic Black	42.3	42.6	43.9	42	42.7	41.6	46.1	42.4
	Mexican-American	26.6	27.3	26.5	26.9	26.9	27.8	26.7	27.2

Table 6. 2000 Census data, population and individuals below poverty for zip code 20009

	Number	Percent	U.S.
Total Population	46567		
Individuals below poverty level	8224	18.0%	12.4%

Improving Healthcare Predictive Modeling using NeuroSequences

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Abstract:

This paper presents a practical method to improve the performance of MLP neural networks on healthcare predictive modeling. By adding a layer of data exploration using SOM, the data is clustered, at the same time the topological property is preserved, and then the task of predictive modeling is transformed to less complexity with the concept of "divide and conquer". The impacts of this new method are discussed and models of 3-month inpatient risk for 2.4 million insured members, an extreme unbalanced data, are compared to the result of a leading commercial risk score software.

1. Introduction

Predictive modeling for healthcare industry is "a set of tools used to stratify a population according to its risk of nearly any outcome"[3]. One of the goals of member profiling is to identify opportunities for intervention before the occurrence of adverse outcomes that result in high medical costs. It often involves data with unknown characteristics. If the targeted outcome is a rare event from the population, then it is usually very difficult to make prediction with such unbalanced data distribution.

Neural network has been one of the important methods for problem solving based upon the concept of artificial intelligence. The easy-to-use supervised learning rule, Backpropagation, has made Multi-Layer Perceptrons (MLP) popular for solving pattern recognition problems. But there also have been some critics for MLP neural networks regarding different aspects from many intelligent researchers since day one. Unfortunately, most of them still are the challenges that neural networks need to face today.

Beside the claim that MLP neural networks may be trapped in local minima instead of finding the global solution, one of the major obstacles for neural networks becoming a real solution for practical problems is that the MLP neural networks have problems of scaling [1]. This issue of what and how Perceptron network will function when increasing the size and complexity of problems is often overlooked. There are also other concerns on MLP neural networks as described in [2]: it is not integrated with cost function; it needs long time to train; it may be over-fitting if training too long; it has catastrophic unlearning phenomenon; and it is mysticism to most people.

Section 2 describes the data representation and feature selection from healthcare raw data. Section 3 revisits the two types of conventional neural networks, MLP and Self-Organized Map (SOM). A practical method, NeuroSequences was proposed to improve MLP neural networks for predictive modeling in section 4, followed by discussion of how this new method can help resolving the drawbacks of MLP neural networks in section 5. Section 6 presents the result of this method applied to a 2.4 million-member population from a health insurance company to assess their inpatient risk for the next 3 months. Comparison with leading commercial rule-based software with clinical and treatment episode is also included. The conclusions and further discussion are given in section 7.

2. Data Representation and Feature Selection

Pre-processing is needed to convert raw data to input features for predictive models. Medical and pharmacy claims history within a certain period of time can be summarized, grouped and aggregated by ICD-9 diagnostic codes, CPT-4 procedure codes and NDC pharmacy codes into a set of input features. This set of input features can also include the utilization and grouping for major disease categories, like CAD, CHF, and Diabetic etc.

Let $X(m)$ be the vector of input features for member *m* from the insured population.

$$X(m) = (x_1(m), x_2(m), \ldots, x_N(m)) \quad (1)$$

Where *N* is the total number of features.

This set of input features can be used to model different healthcare related outcomes. Depending on what target the model is predicting, the most relevant features to the targeted outcome can be selected if their R-square from logistic regression are greater then a chosen minimum criterion, σ.

$$x_i \rightarrow x'_j \text{ if } R_i^2 > \sigma \quad (2)$$

The new input vector for a designed outcome is then

$$X'(m) = (x'_1(m), x'_2(m), \ldots, x'_P(m)) \quad (3)$$

Where *P* is the number of selected features.

3. Conventional Neural Networks

3.1 Multi-Layer Perceptions (MLP)

The MLP neural networks with Backpropagation learning algorithm may have several drawbacks described in section 1; however, they do, in principal, offer all the potential of universal computing devices. They were intuitively appealing to many researchers because of their intrinsic nonlinearity, computational simplicity and resemblance to the behavior of neurons [1].

In training iteration *t* for MLP, the batch mode Backpropagation learning algorithm propagates the error term from output layer back to hidden layers, and updates the weight vector of neuron *v*, $W_v(t)$, using *gradient descent* method:

$$W_v(t+1) = W_v(t) + \alpha(t)\frac{-\partial E_v(t)}{\partial W_v(t)} \quad (4)$$

where $E_v(t)$ the error term propagated back to the neuron *v* and $\alpha(t)$ is the learning factor. The adaptive mechanism for learning factor can be easily achieved by:

$$\alpha(t+1) = \begin{cases} \alpha(t) * 2 & \text{if Error decreases} \\ \alpha(t)/2 & \text{if Error increase} \end{cases} \quad (5)$$

3.2 Self-Organized Map (SOM)

Kohonen's Self-Organizing Maps (SOM) algorithm is considered as one of artificial neural models for the brain, especially the experimentally found "ordered maps" in the cortex layers. Some researchers are able to produce simulation solutions to the cortical mapping problem by using SOM [7].

A SOM consists of a single-layer feedforward network that is utilizing unsupervised competitive learning to produce low-dimensional representation of the training sample while preserving the topological properties of the input space [8].

SOM often is trained by updating the weights for each input vector, the update formula for neuron *v* with weight vector $W_v(t)$ at time *t* is

$$W_v(t+1) = W_v(t) + \Theta(v,t)\alpha(t)(X'_t - W_v(t)) \quad (6)$$

where $\alpha(t)$ is a monotonically decreasing learning coefficient and X'_t is one of $X'(m)$ to be the input of SOM at time *t*. The neighbourhood function $\Theta(v,t)$ depends on the lattice distance between the best matching neuron for X'_t and neuron *v*.

While the SOM algorithm may differ from traditional clustering analysis by adding the element of neighborhood function, the end result of SOM is not so different from clustering analysis in the sense of input-output relationship: there will be one single *winning* neuron, whose weight vector lies closest to the input vector X'_t.

Even though SOM algorithm inherits the capabilities of unsupervised learning and clustering analysis, the one-layer ordered map is simply not enough when a hierarchical structure is required, as the anatomical finding of cortex suggests.

4. Method of NeuroSequences

4.1 Memory and Learning

The architecture of neural networks is loosely based on the structure of human nervous systems. When believing brain is a network of many neurons, researchers in 1960s were interested in modeling brain by grouping a bunch of neurons together. With the learning capability improved by Backpropagation algorithm in the late 1980s, the neural network's knowledge and memories can then be distributed throughout its connectivity, just like a real brain.

However, the structure of neural networks is way too simple compared with the physical architecture of the brain, the neocortex, and the performance of neural networks is still far from satisfaction. On the other hand, neuroscientists have long ago discovered cortical columns [4, 5] in the human 6-layered cerebral cortex in the sense of functional and/or anatomical features. With the advance of modern neuroscience from past decades, researchers have summarized four attributes of neocortical memory [6]:

1. The neocortex stores sequences of patterns.
2. The neocortex recalls patterns auto-associatively.
3. The neocortex stores patterns in an invariant form.
4. The neocortex stores patterns in a hierarchy.

To improve the performance of MLP neural networks closer to a human brain, the structure of MLP neural networks needs to adapt the concept of cortical columns. The focus here is on adding the functionality of auto-association with unsupervised learning, invariant form with clustering analysis, and more layers to the hierarchical structure of the traditional MLP neural networks.

As neural network researchers finding ways to improve MLP structure, some have developed Neural Network Tree (NNTree) [9, 10] to integrate the advantages of decision tree and neural networks. A typical NNTree can have up to 6 levels, or the depth of the tree is 6. However, there are issues surrounding the efficiency and effectiveness for its implementation and the splitting criterion for the non-terminal nodes of the tree [11, 12].

There is another type of research that fits a local model from the winning neuron and a set of neighbors of the SOM map by using a set of single layer neural networks [13]. The training of the system consists of two phases: first, the SOM is trained with the input data set; second, all the single layer neural networks are trained using the weights of SOM. The goal here is to obtain a finite set of local models that represents the global dynamics of the data. However, this method uses alternative cost function with only first order approximation.

4.2 Proposed Training Algorithm

With the needs of unsupervised learning and clustering analysis to be incorporated with neural networks using supervised learning, the proposed method in this paper suggests using one level of SOM and one level with several Backpropagation MLP neural networks; therefore there is no need to eliminate non-terminal nodes as in the NNTree. Then by controlling the data sequences parsed through the subgroups of SOM neurons to MLP neural networks, local dynamic modeling can be achieved under the topological space created by SOM.

In other words, instead of using SOM to transform input data into low-dimensional data projection, the method proposed in this paper uses SOM as a sequence parser, passing groups of input vectors through the SOM neurons to the next layer of MLP networks. Figure 1 illustrates the concept of NeuroSequences.

The detail of parsing the input vectors through SOM is described as the follows. After the ordered map is created from SOM algorithm, subgroups of neurons can be formed according to its property of topological preservation. There are two steps in the process to form SOM subgroups, as described in the following:

1. Rank each SOM neuron with a measurement.
2. Form subgroups based upon that measurement with desirable sizes.

Assuming two subgroups on the SOM plane were formed, the input vectors X_t', which are associated to those neurons in one of the two subgroups, will be then identified and labeled as two partitions are created within the input space.

$$X_t' \rightarrow \begin{cases} G_{s1} & \text{if } \textit{neuron} \text{ in subgroup } 1\, \textit{wins} \\ G_{s2} & \text{if } \textit{neuron} \text{ in subgroup } 2\, \textit{wins} \end{cases} \tag{6}$$

The subgroups of input space, G_{s1} and G_{s2}, then are sent to MLP network 1 and MLP network 2 for processing, respectively.

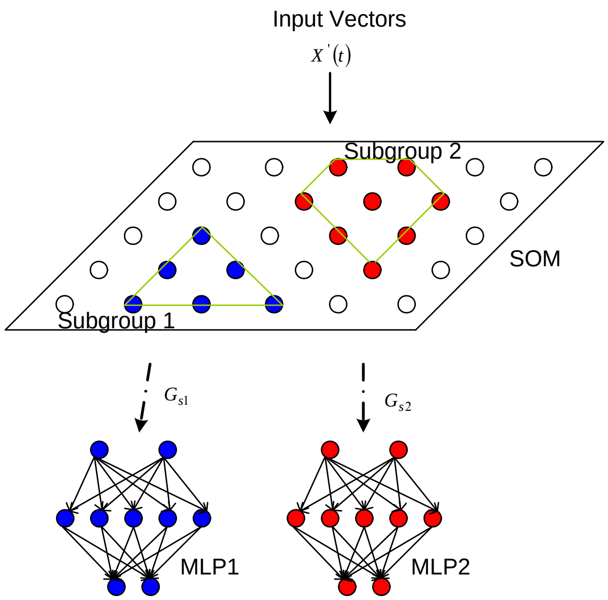

Figure 1. Concept of NeuroSequences

5 Impact of NeuroSequences

The architecture of the proposed method has produced the effects on minimizing the drawbacks of MLP neural networks with two schemes: One is the data exploration with SOM, and the other is controlling data flows. The impact for resampling unbalanced data is also discussed in this section.

5.1 Data Exploration and Visualization

It would be interesting to see how human brain solves complex problems. However, there is no reason to expect that a person can solve a complex problem by using same amount of time, same amount of resource, achieving same level of performance as solving a simple problem. It is almost safe to say that everyone will face difficulties for up scale problems. Still, complex problems need to be solved in the real world.

To conquer a difficult problem, the first thing one can do is to understand the data. Often the process of understanding data is achieved by plotting graphs and charts, and based upon that, our brains can then make decisions to solve the problem. In other words, data visualization has been considered an important way to understand data characteristics. If there is a mechanism for visualization of high-dimensional data, as SOM algorithm does, then we can apply the strategy of divide and conquer to solve complex problems when there is no known good method. This process can also be viewed in the concept of NeuroSequences of Figure 1

As we know that clustering analysis partitions a data set into subsets, as clusters, so that the data in each subset share some common characteristics, SOM can further form subgroups to preserve the input data topology by preserving the neighborhood relationships from the projection [14]. Therefore, the relationships between the SOM neurons can now be very useful for data exploration if the topographic error is minimized.

With this proposed method, the layer of data exploration using SOM is added to reduce the complexity of problem by performing clustering analysis and input space transformation. And since the complexity has been reduced, MLP neural networks can achieve the desired result with less training time, overfitting caused by training too long can be avoided here.

It has been an ultimate goal for many researchers to solve the problem of global minimum with advanced technologies. However, global minimum is not often seen in complex problems. Especially when population is changing, coding system is changing, and fee for service is changing everyday, it certainly is impossible to measure a global minimum without accounting for all the factors. For those problems that global minimum may exist, an advanced search method [17] can help Backpropagation getting out of most local minima and eventually it may reach the lowest point on the error surface. Before that happens, this proposed method could still be useful when solving problems that have more than one solution, i.e. constrain satisfaction. And most of operation research problems, including pattern recognition and member profiling, fit into this category.

5.2 Controlling Data Flows

If divide and conquer can help reduce the complexity of the problem, then controlling the data flow would help driving the solution to a specific direction. This direction here can be viewed as an operational point, which plays a similar role of a cost function. In fact, risk identification often requires careful balancing of sensitivity and specificity.

When we are choosing a point of operation, often we need to consider the resource we have, the penalty for misclassification, or even a desired goal set by management team. Therefore, even though we may show all the relationship between the rate of true positives and the rate of false positives in a ROC curve (Receiver Operating Characteristics) from a risk score system, practically we can only choose one or a few points for operation with the intention of meeting all the criteria I just described above.

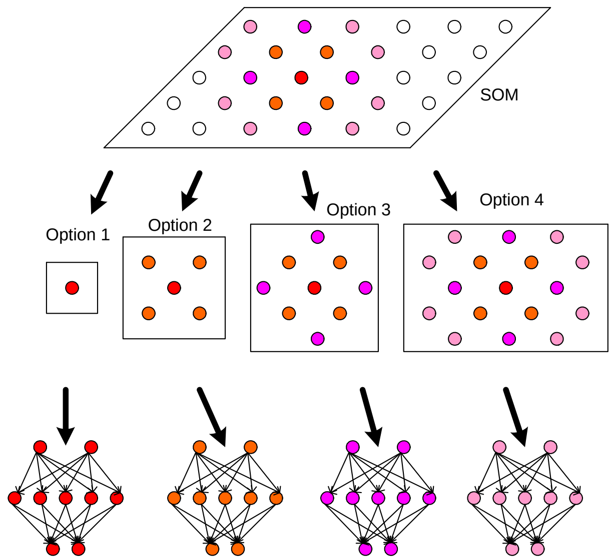

Figure 2. Examples of Controlling Data Flow

The method presented in this paper also includes a flexible mechanism to control the sizes of topological subgroups generated in SOM layer. Assuming the accuracy of a SOM neuron can be painted with 4 different colors. We can use RED color to identify the accuracy of a SOM neuron for 40% or above. ORANGE for 30%, PURPLE for 20%, PINK for 10%, and the rest is uncolored. In order to achieve the goal of operational point, there will be at least 4 choices to setup the SOM subgroup so that appropriate amount of members will be sent to the following MLP network. The examples of controlling data flows are illustrated in Figure 2. With this mechanism, we can approximate the result model to the neighborhood of specific target. Figure 3 shows three models of Neurosequences selection are located in different desired target ROC regions.

5.3 Unbalanced Data

Many traditional approaches to machine learning classification problem assume the target classes sharing the similar prior probabilities. With extreme unbalanced data, those approaches, including MLP neural networks, will certainly fail to create a predictive model if no remedy has been applied. There are several types of techniques that have been studied for this purpose.

Cost sensitive learning is one type of remedies that are used to solve the issue of unbalanced data. This method is intuitively to modify the classifier so that the learning takes place proportionally to the distribution of the classes. Furthermore, the cost or penalty for misclassification could be included in the cost sensitive learning. However, the cost is often difficult to be quantified and the classifier modified with input distribution will not be as useful in other domains.

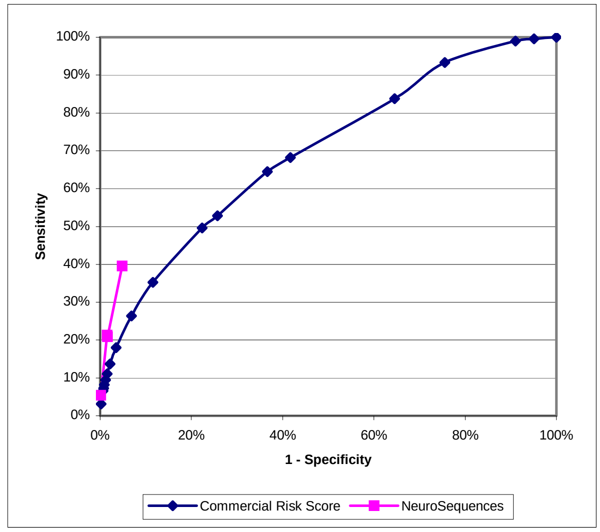

Figure 3. Different Operation Points in ROC curve for NeuroSequences

Resampling is another type of remedies that is not to modify the learning behavior of the classifier but to modify the distribution of the data. While oversampling is to increase the number of records of minority class, undersampling is to decrease the number of records of majority class. If training time and memory complexity are not the issues, oversampling has the advantage over undersampling because no information from data has been lost during the oversampling.

There are more techniques that could be added to resampling methods in a meaningful manner. Therefore, these techniques can normally perform better than random resampling. One of the techniques is to resample the data based on the number of records per cluster rather than just the number of records per class [15]. This guided resampling technique has been proved to perform better than blind resampling, and certain knowledge about the subcomponents for each class is required.

There are two advantages in the method presented in this paper regarding the need of resampling for extreme unbalanced data. First, with property of probability density matching in SOM, the feature map tends to overrepresent regions of low input density and underrepresent regions of high input density [16]. Second, when MLPs resample the data passed from SOM's neurons, it has similar benefit of resampling from clusters, with property of topology preserving in SOM.

6 Model Results for 3-Month Inpatient Risk

A population of 2.4-million Florida members is assessed to predict their future inpatient risk within the next three months. The outcome is designed to be binary. The analysis periods of claim history are set up as Figure 4. The prevalence for validation data is about 1.3%. There is no easy solution for such extreme unbalanced dataset. Even using resampling techniques, traditional MLP neural networks still can not create a robust and reliable model.

A model created by leading commercial health risk assessment software is used for comparison. This software uses Episode Treatment Groups (ETGs) as the fundamental building block for illness classification. However, the risk score from this model leads to too many false positives, as shown in Table 2.

With NeuroSequences, medical and pharmacy claims history of one year are summarized and grouped, according to ICD-9 diagnostic codes, CPT-4 procedure codes and NDC pharmacy codes, into a set of features. The standard inputs consist of 77 features. The most relevant features to the designed outcome are selected with a minimum criterion of R-square. For this dataset, 53 features are selected based upon equation (2).

After the number of input features is determined, the SOM map used in the simulations is then constructed with the dimensions of 8 columns by 12 rows, as shown in Figure 5. The result of SOM training can be painted with different colors on this two dimensional map. For examples, Red paint indicates the SOM neurons with accuracy of 15% or above. Purple for 10%, and Pink for 6%. For the purpose of controlling data flow, it is flexible to define the number and size of subgroups based upon the SOM topology. Figure 5 also illustrates the subgroups from the 15k model.

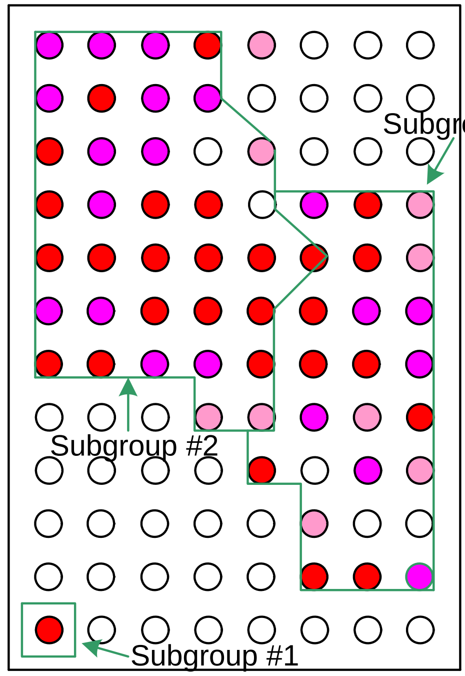

Figure 5. Example of SOM Topology

MLP networks are then trained with the subsets of the input data, as described in Figure 1 and equation (5). If the input data are excluded from the designed subsets, as associated with the white-color neurons or outside of all subgroups, then they will be filtered to be the default class. The MLP networks used in the simulations are Backpropagation MLP networks with adaptive learning factor. The number of hidden neurons is set to be 10, and the number of iterations is 500.

Table 1. The example of confusion matrix

		Target	
		True	*False*
Prediction	*True*	TP	FP
	False	FN	TN

The performance for a binary output is normally presented with a confusion matrix, as shown in Table 1. True positive (TP), false positive (FP), false negative (FN), and true negative (TN) are counted from the prediction. With this matrix, we can then calculate the sensitivity and positive predictive value (PPV) with the following formula:

$$Sensitivity = \frac{TP}{TP + FN}$$

$$PPV = \frac{TP}{TP + FP}$$

A predictive model normally wants to maximize these two measures. As described in Figure 3, NeuroSequences can create different models when targeting different operational points. The 5k model created by NeuroSequences in Table 2 is targeting to select 5,000 members who are likely to have an inpatient stay in the next three months. Table 2 also lists a 10k model and a 15k model. Figure 6 shows the bar chart for TP and FP from risk scores and simulations.

7. Conclusions and Further Discussion

This paper proposes a practical method to improve the performance of MLP neural networks on healthcare predictive modeling. By adding a layer of data exploration using SOM, the task of predictive modeling was transformed to less complexity with the concept of "divide and conquer". The impacts of this new method were discussed in Section 3 regarding to those drawbacks of traditional MLP neural networks.

Table 2. Comparison between NeuroSequences and Commercial Risk Score

Commercial Risk Score	**True Positives**	**False Positives**	**Total**	**Sensitivity**	**PPV**
> 13	1,748	9,099	10,847	5.31%	16.12%
> 14	1,619	8,124	9,743	4.92%	16.62%
> 15	1,531	7,346	8,877	4.65%	17.25%
> 16	1,416	6,679	8,095	4.30%	17.49%
> 17	1,302	6,121	7,423	3.96%	17.54%
> 18	1,213	5,582	6,795	3.69%	17.85%
> 19	1,143	5,116	6,259	3.47%	18.26%
> 20	1,081	4,695	5,776	3.29%	18.72%
> 21	1,019	4,356	5,375	3.10%	18.96%
> 22	973	4,042	5,015	2.96%	19.40%
Chen's model					
5k model	1,778	2,708	4,486	5.40%	39.63%
10k model	2,412	5,913	8,325	7.33%	28.97%
15k model	3,004	10,336	13,340	9.13%	22.52%

Besides the flexibility of approaching to a designed operational point, this method also maintains the property of computational simplicity from SOM and MLP. Also an advanced search method can help Backpropagation and MLP getting out of most local minima.

However, there are downsides, too. This method needs more training data to take the advantage of data exploration and followed with multiple MLP neural networks. This may seem to be critical to some applications, but often not an issue for healthcare predictive modeling and other complex problems.

Another issue is that global minimum may still be out of reach when the data can be trained with limited time only. But nevertheless, this proposed method could still be used for solving problems that can often allow more than one solution, i.e. constrain satisfaction. Fortunately, problems of pattern recognition and classification fit into this category.

Currently, SOM and MLPs are trained separately in this proposed method. And their performances are quite good compared to the current method used. But it would become better if further researches can focus on how to train SOM and MLPs at the same time.

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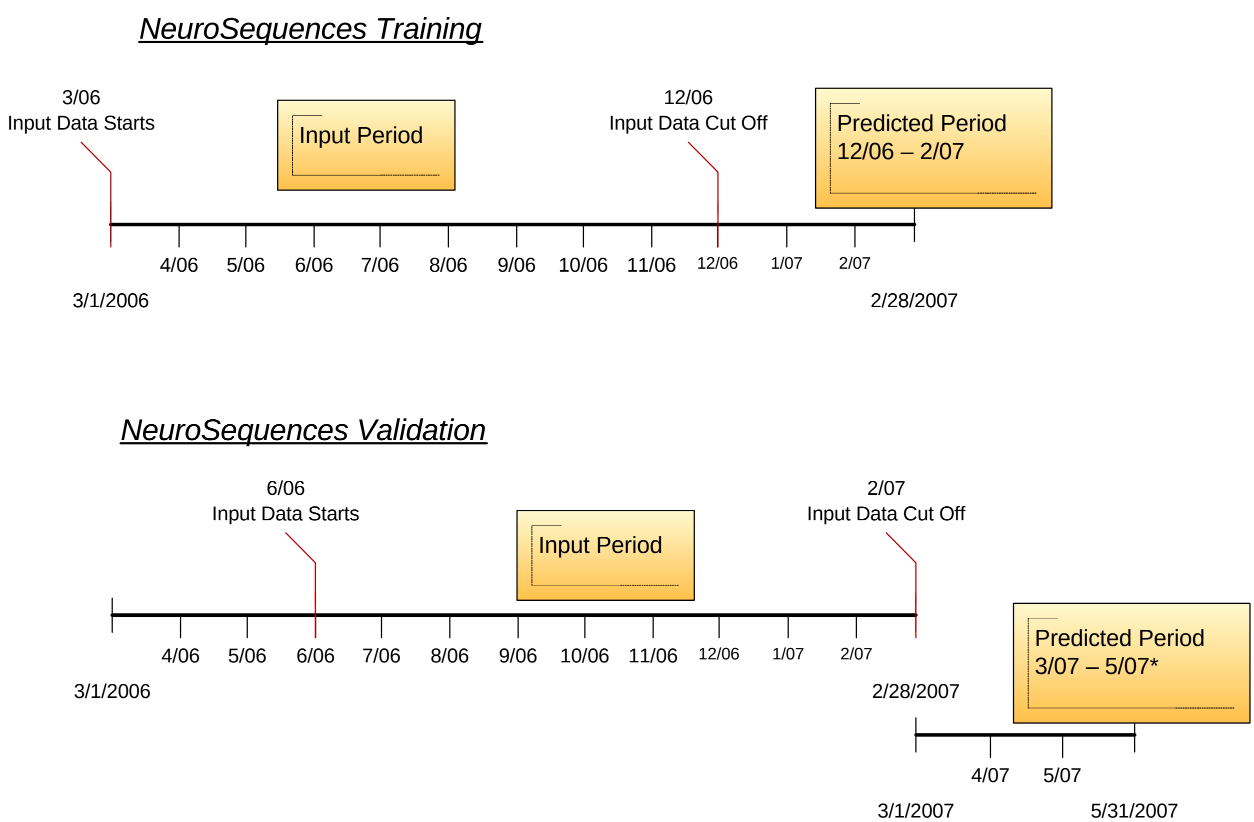

Figure 4. Timelines for Training and Validation

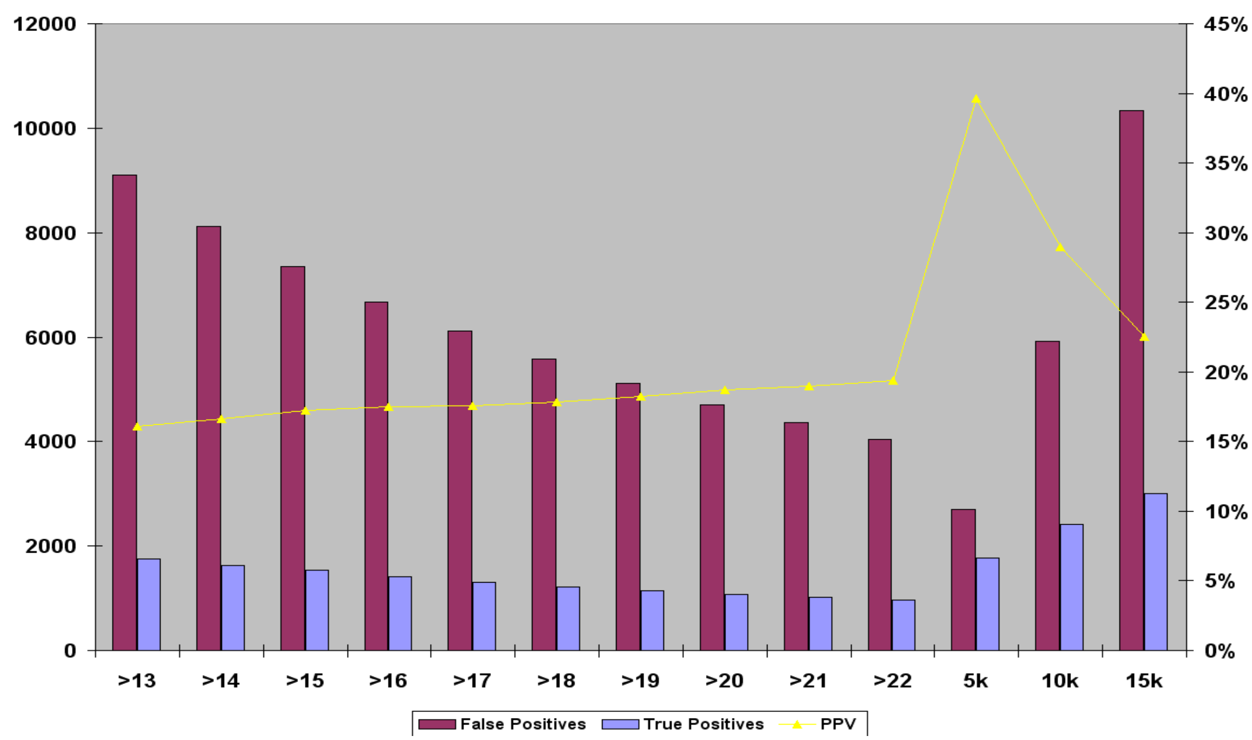

Figure 6. Bar Charts for TP and FP from Simulations

Projections of Education and Training Needs

Session Chair: Tom Snyder, National Center for Education Statistics

The National Center for Education Statistics Projections Program

William Hussar, National Center for Education Statistics

The U.S. Department of Education's National Center for Education Statistics (NCES) has been producing projections of education statistics since 1964. This presentation will examine the NCES projections program. Topics to be discussed in this presentation include: (1) the users of the NCES projections; (2); data sources used in developing the projections; (3) the different education statistics that are projected by NCES; (4) the different methodologies used in producing the projections; and (5) the accuracy of the NCES projections. Examples of the projections and measures of projections accuracy will be taken from the recently released Projections of Education Statistics to 2016.

Employment Related to Final Demand for Medical Care Services

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

This study examines employment related to personal consumption expenditures on medical care services. Using input-output methods developed by the Bureau of Labor Statistics, employment related to spending on medical care over the 1998 to 2006 period is compared with expected employment for 2016. The impact of changing patterns of consumption spending is examined, and occupational employment data for 2006 and 2016 are compared.

Education and Training Classification Systems

Ian D. Wyatt and Michael Wolf, Presented by Roger Moncarz and Olivia Crosby Bureau of Labor Statistics, U.S. Department of Labor

Learn which occupations will offer the best prospects for today's college graduates. The talk will focus on how changes in the technology, global competition and business practices are expected to reshape tomorrow's job market and how these changes will affect education and training needs.

Employment Related to Final Demand for Medical Care Services

Eric B. Figueroa
Bureau of Labor Statistics (BLS), Office of Occupational Statistics and Employment Projections (OOSEP)

The research contained in this paper reflects my research alone and is not the official view of OOSEP or the BLS.

Introduction

Over recent years, final demand for medical care services has grown strongly. From 1986 to 1996, and again from 1996 to 2006, this category of consumer spending grew faster than Gross Domestic Product (GDP) (see table 1). Strong growth is expected to continue over the 2006 to 2016 period according to projections prepared by the Office of Occupational Statistics and Employment Projections (OOSEP) of the Bureau of Labor Statistics (BLS). OOSEP projects final demand for medical care services to grow at an annual average rate of 3.7%, exceeding the 2.8% rate projected for GDP. As a result, spending on medical care services is projected to increase from \$1.3 trillion in 2006 to nearly \$1.9 trillion in 2016.

This paper estimates employment change expected to result from growth in projected consumer spending on medical care services. The analysis is based on the most recently published OOSEP employment projections for the 2006 to 2016 period[1]. This estimation is carried out using two sets of matrices developed as part of OOSEP's employment projections process. These are employment requirements matrices, which relate final spending to industry employment; and staffing patterns matrices, which relate industry employment to occupational employment. The use of these tables allows us to measure the impact of projected growth in demand for medical services upon industry employment and occupational employment.

This analysis finds that rapidly increasing spending on medical care services is projected to generate strong employment growth among industries within the Health care and social assistance sector. Within this sector, the industries projected to see the largest growth are Hospitals and Offices of health care practitioners.

The strong spending growth will also generate strong employment growth among several health-related occupations (see table 5). The largest projected employment growth resulting from this spending is among registered nurses. Increased spending on medical care services is also expected to generate strong job growth among home health aides; nursing aides, orderlies and attendants; personal and home care aides; and medical assistants.

Data

Historical data on final demand for medical care services are obtained from the Department of Commerce's Bureau of Economic Analysis (BEA) which publishes them as part of the National Income and Product Accounts (NIPA)[2]. Data on final demand for medical care services, are classified as part of personal consumption expenditures (PCE), and represent consumer spending on the following categories of medical care services:

professional services:	- physician services
	- dentist services
	- other professional services
hospital services:	- nonprofit hospital services
	- proprietary hospital services
	- government hospital services
nursing home services	
health insurance:	- medical care hospitalization
	- income loss
	- worker's compensation.

Final demand for medical care services excludes spending on goods. For example, consumer spending on healthcare-related goods such as drug preparations and ophthalmic products is excluded. Also excluded is business spending on healthcare-related goods, such as private fixed investment on medical equipment and instruments.

Limitations

There are several limitations to the methods used in this analysis. First, the employment requirements and the staffing patterns matrices were not designed to analyze employment impacts at this level of detail. Both matrices embody economy-wide relationships: employment requirements tables relate industry employment to aggregate GDP, and staffing patterns

[1] For further information on OOSEP's employment projections for the 2006 to 2016 period, including employment requirements and staffing pattern matrices, visit: http://www.bls.gov/emp/

[2] For more information on NIPA data, visit: http://www.bea.gov/

matrices relate total employment across all industries and occupations. It is not clear that the economy-wide relationships embedded in these tables hold when analyzing a specific piece of the economy, such as the subset of industries impacted by final demand for medical care services. In the absence of other tools however, it is assumed that the use of these tables is a reasonable method for estimating the impact of medical care spending on employment.

Another limiting assumption relates to adjustments for imports. In this analysis, measures of demand are adjusted at the commodity level to remove spending on imports. Import spending is removed because it generates employment abroad, not domestically. However, there are no data on import spending by final demand component. Therefore, it is assumed that a component's share of import-spending on a given commodity is proportional to its share of total spending. In the absence of such component-specific data, it is assumed that this approach provides a reasonable method of estimating spending on domestically produced commodities by demand component.

Factors Driving Medical Care Spending

Final demand for medical care services is driven by several factors. Improvements in medical technology have provided treatments and therapies that were previously unavailable, increasing the demand for services[3]. In addition, the increase in third party payments by private health insurers as well as Medicare and Medicaid, have also contributed to increasing demand.

Another factor increasing demand is the aging of the population. In 2006, the oldest members of the baby boom generation will turn 60. As this large segment of the population ages, the share of the elderly in the population is projected to increase. The elderly consume health care services more intensively than do other segments of the population; hence their increasing numbers is expected to drive increased spending on medical care services.

Medical Care Spending by Commodity

To project employment, OOSEP first develops an historical input-output time series, including final demand matrices[4]. The final demand matrices allocate final spending, along the columns, to spending on detailed commodities, along the rows[5]. Final spending on medical care services is allocated to three major commodity sectors: Financial Activities, Professional Business Services, and Health Care and Social Assistance.

At the detailed level, this spending falls within nine commodities. These are shown below, grouped by major sector. Also shown are their 2006 and 2016 values and resulting annual average growth rates:

Spending related to final demand for medical care services, by major sector and detailed commodity (billions of chained 2000 dollars):

Major sector and detailed commodity	2006	2016	2006-16 growth rate
Financial Activities:			
Insurance carriers	112.8	160.0	3.6
Consumer goods rental and general rental centers	2.4	3.2	2.9
Professional & Business Services:			
Specialized design services[6]	0.0	0.0	4.7
Health Care and Social Assistance:			
Offices of health practitioners	427.5	635.6	4.0
Home health care services	66.0	114.6	5.7
Outpatient, laboratory and other ambulatory care	117.5	171.0	3.8
Hospitals	487.0	667.0	3.2
Nursing care facilities	72.9	86.0	1.7
Residential care facilities	21.2	27.1	2.5

In both 2006 and 2016, over half the spending on medical care services is found within two commodities in the Health Care and Social Assistance sector: Hospitals and Offices of health practitioners. Large growth is expected in these commodities as medical advances and the aging population increase consumer demand for new services. The relatively faster growth in Offices of health care practitioners reflects an expectation that cost pressures will continue to shift the

[3] "The Long-Term Outlook for Health Care Spending," Congress of the United States. Congressional Budget Office (November 2007)

[4] OOSEP's input-output time series is based on benchmark input-output data published by BEA. For a description of BEA's input-output tables, visit: http://www.bea.gov

[5] This allocation is achieved using two inputs: final spending data from the BEA National Income and Product Accounts (NIPA) and commodity distributions for these spending data from BEA benchmark input-output tables.

[6] The only commodity spending found within the Professional and business sector, for specialized design services, was 26.0 million chain-weighted dollars in 2006. This amount rounds to zero when transformed to a billion dollar basis.

delivery of some services from expensive inpatient facilities to the offices of health practitioners.

The fastest growth in medical care spending on commodities is expected in Home health care services. Strong growth is expected due to the rising population of the elderly seeking home health services, and the relatively cheaper cost of providing some health related-services in a home setting as opposed to an inpatient facility.

Industry Employment Required to Satisfy Final Demand for Medical Care Spending

To estimate the industry employment generated by final demand for medical care services, OOSEP derives employment requirement tables[7]. For a given year, post-multiplying the employment requirements table by the vector of commodity final demand for medical care services yields an estimate of the employment generated by purchases of these services.

Most industry employment generated by final demand for medical care services is found within the service-providing sectors (see Table 2). The health care and social assistance sector had the largest such employment in 2006. As shown below, most employment within this sector is found in two detailed industries: Hospitals and Offices of Health Practitioners.

Employment generated in detailed industries within the Health care and social assistance sector by final demand for medical care services (employment in thousands):

Major sector and detailed Industry	2006	2016	2006-16 growth rate
Health care and social assistance sector:	12,117	14,828	2.0
Offices of health practitioners	3,755	4,579	2.0
Home health care services	914	1,456	4.8
Outpatient, laboratory and other ambulatory care	937	1,172	2.3
Hospitals	4,321	5,041	1.6
Nursing care facilities	1,556	1,737	1.1
Residential care facilities	625	831	2.9
Individual and family services[8]	0	1	8.1
Community, and vocational rehabilitation services	3	6	5.5
Child day care services	5	7	2.7

This concentration reflects the commodity spending patterns, discussed above, showing concentrated spending on services provided by Hospitals and Offices of health practitioners. As a result, Hospitals and Offices of health care practitioners are the detailed industries expected to see the largest employment growth related to final demand for medical care services. Hospitals are expected to add about 719,000 new jobs related to such spending; and Offices of health care practitioners is expected to add about 824,000 new jobs.

Large employment growth is expected as these industries seek to supply consumer demand driven by medical advances and the aging population. The relatively stronger growth in Offices of health care practitioners reflects an expectation that cost pressures will continue to shift the delivery of some services from expensive inpatient facilities to less expensive locations, such as doctors' offices.

The detailed industry projected to see the third-largest employment increase related to growth in final demand for medical care services is Home health care services. In addition, this industry is projected to have one of the fastest rates of industry employment growth. Strong employment growth is expected as establishments in this industry create new jobs to meet rising demand for home health care services. As discussed above, this demand is expected to be driven by an increasingly older population seeking delivery of health services in their homes. Such demand will be spurred, in part, by the relatively cheaper costs of providing some services at home as opposed to an inpatient facility.

Occupational Employment Required to Satisfy Final Demand for Medical Care Spending

To estimate the occupational employment generated by final demand for medical care services, OOSEP develops and projects a staffing patterns matrix. This matrix is principally based on data from the BLS Occupational Employment Statistics (OES) program, and relates industry employment to occupational employment. The staffing pattern matrix provides an occupational distribution of the employment found within each industry[9].

A base-year staffing pattern matrix was developed for 2006 using historical employment data. OOSEP analysts developed change factors which were applied

[7] For information on the OOSEP's employment requirements tables, visit: http://www.bls.gov/emp/empind4.htm

[8] In 2006, the estimate of employment generated by final demand for medical care services in the Individual and family services industry was less than 500. When adjusted to thousands, this figure rounds to zero.

[9] For information on OOSEP's staffing pattern matrix, refer to documentation for the National Employment at: http://www.bls.gov/emp/empocc2.htm

to the base-year distributions to yield projected distributions for 2016. Projected industry employment for 2016 was applied to the projected occupational distributions, yielding a projection of occupational employment for 2016.

In both 2006 and 2016, most occupational employment generated by final demand for medical care services is found within two major groups: Professional and related occupations and Services occupations (See table 3). The former, Professional and related occupations, will have the largest employment, expected to grow at a 2.2% rate from 2006 to 2016. Among detailed occupations within this group, the largest employment growth is expected for registered nurses (See table 4). Physicians and surgeons, also included in this group, are also expected to be among the top ten detailed occupations in terms of employment growth related to medical care spending.

Strong employment growth among registered nurses is projected due to several factors. Because nurses are expected to provide a cost-effective alternative to physicians and other higher wage occupations, their utilization is expected to increase among most industries. In addition, nursing employment in 2006 was concentrated in the hospital industry, which is expected to see large growth. Strong projected employment growth for hospitals, combined with increasing utilization, is driving the strong employment gains among registered nurses.

Strong growth in the employment of physicians and surgeons is expected due to increasing demand for the services offered by Offices of health practitioners, where these occupations are concentrated. Although nurses and physicians assistants will increasingly take over some responsibilities, this trend is not expected to offset the strong growth in demand for physicians and surgeons.

Services occupations are expected to have the second-largest employment related to medical care spending, among major occupational groups. Employment in this group is projected to grow at a 2.4% annual average rate over the 2006 to 2016 period (see table 4). This relatively strong employment growth reflects robust growth in several health care-related occupations, such as home health aides; nursing aides, orderlies, and attendants, personal and home care aides, and medical assistants.

Employment growth among home health aides and personal and home care aides is expected to be driven by strong growth in demand for home health care services. Establishments striving to meet the demands of an aging population of the delivery of health services in a home setting are expected to generate strong employment gains in these occupations.

Table 1. Final spending for selected categories, 1986, 1996, 2006, and projected 2016

Category	Billions of chained 2000 dollars				Average annual rate of change		
	1986	1996	2006	2016	1986-96	1996-2006	2006-16
Gross domestic product	$6,263.6	$8,328.9	$11,319.4	$14,875.2	2.9	3.1	2.8
Personal consumption expenditures	$4,228.9	$5,619.5	$8,044.1	$10,718.3	2.9	3.7	2.9
Motor vehicles and parts	256	285.3	437.3	640.5	1.1	4.4	3.9
Other durable goods	174.5	311.5	756.9	1387.0	6	9.3	6.2
Nondurable goods	1344.7	1680.4	2337.7	2745.8	2.3	3.4	1.6
Housing services	717.6	901.1	1148.3	1471.9	2.3	2.5	2.5
Medical services	669.9	922.5	1300.3	1866.3	3.3	3.5	3.7
Other services	1092.0	1533.9	2096.2	2815.4	3.5	3.2	3.0
Residual/1	-25.8	-15.3	-32.6	-208.6	...	...	...

1/ The residual is the difference between the first line and the sum of the most detailed lines.

SOURCE: Historical data, Bureau of Economic Analysis; projected data, Bureau of Labor Statistics.

Table 2. Employment related to consumer spending on medical care services, 1996, 2006, and projected 2016, by major industry sector (employment in thousands)

Category	Employment (thousands)			Percent of total employment			Change		Average annual rate of change	
	1996	2006	2016	1996	2006	2016	1996-2006	2006-2016	1996-2006	2006-2016
Total industry employment[1]	132,470	148,823	164,390	100.0	100.0	100.0	16,353	15,567	1.2	1.0
Employment related to PCE	85,071	95,703	105,875	64.2	64.3	64.4	10,632	10,172	1.2	1.0
Employment related to spending on Medical care services	16,398	19,662	23,756	12.4	13.2	14.5	3,264	4,093	1.8	1.9
By major industry sector:										
Goods Producing	786	604	549	0.6	0.4	0.3	-182	-55	-2.6	-0.9
Manufacturing	622	463	413	0.5	0.3	0.3	-158	-51	-2.9	-1.2
Other goods producing	164	141	137	0.1	0.1	0.1	-23	-4	-1.5	-0.3
Service producing	15,613	19,058	23,206	11.8	12.8	14.1	3,446	4,148	2.0	2.0
Utilities	30	24	20	0.0	0.0	0.0	-6	-4	-2.4	-1.7
Trade	341	276	272	0.3	0.2	0.2	-65	-4	-2.1	-0.2
Wholesale trade	187	180	167	0.1	0.1	0.1	-7	-13	-0.4	-0.7
Retail trade	154	97	105	0.1	0.1	0.1	-58	9	-4.6	0.9
Transportation & warehousing	206	224	249	0.2	0.2	0.2	18	25	0.8	1.1
Information	156	138	148	0.1	0.1	0.1	-18	10	-1.2	0.7
Financial activities	1,021	1,419	1,747	0.8	1.0	1.1	398	327	3.3	2.1
Professional & business services	1,631	2,027	2,363	1.2	1.4	1.4	397	336	2.2	1.5
Educational services	28	34	41	0.0	0.0	0.0	6	7	1.9	2.0
Health care & social assistance	9,880	12,117	14,828	7.5	8.1	9.0	2,237	2,711	2.1	2.0
Leisure and hospitality	378	415	580	0.3	0.3	0.4	37	165	0.9	3.4
Other services	112	105	110	0.1	0.1	0.1	-8	6	-0.7	0.5
Government	1,829	2,279	2,848	1.4	1.5	1.7	450	569	2.2	2.3

1 Excludes secondary employment

SOURCE: Bureau of Labor Statistics

Table 3. Occupational employment related to Personal Consumption Expenditures (PCE) and to final demand for medical care services, by major category (employment in thousands)

Major Occupational Category	Employment related to PCE		Average annual of change	Employment related to medical care services		Average annual of change
	2006	2016	2006-16	2006	2016	2006-16
Total, all occupations	96,909	107,131	1.0	19,798	23,902	1.9
Management, business, & financial occupations	9,170	10,103	1.0	1,584	1,887	1.8
Professional and related occupations	16,942	20,615	2.0	6,840	8,518	2.2
Service occupations	23,097	26,986	1.6	4,994	6,327	2.4
Sales and related occupations	12,749	13,310	0.4	656	764	1.5
Office and administrative support occupations	16,437	17,440	0.6	3,903	4,453	1.3
Farming, fishing, and forestry occupations	732	732	0.0	33	36	1.1
Construction and extraction occupations	2,045	2,201	0.7	305	340	1.1
Installation, maintenance, & repair occupations	3,581	3,860	0.8	345	392	1.3
Production occupations	5,768	5,390	-0.7	556	565	0.2
Transportation & material moving occupations	6,388	6,495	0.2	582	619	0.6

SOURCE: Bureau of Labor Statistics

Table 4. Ten occupations with the largest employment change related to final demand for medical care services, 2006 to 2016 (employment in thousands)

Occupation	Employment related to spending on Medical Care Services		Change	Average annual rate of change
	2006	2016	2006-16	2006-16
Registered nurses	1,795	2,298	503	2.5
Home health aides	448	647	199	3.7
Nursing aides, orderlies, and attendants	1,075	1,272	197	1.7
Personal and home care aides	274	434	160	4.7
Medical assistants	376	515	139	3.2
Office clerks, general	522	631	109	1.9
Customer service representatives	273	363	90	2.9
Receptionists and information clerks	397	483	87	2.0
Licensed practical & licensed vocational nurses	551	634	83	1.4
Physicians and surgeons	452	534	82	1.7

SOURCE: Bureau of Labor Statistics

Education and Training Classification Systems

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This paper is a modified version of a chapter published in the 2007-08 edition of the *Occupational Projections and Training Data*, a statistical and research supplement to the *Occupational Outlook Handbook*.

The Office of Occupational Statistics and Employment Projections of the Bureau of Labor Statistics (BLS) produces many types of information about education and training requirements. The *Occupational Outlook Handbook*, for example, gives detailed descriptions of the education and training requirements of occupations and occupational groups. Each of the 753 occupations for which the office publishes data are classified by education and training categories. This allows occupations to be grouped and allows for estimates of the education and training needs for the population as a whole and of the outlook for workers with various types of educational and training attainment.

The Bureau uses two classification systems to describe the education and training needs of occupations. This paper summarizes these two methods of classifying occupations and then analyzes the education and training needs of the future workforce based on the 2006-16 employment projections. The chapter concludes with a list of occupations that have above the median wages and above average employment growth, which are expected to provide good job prospects for workers at each level of educational attainment.[1]

The first system, begun in 1994, assigns occupations to a single education and training category, the one reflecting the most common path into the occupation. This classification is based on analysis by BLS economists.

The second system, introduced in 2004, assigns each occupation to an "educational attainment cluster" based on the educational attainment of current workers in the occupation. These two systems are complimentary and, together, create a more complete picture of occupational education and training requirements.

Eleven category system

BLS identifies 11 education and training categories that describe the most significant education and training pathway to employment for each occupation. A category is defined as the most significant source of education or training needed to become qualified in an occupation. The categories are as follows:

1. First professional degree
2. Doctoral degree
3. Master's degree
4. Bachelor's or higher degree, plus work experience
5. Bachelor's degree
6. Associate degree
7. Postsecondary vocational award
8. Work experience in a related occupation
9. Long-term on-the-job training
10. Moderate-term on-the-job training
11. Short-term on-the-job training

BLS economists assign each occupation to one of these categories based on their knowledge and judgment. Economists analyze data from BLS and other government and private organizations, and interviews with educators, employers, training experts, and experts in professional and trade associations, and unions. For some occupations, such as physician and lawyer, the education and training required is straightforward and established by government laws and regulations. For other occupations, such as computer programmer or industrial machinery repairer, entry requirements vary considerably. When an occupation has more than one path of entry, BLS identifies the path that research suggests is applicable to most current entrants**.**

This education and training classification system is simple and includes non-educational paths of entry, such as on-the-job training and work experience. Management occupations, for example, usually require years of experience working in a related job.

However, this classification system does not show the extent to which there are multiple paths of entry into an occupation. It also does not show that there may be multiple entry requirements: an occupation that requires on-the-job training, for example, might also require postsecondary education. For jobs requiring moderate or long-term on-the-job training, employers often try to hire individuals with at least some college education, or even a bachelor's degree, before making a large investment in their training.

[1] For a full listing of the education or training categories and education cluster assignments for all 753 detailed National Employment Matrix occupations, see chapter III of the Occupational Projections and Training Data, 2007-08 edition, available online at http://www.bls.gov/emp/optd/

Educational attainment cluster system

The educational attainment cluster system sorts occupations according to the highest level of educational attainment of current workers. It can be used to study the job outlook for college graduates or the outlook for workers with other levels of education. This system, unlike the first one, allows occupations to fall in to multiple educational attainment categories. These are identified as "mixture" occupations.

Occupations are grouped according to the percentage of workers who have a high school diploma or less, some college or an associate degree, or a college diploma (bachelor's degree) or higher. According to the percentage of workers falling into each of these three educational levels, the occupation is assigned to one of six hierarchical education clusters shown in table 1.[2]

If an education level represents the highest educational attainment of at least 20 percent of workers in an occupation, that education level is included in the education category of the occupation. For example, if more than 60 percent of workers have a high school diploma or less, less than 20 percent have some college or an associate degree, and less than 20 percent have a bachelor's or higher degree, that occupation is considered a high school (HS) occupation. However, if more than 20 percent have a high school degree or less, more than 20 percent have attended some college or held an associate degree, and less than 20 percent have a bachelor's or higher degree, the occupation is considered to be a high school/some college (HS/SC) occupation.

The key cutoff level for classifying occupations is set at 20 percent to help correct for workers in an occupation who have education levels well outside the norm. (See Appendix.)

When the cluster system was first developed for the 2002-12 projections, the Current Population Survey (CPS) was the source of educational attainment data. For the 2006-16 projections, the CPS was replaced as the source of educational attainment data by the American Community Survey (ACS). (For more information on this change, see the Appendix.)

The cluster system categorizes occupations on the basis of the educational attainment of 25- to 44-year-olds working in the occupation because these younger workers were assumed to better reflect current hiring practices than information on all workers would.

This system highlights the fact that there are often multiple pathways into an occupation. For example, according to 2005-06 ACS data, 51 percent of electricians aged 25 to 44 years have a high school diploma or less, whereas 42 percent have some college or an associate degree as their highest level of educational attainment. The education cluster system, which assigns electricians to the high school/some college (HS/SC) cluster, has the advantage of being able to capture this split. However, it has the disadvantage of being less able to address the role of training and skills acquired outside of college in career preparation. The 11 category classification system, which puts electricians into the long-term on-the-job training category, better addresses the skill requirements needed for a job.

Projecting education and training requirements

The two classification systems can be used to estimate the number of jobs that will fall into each education and training category. This provides information on the future training needs of the workforce. It can also provide an answer to the frequently asked question: "what is the outlook for college graduates?"

Projections by education and training category. Table 2 provides the current and projected employment distribution, and the projected numerical and percent change of jobs within the 11 education and training categories. It also lists the total number of job openings by education and training category that are expected over the 2006-16 decade. These openings are due to growth and the need to replace workers who permanently leave the occupation.[3]

As table 2 shows, short-term and moderate-term on-the-job training are by far the largest education and training categories. In 2006, 34.7 percent of all jobs were assigned to the short-term on-the-job training category and 18.1 percent were assigned to the moderate-term on-the-job training category meaning that these jobs can usually be learned in 1 year or less. Over the 2006-16 decade, 54.5 percent of total job openings fall into one of these two on-the-job training categories.

These two categories, however, make up a slightly smaller proportion of projected total jobs. Jobs requiring postsecondary awards and degrees make up a larger proportion of projected jobs, and jobs that

[2] Occupations falling in the high school and college (HS/C) category were included in the HS/SC/C cluster.

[3] For a discussion of the calculation of replacement needs, see chapter V of the 2007-08 edition of the Occupational Projections and Training Data Bulletin, available at http://www.bls.gov/emp/optd/optd005.pdf

primarily require a doctoral degree are expected to increase the fastest—but to generate relatively few new jobs. Most of these new jobs will stem from growth of postsecondary teachers. Occupations for which a bachelor's degree is the most significant source of education or training are expected to gain the largest share of employment over the 2006-16 decade—rising from 12.3 percent in 2006 to 13.0 percent in 2016.

Projections by educational attainment cluster. The cluster classification system also can be used to assess the future education requirements. The number of jobs in each of the six cluster categories can be projected, and these projections can be combined and modified to project the number of jobs to be filled by those with a high school diploma or less, those with some college, and those with a bachelor's or higher degree.

Employment projections by educational attainment cluster are presented in table 3. As shown only two clusters—some college/college occupations and college occupations—are expected to have an increasing proportion of jobs between 2006 and 2016. These two clusters will rise from 26.7 percent to 28.0 percent of all jobs during the decade, meaning that jobs usually filled by the most highly educated workers are expected to increase fastest over this period. Still, by far the highest proportion of jobs in both 2006 and 2016—47.4 percent and 46.5 percent, respectively—fall in to the high school/some college (HS/SC) cluster.

With modification, the six educational attainment clusters can serve as the basis for projecting the number of jobs that fall into three major educational attainment groups: workers with a high school degree or less, those with some college, and those with a bachelor's or higher degree. To arrive at the projection by these three broad educational attainment groups, the proportion of jobs *within* each of the six clusters that is filled by those with a high school diploma or less, some college, or a bachelor's or higher degree is determined. Projected employment change in an occupation is assigned to the three groups based on the education cluster assigned to the occupation. If the occupation is a high school (HS), some college (SC), or college (C) occupation, *all* jobs are projected to require this level of educational attainment. If the occupation is a "mixture occupation," that is, it is composed of two or three levels of educational attainment; projected jobs are distributed according to the existing ratio of workers who fall into the educational attainment groups comprising the cluster.

For example, for college (C) occupations (those with 60 percent or more of workers having a bachelor's or higher degree), it is assumed that all jobs in the occupation require a college degree. For a mixture occupation, such as some college/college (SC/C), it is assumed that *all* jobs in the cluster either require some college or a bachelor's or higher degree. To calculate the number of "some college" jobs in the occupation, analysts compute the ratio of the workers in that occupation who have some college to the workers who have some college or a bachelor's or higher degree. The number of "some college" jobs in the occupation is the value of this ratio multiplied by the employment level of the occupation. The procedure is applied to the other mixture occupations.

In this analysis, this technique was applied to data for 2006 and data for the projected 2006-16 decade.

The following tabulation summarizes how employment growth is assigned to the three educational attainment groups of high school or less (high school), some college (some college), and bachelor's or higher degree (college) in the education cluster classification system.

Exhibit 1. Projecting jobs by educational attainment group

Education cluster	Proportion of projected jobs assigned to three educational attainment groups
HS	All projected jobs are considered "high school" jobs
HS/SC	Projected jobs are assigned to "high school" or "some college" based on the actual 2006 proportion of workers in the cluster with a high school degree or less and the proportion with some college
SC	All projected jobs are considered "some college" jobs
HS/SC/C	Projected jobs are assigned to all three groups based on the actual 2006 proportion of workers in the cluster with each level of educational attainment
SC/C	Projected jobs are assigned to "some college" or "college" based on the actual 2006 proportion of workers in the cluster with some college and the proportion with a college or higher degree
C	All projected jobs are considered college jobs
HS/C	Projected jobs are treated the same as HS/SC/C jobs

What does this assignment method reveal about the projections of employment by educational attainment over the 2006-16 decade? As Table 4 shows, the projected change in employment for each of the 753 detailed occupations was assigned to the three educational attainment groups (high school or less, some college, and bachelor's or higher degree). Among these three groups, jobs projected to be filled by workers with a high school degree or less will account for the largest share, 43.0 percent, of all jobs in 2016. However, the jobs expected to be filled by those with a bachelor's or higher degree are expected to grow fastest at 14.8 percent.

Taking growth and replacement needs into consideration, a greater proportion of total job openings are projected to be filled by workers with at least some college rather than by those with a high school degree or less. An estimated 57.3 percent of job openings are expected to be filled by those with some college or a bachelor's or higher degree, whereas 42.7 percent of jobs are expected to be filled by those with only a high school degree or less. This figure is most likely an underestimate because the method for assigning projected employment to educational category assumes no upgrading of educational requirements for occupations over the projection decade.

Results and applications of the two classification systems

Combining the two classification systems—the 11 education and training categories and the 6 educational attainment clusters—uses the strengths of each system to provide further insight into the education and training requirements of jobs. For example, both stonemasons and maids and housekeeping cleaners are high school (HS) occupations under the cluster system. According to the 11 category system, however, stonemasons usually need long-term on-the-job training, whereas maids and housekeeping cleaners usually need short-term on-the-job training. Their respective earnings reflect, in part, the differences in training requirements; stonemasons' median annual wages of $35,960 in May 2006 were more than double the $17,580 median annual wages of maids and housekeeping cleaners. Similar differences exist within each education and training category.

Similarly, both stonemasons and police and sheriff's patrol officers usually need long-term on-the-job training. However, their educational attainment is quite different. Eighty-two percent of stonemasons have a high school diploma or less, whereas 85 percent of police and sheriff's patrol officers have attended some college or have completed college. Compared with stonemasons' median annual wages of $35,960 in May 2006, police and sheriff's patrol officers' median annual wages in May 2006 were $47,460. Again, the respective earnings in each of these two occupations reflect, in part, differences in educational attainment.

Appendix:
The educational attainment distribution of occupations: A note on methodology

Since 2004, the Office of Occupational Statistics and Employment Projections has estimated the educational attainment distribution of employed 25- to 44-year-olds for each of the detailed National Employment Matrix occupations. For the 2002-12 and 2004-14 employment projections, the Current Population Survey (CPS) was the source of these data. Because of the size of the CPS survey, 3 to 5 years of data had to be combined for many of the occupations in order to meet BLS criteria for publication and statistical significance. Other occupations had to be estimated by proxy. For more information on how the CPS was used to derive educational attainment data by occupation see chapter I, *Occupational Projections and Training Data*, bulletin 2602.

Beginning with the 2006-16 employment projections, the American Community Survey (ACS) replaces the CPS as the source of educational attainment data by occupation. This relatively new Census Bureau survey is designed to replace the long-form version of the decennial census. This survey is based on a much larger sample of workers compared to the CPS, and thus provides greater accuracy in the assignment of educational attainment data to individual occupations. The ACS surveys about 3 million households annually, collecting demographic and employment information. The data developed for educational attainment were based upon the public microdata file, which includes about 1.5 million households or about half of the original sample. Two years of public microdata, 2005 and 2006, were used. With 2 years of data, the total sample includes about 3 million households, a substantially larger sample than was used in prior analyses.[4]

Occupational information in the ACS is classified under a taxonomy that, while consistent with the 2000 Standard Occupational Classification (SOC) system, does not provide the same level of occupational detail as the National Employment Matrix. The ACS occupational classification includes 502 occupations but only publishes data for 465 occupations. The 2006-16 National Employment Matrix published projections for 753 detailed SOC-consistent occupations.
The ACS reduced 502 occupations to 465 occupations to maintain respondent confidentiality; the ACS does not publish microdata for occupations with a weighted estimated employment of less than 10,000. Instead, the ACS merged those occupations with related occupations to create a total of 465 occupations. Details of the occupational coding and of how these merged occupations were created can be found at the U.S. Census Web site:
http://www.census.gov/acs/www/Products/PUMS/C2SS/CodeList/2005/Occupation.htm.

Because the ACS includes fewer occupations than the National Employment Matrix, proxy data was used for some Matrix occupations. For example, marketing and sales managers are a single occupation in the ACS, but are two distinct occupations in the Matrix. Since the ACS does not distinguish between the two occupations, the same levels of educational attainment were assigned to both occupations.

Switching to the ACS also led to a change in the methodology for suppressing unreliable data. Previously with the CPS, all data were suppressed for an occupation if the weighted employment in the occupation fell under 10,000. If data were suppressed, they were replaced by one of several substitute data sources.

With the ACS, individual cells (for example, the percent of college graduates in a particular occupation) were suppressed rather than all data for that occupation. Instead of using alternate data sources, cells were simply suppressed. Thus, all of the data for this classification came from a single, uniform data source. Suppression decisions were made based upon the standard error relative to the estimated value of the cell.

As mentioned above, BLS analysts combined ACS data from 2005 and 2006 to create publishable estimates of educational attainment. With a 2-year sample, the standard error of every estimated value was calculated. For the 465 detailed ACS occupations, the standard error was calculated for the percent of workers with a high school degree or less in that occupation (HS), the percent with some college or an associate degree (SC), and the percent with a college degree or higher degree (C). With 465 occupations having 3 cells each (HS, SC, and C), there were 1,395 (465 x 3=1,395) estimated values. Only 118 of those 1,395 values were not published because the standard error values were too high. In all cases, the suppressed estimated value (the percent of workers in an occupation) was below the 20 percent level of significance for the classification systems.

In the unpublished data, one standard error exceeded 50 percent of the estimated value. For example, if 10 percent of workers in an occupation were estimated to

[4] While preparing the educational attainment data for this edition of OPTD, results from the CPS and ACS were compared. The two surveys produced very similar results, and few occupations would have fallen into a different educational attainment category if the CPS had been used instead of the ACS.

have a college degree, then the data were not published if the standard error was greater than 5 percent.

Another part of the methodology for the education clusters was the determination that if fewer than 20 percent of workers in an occupation had a given level of education, that level should be ignored. Deciding on the 20-percent cutoff point required extensive research. When the education cluster system was first developed and preliminary results were examined, three cutoff points were proposed—15 percent, 20 percent, and 25 percent.

The first step in determining which level of significance to use involved studying the occupations that changed their education cluster when the cutoff point was changed. Of the occupations that changed categories, most did so between the 15 percent and 20 percent cutoff points. Far fewer occupations shifted categories between the 20 percent and 25 percent cutoff points. As the cutoff point increased, the number of occupations in mixture clusters—for example, high school/some college (HS/SC) compared to high school (HS)—decreased.

Moreover, an examination of the data suggested that the 20 percent cutoff level provided the most logical and reasonable cluster assignment for occupations with well-defined training paths. This examination of data also relied on the occupational expertise of analysts who develop employment projections and related information for the *Occupational Outlook Handbook* and other OOSEP publications.

Table 1. Definitions of education clusters			
Education cluster	**Percent of employees aged 25 to 44 in the occupation whose highest level of educational attainment is—**		
	High school or less	**Some college (including associate degree)**	**Bachelor's or higher degree**
High school (HS)	Greater than or equal to 60 percent	Less than 20 percent	Less than 20 percent
High school/some college (HS/SC)	Greater than or equal to 20 percent	Greater than or equal to 20 percent	Less than 20 percent
Some college (SC)	Less than 20 percent	Greater than or equal to 60 percent	Less than 20 percent
High school/some college/ college (HS/SC/C)	Greater than or equal to 20 percent	Greater than or equal to 20 percent	Greater than or equal to 20 percent
Some college/ college (SC/C)	Less than 20 percent	Greater than or equal to 20 percent	Greater than or equal to 20 percent
College (C)	Less than 20 percent	Less than 20 percent	Greater than or equal to 60 percent

Table 2. Employment and total job openings by education and training category, 2006 and projected 2016
(Numbers in thousands)

Most significant source of education and training	Employment				2006-16 change		Total job openings due to growth and net replacement needs, 2006-16[1]	
	Number		Percent distribution					
	2006	2016	2006	2016	Number	Percent	Number	Percent distribution
Total, all occupations	150,620	166,220	100.0	100.0	15,600	10.4	50,732	100.0
'First professional degree	1,970	2,247	1.3	1.4	277	14.0	638	1.3
'Doctoral degree	2,025	2,462	1.3	1.5	437	21.6	793	1.6
'Master's degree	2,167	2,575	1.4	1.5	409	18.9	819	1.6
'Bachelor's or higher degree, plus work experience	6,524	7,117	4.3	4.3	592	9.1	2,008	4.0
'Bachelor's degree	18,585	21,659	12.3	13.0	3,074	16.5	6,706	13.2
'Associate degree	5,812	6,899	3.9	4.2	1,087	18.7	2,240	4.4
'Postsecondary vocational award	7,901	8,973	5.2	5.4	1,072	13.6	2,491	4.9
'Work experience in a related occupation	14,579	15,889	9.7	9.6	1,310	9.0	4,126	8.1
'Long-term on-the-job training	11,489	12,200	7.6	7.3	711	6.2	3,272	6.5
Moderate-term on-the-job training	27,230	29,248	18.1	17.6	2,018	7.4	7,516	14.8
'Short-term on-the-job training	52,339	56,951	34.7	34.3	4,613	8.8	20,123	39.7

[1] Total job openings represent the sum of employment increases and net replacements. If employment change is negative, job openings due to growth are zero and total job openings equal net replacements.
NOTE: Detail may not equal total or 100 percent due to rounding.

Table 3. Employment and total job openings, 2006-16 by six education clusters
(Numbers in thousands)

Education cluster	Employment				Change			Total job openings due to growth and net replacements, 2006-16[1]	
	Number		Percent distribution		Number	Percent distribution	Percent		
	2006	2016	2006	2016				Number	Percent distribution
Total	150,620	166,220	100.0	100.0	15,600	100.0	10.4	50,732	100.0
High school occupations	16,959	18,115	11.3	10.9	1,155	7.4	6.8	5,511	10.9
High school/some college occupations	71,343	77,296	47.4	46.5	5,953	38.2	8.3	23,077	45.5
Some college occupations	287	340	.2	.2	53	.3	18.4	97	.2
High school/some college/college occupations	21,883	24,003	14.5	14.4	2,120	13.6	9.7	7,710	15.2
Some college/ college occupations	22,137	25,450	14.7	15.3	3,313	21.2	15.0	7,749	15.3
College occupations	18,011	21,017	12.0	12.6	3,006	19.3	16.7	6,587	13.0

[1] Total job openings represent the sum of employment increases and net replacements. If employment change is negative, job openings due to growth are zero and total job openings equal net replacements.

NOTE: Detail may not equal total or 100 percent due to rounding.

Table 4. Employment and total job openings by three education clusters, 2006 and projected 2016

(Numbers in thousands)

Education cluster	Employment				Change			Total job openings due to growth and net replacements, 2006-16[1]	
	Number		Percent distribution		Number	Percent distribution	Percent		
	2006	2016 2	006 2	016				Number	Percent distribution
Total	150,620	166,220 1	0 0.0 1	0 0.0	15,600	100.0	10.4	50,732 1	0 0.0
High school graduate or less	66,365	71,484 4	4.1 4	3.0	5,119	32.8	7.7	21,656 4	2. 7
Some college	46,229	51,074 3	0.7 3	0.7	4,845	31.1 1	0.5	15,534 3	0. 6
Bachelor's degee or higher	38,026	43,663 2	5.2 2	6.3	5,637	36.1 1	4.8	13,542 2	6. 7

[1] Total job openings represent the sum of employment increases and net replacements. If employment change is negative, job openings due to growth are zero and total job openings equal net replacements.

NOTE: Detail may not equal total or 100 percent due to rounding.

Concurrent Sessions II

Special Topics in Forecasting

Session Chair: Jeff Busse, U.S. Geological Survey

Proxies, Price Measures, and the Prospective Payment Systems: Forecasting Inflationary Price Measures for Medicare

Benjamin Porter, CMS OACT Market Basket Team and Global Insight Market Basket Team

Through an assortment of prospective payment systems (PPS), Medicare purchases annually over $270 billion in health care goods and services. The Centers for Medicare and Medicaid Services (CMS) develops the statutorily-required input price indexes that provide the foundation for yearly updates to those PPS payments. These indexes, or market baskets, are intended to solely measure the inflationary price pressures that face Medicare providers in efficient markets. This analysis examines the construction of the market basket input cost categories, the calculation of their respective cost shares, and the modeling techniques used to forecast the various price proxies assigned to those categories.

Evaluating Census Forecasts

Herman Stekler, The George Washington University

The Census Bureau makes periodic long-term forecasts of both the total US population and the population of each of the states. Previous evaluations of these forecasts were based on the *magnitude* of the discrepancies between the projected and actual population figures. However, it might be inappropriate to evaluate these long-term projections with the specific quantitative statistics that have been useful in judging short-term forecasts. One of the purposes of a long range projection of each state's population is to provide a picture of the distribution of the aggregate US population among the various states. Thus the evaluation should compare the projected distribution of the total US population by states to the actual distribution. This paper uses the dissimilarity index to evaluate the accuracy of the Census projected percentage distributions of population by states.

The Relationship between Oil Markets and Shipping Tanker Rates:
Forecasting Spot Tanker Prices for the West African-U.S. Gulf of Mexico Market

Angela Poulakidas, Queensborough Community College and Fred Joutz, The George Washington University

We investigate a dynamic model explaining spot tanker rates. The West African-U.S Gulf Tanker Rates, West Texas Intermediate spot and 3 month futures contract, and U.S Weekly Petroleum Inventories are analyzed using cointegration and Granger causality analysis, from 1997 through 2007, in order to examine the lead-lag relationship between oil prices and tanker freight rates. We find a significant relationship between spot and future crude oil prices, crude oil inventories and tanker rates. The significant increase of freight rates, and the simultaneous increase in oil prices, during the recent years, provides an intriguing economic environment to identify relationships between shipping market rates and oil prices. These relationships have significant implications for the markets. At the practical level forecasts may provide greater understanding of the relationships and improve operational management and budget planning decisions. We conclude with a simple dynamic forecasting exercise at the 1-week ahead and 4-week ahead horizons.

Forecasting Interments and Gravesites in VA National Cemeteries

Kathleen Sorensen, U.S. Department of Veterans Affairs, National Cemetery Administration

The U.S. Federal Government has a commitment to veterans to provide them with certain benefits including burial in a national cemetery. In fiscal year 2007, more than 100,000 veterans and their dependents were buried in national

cemeteries. Forecasting future demand for burial sites in existing national cemeteries and estimating depletion dates of available sites in developed and undeveloped cemetery land is an essential planning tool. This paper presents a new model that uses projected veteran deaths by county, ratio correlation and perpetual inventory methods to meet the needs of budget and policy analysts.

Proxies, Price Measures, and the Prospective Payment Systems: Forecasting Inflationary Price Measures for Medicare

Benjamin Porter
Centers for Medicaid & Medicare Services OACT Market Basket Team and
Global Insight Market Basket Team

Overview

The Centers for Medicare and Medicaid Services (CMS) annually makes over $275 billion in payments to fee-for-service (FFS) providers for care delivered to Medicare beneficiaries.[1] The vast majority of these purchases (approximately 85 percent) are paid for based on a prospective payment system (PPS).[2] CMS develops the statutorily-required input price indexes that provide the foundation for yearly updates to these PPS payments. The indexes, or market baskets, are intended to measure and project the inflationary price pressures that face Medicare providers. The following analysis examines the construction of the market basket input cost categories, the calculation of their respective cost shares, and the modeling techniques used to forecast the various price proxies assigned to those categories.

Background

From the advent of the Medicare program to the early 1980s, the Health Care Financing Administration (HCFA; now CMS) reimbursed health care providers for the goods and services they delivered to Medicare beneficiaries on a cost-basis. Providers completed reports detailing their services and associated costs, and Medicare compensated them on the basis of these reports. Starting in the 1970s, rapidly rising hospital expenditures led to increased pressure on Medicare officials to develop a payment method that promoted greater efficiency on the part of providers. In October 1983, HCFA began paying for hospital services on a prospective basis.[3] Over the years, Medicare has since instituted additional prospective payment systems (such as the skilled nursing PPS and the Home Health Agency PPS, etc.) to pay for various types of care received by its 44 million beneficiaries[4].

Under Medicare's various prospective payment systems, base payment rates are established for each provider type and remain in effect for a fixed period (usually one year). On an annual basis, the base rates are updated to reflect price inflation, as measured by the corresponding market baskets. The actual payments to providers begin with the base rate and may undergo adjustment to address various exogenous factors such as outliers, case-mix, uncompensated care, and geographic differences.

Input Price Indexes

The input price indexes used to update PPS payments are fixed-weight, Laspeyres-type price indexes and are intended to measure pure price change. They are not intended to reflect cost changes that would be inclusive of variations in the quantity or intensity of goods and services delivered subsequent to the base period.

The indexes are designed as normative input price indices. That is, they are based on weights that reflect the input mix actually observed in the given health sector, but with price proxies taken from the economy as a whole (where competitive pressures enforce efficiency in both costs and prices). Each of these indexes represents an approximation of what health care price changes would be if demand and supply were determined in efficient markets.

Currently, Medicare uses PPS-based systems to pay acute inpatient hospitals, outpatient hospitals, inpatient psychiatric facilities, inpatient rehabilitation facilities, long-term care hospitals, home health agencies, hospice facilities, and skilled nursing facilities. Physician payments are handled somewhat differently. Rate setting for the Medicare Physician Fee Schedule is based on the sustainable growth rate (SGR) formula. However, one market basket, the Medicare economic index (MEI) which measures the input price pressures

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[1] MedPAC Data Book 2006: Section 1 National Health Care and Medicare Spending. Chart 1-12: Medicare FFS providers: Number and spending.

[2] The remaining 15% of estimated FFS spending is paid to clinical labs, durable medical equipment, and ambulatory surgical centers that are separately reimbursed.

[3] Freeland, Mark S., Anderson, Gerard, and Schendler, Carol Ellen, "National Input Price Index", Health Care Financing Review, (Summer 1979).

[4] 2007 CMS Data Compendium, http://www.cms.hhs.gov/DataCompendium/17_2007_Data_Compendium.asp#TopOfPage

faced by physicians, is incorporated into the final update.

The Office of the Actuary (OACT) is the component within CMS that develops the input price indexes. OACT is responsible for determining the relevant cost components for each market basket while Global Insight, Incorporated (GII), a nationally-recognized economic and financial forecasting firm, contracts with CMS to produce the 10-year price forecasts for each of the individual price proxies assigned to the various cost categories.

The Office of the Actuary is responsible for five major market baskets: inpatient hospital (IPPS) (2002=100)[5], rehabilitation-psychiatric-long-term care (RPL) (2002=100), home health (HHA) (2003=100), skilled nursing facilities (SNF) (2004=100), and the Medicare economic index (MEI) (2000=100).[6] Depending on the provider type, payments are made on either a fiscal year (FY) October 1st – September 30th, calendar year (CY) January 1st – December 31st, or a rate year (RY) July 1st – June 30th basis. Table 1 shows estimates of 2006 FFS Medicare expenditures paid to providers.[7]

Building an Input Price Index

Each market basket has between four and five major components: compensation, utilities, professional liability insurance, all other products and services, and capital costs.[8] Each cost share of a given market basket is calculated by estimating total base-period expenditures for a set of mutually exclusive and exhaustive spending categories for each provider type. The cost share is simply the proportion of total costs that each category represents. The main source of data used to determine the cost shares is the Medicare cost reports (MCR), which providers are legally required to file annually.[9] CMS supplements the MCR data with data from the Bureau of Economic Analysis' (BEA) benchmark Input-Output (I-O) tables, which are adjusted to reflect base-year dollars. Unlike other providers, physicians are not required to file a MCR. Consequently, CMS relies on data from a survey conducted by the American Medical Association (AMA) to obtain the cost shares for the practice expense portion of the MEI.

The composition of each input price index is constructed based on the specific inputs required of each type of service. For example, the HHA market basket includes a cost category for transportation services which is neither applicable nor included in any of the other market baskets.

Table 2 summarizes the major component cost shares of each market basket. In general, compensation costs tend to account for the majority of the total costs, irrespective of provider type. Table 3 shows how the underlying detail of the major cost components can be broken out using the IPPS market basket as an example.

After CMS has designed the structure of each market basket, the most technically appropriate price or wage series (which CMS refers to as a price proxy) is matched to each cost category. With the exception of the Professional Liability proxy and the capital expenditure proxies, all CMS market basket price proxies are based on producer price indexes (PPIs), consumer price indexes (CPIs), or employment cost indexes (ECIs), which are estimated and published by the Bureau of Labor Statistics (BLS).

CMS evaluates each price proxy using various criteria including reliability, timeliness, availability, and relevance. Reliability indicates that the index is based on valid statistical methods and has low sampling variability. Timeliness relates to a proxy being published regularly, preferably once a quarter. Availability means that the proxy is publicly-available. Finally, relevance means that the proxy is applicable and representative of the cost category to which it is applied.

The final PPS payment update factor (as measured by the four-quarter percent change moving average (PCHMA) in the respective market basket) represents the projected price inflation for the upcoming payment year and is published in the Federal Register at least 60 days prior to its implementation.[10]

[5] Where (2002=100) means the current base year is equal to 2002.
[6] The IPPS market basket also provides the basis for updates to the hospice and outpatient PPS payments.
[7] Based on 2006 estimates from the Medicare Economic Payment Advisory Commission (MedPAC). Payments under the Medicare Advantage and Part D plans are not included.
[8] PPS payments to hospitals are comprised of two components; one payment is for operating costs while the other is for capital costs. The construction of the hospital capital input price index is somewhat different than those discussed here and is, thus, omitted. For more information on the hospital capital input price index, contact Mary Kate Catlin (Mary.Catlin@cms.hhs.gov).
[9] Under § 413.20(a), all providers participating in the Medicare program are required to maintain sufficient financial records and statistical data for proper determination of costs payable under the program. In addition, providers must use standardized definitions and follow accounting, statistical, and reporting practices that are widely accepted in the health care industry and related fields. Under § 413.20(b) and § 413.24(f), providers are required to submit cost reports annually, with the reporting period based on the provider's accounting year. Additionally, under § 412.52, all hospitals participating in the prospective payment system must meet cost reporting requirements set forth at § 413.20 and § 413.24
[10] Unlike the other PPS payment updates, the MEI is based on historical price growth.

The Four-Quarter Percent Change Moving Average

To better understand the methodologies and applications employed in creating the market baskets, it is important to understand the underlying PCHMA transformation. Rather than rely on a point-in-time estimate of a single projected quarter for the PPS payment update factor, CMS uses a transformation that captures the PCHMA of the market basket. This transformation takes into account the current quarter and the preceding seven quarters, which smoothes out seasonal variation, and is defined as follows in Equation 1 below:

Equation 1: PCHMA

$$\%ChangeMovAvg_t = \left[\left(\frac{Average(X_t, X_{t-1}, X_{t-2}, X_{t-3})}{Average(X_{t-4}, X_{t-5}, X_{t-6}, X_{t-7})}\right) - 1\right] * 100$$

While the PCHMA does have the benefit of reducing volatility, it adds a layer of complexity to interpreting changes in the forecast. For example, an increase in growth in one quarter of a series remains in the PCHMA calculation for a total of eight quarters. For the first four quarters after the increase, the PCHMA is higher due to the increase being in the numerator of the calculation. The PCHMA for the next four quarters shows the same magnitude of change, but as a decrease in growth for the series. This decrease occurs due to the one-quarter increase now being included in the denominator of the PCHMA calculation. Chart 1 in the appendix shows the effects of a 1% increase in growth in one quarter on the PCHMA calculation. This "extending" phenomenon, where a shock or shift in growth rates is distributed across 2 years, makes it necessary to dig deeper when analyzing changes in the forecast and can complicate one's understanding of how shocks will impact the market baskets.

The remainder of this paper will discuss the general modeling approaches GII uses to forecast the price indexes, and the importance of accuracy in forecasting market baskets for Medicare payments.

Price Forecasting Methodology

GII provides the forecasts of the price proxies for CMS, which are then weighted and summed to form a market basket. Conceptually, prices are determined by their input costs on the supply side and market activity on the demand side. Thus, each price model has two major components, the cost term and the market term. Costs are expected to be the primary determinant of prices, while market activity explains deviations from the cost path, as shown in Chart 2 of the appendix. For pricing models, as shown in Equation 2 below, GII estimates the forecasting equations using ordinary least squares with the models specified in percent change functional form.

Equation 2: Generalized Pricing Model

$$\%(PRICE_t) = b_0 + b_1\%(COST_t) + b_2(MARKET_t)$$

Price Forecasting Methodology: Cost Term

Since every industry and product is unique, GII projects prices from a microeconomic perspective. That is, GII uses a stages-of-processing approach where pricing models are constructed to reflect how they relate to one another in the supply chain. By structuring the projection in this manner, the flow of costs can be tracked through the production process, facilitating a transparent structural analysis to the forecast. For example, Table 4 in the appendix is an excerpt from a BLS PPI Detailed Report to illustrate the bottom up approach. The table shows how regular gasoline combines with mid-premium and premium gasoline to form the motor gasoline index, which rolls up to the gasoline index. At the next higher level, the primary products index for petroleum refineries is a combination of liquefied refinery gases, gasoline, jet fuel, kerosene, light fuel oils, heavy fuel oils, and asphalt. Therefore, by using the same system as the BLS to link models, GII can similarly trace the effect of changes in raw materials through the supply chain.

To develop the cost term for the pricing model, GII develops a composite cost model. The composite cost model for each good or service is a unique mix of labor, material, and energy inputs, as shown in the composite cost Equation 3.

Equation 3: Composite Cost

$$C_t = w_1\sum_{i=1}^{I} r_i L_{i^t} + w_2\sum_{j=1}^{J} r_j M_{j^t} + w_3\sum_{k=1}^{K} r_k E_{k^t} \text{ where:}$$

w_1 = weight of labor cost component

w_2 = weight of material cost component

w_3 = weight of energy cost component

r_i = relative weight of i^{th} labor cost

r_j = relative weight of j^{th} material cost

r_k = relative weight of k^{th} energy cost

L_i = i^{th} labor cost term

M_j = j^{th} material cost term

E_k = k^{th} energy cost term

Each general cost category has a specific weight, w_i, where the sum of all three weights equals 1. To determine the relative weights for each input, r_i, GII uses published information from organizations such as the BLS and the U.S. Census Bureau. GII prefers to use these relative weights when the data are available. In cases where this information is not available, econometric analysis is performed to determine the appropriate weights for the cost term.

Price Forecasting Methodology: Market Term

The market term plays the role of explaining deviations in price from the baseline cost. Although the production costs for a product are a primary driver in determining its price, supply and demand factors influence the price as well. To take into account the supply and demand of a product or service, GII uses a market term that uses the ratio of demand over supply minus one, which is shown in Equation 4 below.

Equation 4

$$MARKET_t = (DEMAND_t / SUPPLY_t) - 1$$

When demand is greater than supply, the market term is positive and puts pressure on the price to increase. Similarly, when consumers are demanding less than supply, the term is negative and price escalation would be expected to slow or prices actually fall. Finally, when firms have supplied just sufficiently enough to meet demand, the market term is zero has no influence over price.

For the demand portion of the market term, GII calculates the expected demand of a product or service using published industrial information. Since each product may be used by a variety of other industries, each end market has its own separate measure representing how much activity is expected to change for that market in the coming quarter. Factors that comprise a demand index may include industrial production, income, unemployment, consumer expenditures, business investment, capacity utilization, sales, and inventory change. The demand factors may also be lagged reflecting leadtimes in different end-markets. These production indexes are then weighted based on how much of a commodity is usually demanded by particular industries, and summed into a single demand factor for that commodity. This calculation is shown in Equation 4. As with the cost term, the relative weights for the composite production indexes are constructed from public sources, such as BEA's *Input-Output Structure of the U.S. Economy,* as well as other trade and industry sources.

Equation 4

$$DEMAND_t = \sum_{i=1}^{n} r_i * IND_{it-L_i}$$

Where:

r_i = relative weight of i^{th} industrial production or comparable activity measure

IND_i = the index of industrial production or comparable activity measure for the i^{th} industry or sector using the commodity as an input

L_i = The lag associated with the i^{th} industry

The supply factor of the market term is based on past levels of a sector's demand factor. Since firms tend to use trends in demand as a guide in determining capacity and therefore potential supply, GII bases its supply factor on a moving average of the demand factor over T periods. The moving average for period t extends from t-1 (the period immediately before t) to t-T. The value of T varies by sector; it may be as high as 10 to 12 quarters for especially for long lead time products or capital intensive industries. Thus, if demand for a commodity recently increased, a company will increase its production of that commodity. The equation for the supply factor is expressed in Equation 5.

Equation 5

$$SUPPLY_t = \sum_{i=1}^{T} \frac{1}{T} * DEMAND_{t-i}$$

Where:

T = the number of historical periods over which producers form demand expectations.

Additional Complexities of Market Baskets

In addition to developing forecasts of the numerous component series, GII also works directly with CMS to overcome data limitations critical to market basket creation. In some instances, there are no publicly available series that correlate with the desired component. For example, malpractice insurance premiums are an important cost that physicians and hospitals incur and as such it is used as a cost component in many of the market baskets produced for CMS by GII. However, there is no suitable proxy to represent malpractice insurance prices.[11] In fact, in 2003 the GAO conducted a study on Medical Malpractice Premiums and concluded that there was a lack of comprehensive data at the national and state levels on insurers' medical malpractice claims and the associated losses to permit analyzing the composition and causes of those losses.[12] In the absence of such data, it is difficult to understand the underlying causes and relationship contributing to insurance premiums.

Consequently, GII in conjunction with CMS, constructed a physician malpractice insurance index using rate data provided to CMS by a number of insurance carriers around the country. Data on rates for different carriers and medical specialties for every state are compiled in to a weighted index. Weights are determined by the number of practicing physicians in a state as well as the market share of insurance carriers covering each market.

Additionally, not all required data series are provided in the quarterly formats necessary for market basket forecasting. For example, CMS uses Multi-Factory Productivity (MFP) to adjust the underlying MEI components productivity to avoid double counting of gains in earnings resulting from growth in productivity. Without the adjustment, productivity gains from producing additional outputs with a given amount of inputs would be included in both the earnings components of the MEI and in the additional procedures that are billed. However, MFP is only reported annually.

The conversion of annual data to quarterly data may be achieved through several simple methods from linear distribution to pro rata distribution. However, these approaches fail to account for what is commonly referred to as the "step problem" between the 4th quarter of one year and the 1st quarter of the subsequent year. Under these approaches, significant changes in the growth rate occur between the 4th and 1st quarter of continuous years. However, to alleviate the "step problem" GII relies on a conversion method based on a Bassie methodology. Bassie was the first to devise a simple and convenient method of constructing a quarterly series whose quarter movements would closely reflect those of a related series, and would ensure a smooth progression between the 4th quarter and 1st quarters of successive years while maintaining consistency with the annual totals.

Market Baskets in Practice

To demonstrate the application of the market baskets in practice, an example illustrating how components sensitive to energy prices can impact the IPPS market basket over the 10-year forecast interval is provided. To show the impact, all 22 components of the 2006Q4 (2006 4th quarter) forecast for the IPPS market basket are held constant, with the exception of four energy and energy-sensitive components. As each quarter passes, only the energy or energy-related component forecasts will be updated.

Of the four cost components in the IPPS market basket examined as part of this simulation, two are considered primary energy components, the PPI for Electricity and the PPI for Natural Gas. The next two are secondary energy components, which are the PPI for Industrial Chemicals and the PPI for Rubber & Plastics, since energy is a large share of their input costs relative to other components. Unlike the primary components, the secondary energy components have petrochemical cost inputs and therefore mimic fluctuations seen in the oil markets.

Chart 3 of the appendix shows the impact of both the primary and secondary energy components in 2006Q4, 2007Q2, and 2007Q4. As seen in this chart, the filter-through effect of energy on these components has made a significant difference in the forecast, with the largest difference in the 10-year forecast interval occurring in 2010Q1[13]. To decompose whether the changes originate from the primary or secondary components, the three forecasts are examined again, but only the primary components are changed.

Chart 4 isolates the impact of the primary energy components in 2006Q4, 2007Q2, and 2007Q4. From the 2006Q4 to 2007Q4 forecasts, the PCHMA outlook for Natural Gas has been revised upward by approximately 14% in 2010Q1, the quarter where the greatest change in the IPPS market basket was observed. For electricity, GII's forecast was revised upward by a relatively small amount. Despite the combined increases in energy costs, as Chart 4 indicates, their impact was diminished by the components' small weights in the market basket. The PPI for Electricity carries an approximate .7% weight in the IPPS market basket, and the PPI for Natural Gas carries an approximate .2% weight.

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[11] The Bureau of Labor Statistics does publish a Medical Malpractice Insurance index (Series ID: PCU524126524126402), but the history is not sufficiently long enough to build an accurate model.

[12] *Medical Malpractice Insurance: Multiple Factors Have Contributed to Increased Premium Rates*. GAO-03-702. Washington, D.C.: June 27, 2003.

[13] The largest difference, in terms of PCHMA, occurred in 2010Q1 with a difference of .23. See Chart

The reason the market basket exhibited a greater change in Chart 3 is a result of the filter-through effect of energy in the secondary components, Industrial Chemicals and Rubber & Plastics. Each of these components has a larger weight of approximately 2% in the market basket.[14] As shown in this example, when considering changes in the forecast, one must take into account the relative cost share of a component, and the magnitude of the change. Also, the secondary components are driven by petrochemicals, whose forecast experienced relatively large upward revisions between the 2006Q4 and 2007Q4 forecasts.

Ensuring the Accuracy of Forecasts for Market Baskets

Under the Medicare PPS, the actual market basket increase for a given period can be higher or lower than the forecasted increase projected at the time a payment update is determined. This phenomenon is commonly referred to as forecast error. Accuracy in the market basket forecasts plays a critical role in ensuring that Medicare providers receive the appropriate payment update each year. For example, given the level of Medicare spending in 2006 for Inpatient hospitals, a 0.1 percentage point difference between the forecasted and actual market baskets could result in a difference of approximately $110 million in aggregate payments.

For two of the market baskets (skilled nursing facilities and capital), a mechanism exists to adjust for forecast error. For these PPSs, CMS establishes a threshold of the difference between projected market basket price growth and the actual market basket price growth. If this threshold is surpassed, the following year's update accounts for the difference. For example, CMS currently makes a forecast error adjustment in the SNF market basket framework if a previous forecast of input prices varies by at least 0.5 percentage points from actual input price changes. Similarly, the capital market basket has a forecast error threshold of 0.25 percentage point.

Given the importance of accuracy in this process, GII regularly tracks model performance across both the top line market basket, as well as all corresponding forecasted components. To accomplish this objective, GII relies on two primary methodologies. First, to ensure that GII's models are accurate and unbiased in an absolute sense, GII solves all models with known values of the independent variables and compares the results to the actual values of the dependent variable, something the organization refers to as a null solve. The differences in the actual and predicted values are calculated to reproduce the residuals and allow analysis of model accuracy and bias. The null solve allows us to check for accuracy by seeing how close to zero the residuals are, and for bias by checking whether residuals are not consistently positive or negative. For example, Chart 6 below shows the levels of a null solve for the PPI for Industrial Chemicals. Since this model is specified in percent change form, calculated residuals for the model are also shown in the percent change form (Chart 7). Except for one unusual boom period in 2003, the residuals are very close to zero, and are randomly positive or negative. Thus, these results suggest that the chemicals model is both accurate and unbiased.

The second methodology for examining model accuracy is to look at market basket forecast performance. It is important to note that most of the market baskets rely on a six-quarter forecast horizon for setting reimbursement rates. For example, to set the final IPPS market basket update for FY 2009, CMS will use the 2009Q3 forecasted four-quarter PCHMA generated from the 2008Q2 forecast. Therefore, for GII to evaluate actual forecast error, both the overall market basket forecast errors and the error associated with each of the underlying components of that market basket must be examined. This is accomplished by calculating the forecasted less the actual PCHMA. Positive forecast errors are indicative of model over-estimation, while negative forecast errors suggest model under-estimation. Table 5 shows the overall IPPS market basket forecast error and the forecast error for select components. The plus signs indicate that the component was over-forecasted and the minus signs indicate that is was under-forecasted. As the table reveals, the overall forecast of the market basket generally exhibits a reasonable mixture of over- and under-estimation that ranges within .2 percentage points. Finally, it is worth noting that the top line of the market basket is not forecasted; only the individual cost categories are forecasted, weighted and summed to the top line values. As a result, systemic over or under prediction at the top line market basket value does not necessarily imply model bias. Rather, a closer examination of the underlying components is required to determine if there is a bias in the components that is contributing to the observed top line over or under prediction.

Conclusion

The market baskets that are used to update the Medicare prospective payment systems play a vital role in helping to ensure access to care for millions of beneficiaries and encourage efficiency on the part of the program's many providers.

[14] In the IPPS market basket, the PPI for Industrial Chemicals carries a 2.1% weight, and the PPI for Rubber & Plastics has a 2.0% weight.

The creation and refinements of the various input prices indexes represent meticulous exercises that incorporate the best and latest available data at the time of their construction. Each market basket's cost categories are selected, cost shares are generated by analyzing provider-provided data, and price projections are made.

The final step in the process, estimating future movements in prices, is by its very nature, subject to uncertainty. However, the critical element and elegance of the selected forecasting methodologies and modeling approaches are that permit and accurate "decomposition" of forecast errors to determine the driving factors of the error and adjust future forecasts to account for any identified bias.

TABLE 1: Selected Medicare FFS providers--2006 Spending[15]

Provider Type	$ Billions	Market Basket	Basis
Inpatient hospital	109.5	IPPS	FY
Outpatient hospital	30.0	IPPS	FY
Hospice 8.	9	IPPS	FY
Rehab 6.	2	RPL	FY
Psych 4	.1	RPL	RY
Long-term care	4.6	RPL	RY
Home health	13.4	HHA	CY
Skilled Nursing	20.8	SNF	FY
End Stage Renal Disease (ESRD)	5.7	ESRD	CY
Physicians 6	6.7	MEI	CY

TABLE 2: Medicare Cost Shares for Selected Market Baskets

Cost component	IPPS	RPL	SNF
Compensation 6	5.503	68.769	64.077
Utilities 1	.251	0.656	1.551
Professional Liability	1.589	1.161	1.717
Other products	20.336	13.323	19.03
Other services	11.321	5.942	6.418
Capital *		10.149	7.207

* The acute inpatient hospital capital payments are updated separately from the hospital operating cost payment.

Cost component	HHA
Compensation 7	7.082
Utilities 0	.694
Admin & General	16.712
Transportation 2	.494
Capital costs	3.018

Cost component	MEI
Physician compensation	52.466
Non physician compensation	13.808
Professional Liability	3.865
All other practice expense	29.861

[15] The remainder of FFS CY2006 payments include payments for dental services and durable medical equipment

TABLE 3: Detailed Cost Categories, Price Proxies, and Cost Weights for the IPPS (base year 2002)

Inpatient Hospital Input Price Index		
Cost Description	Price-Wage Variable	Weight
Total - PPS02		100.00%
Compensation		59.99%
Wages	ECI- Hospital Workers (Civilian)	48.17%
Benefits	ECI- Hospital Workers (Civilian)	11.82%
Professional Fees		5.51%
Professional Fees	ECI- Compensation Prof. and Tech. (Private)	5.51%
Utilities		1.25%
Electricity	PPI - Commercial Electric Power	0.67%
Fuel, Oil, Coal, Etc.	PPI - Commercial Natural Gas	0.21%
Water & Sewerage	CPI - Water & Sewage	0.38%
Professional Liability Insurance		1.59%
Malpractice	CMS - Prof. Liab. Prem.	1.59%
All Other		31.66%
All Other Products		20.34%
Drugs	PPI - Prescription Drugs	5.86%
Food-direct purchase	PPI - Processed Foods	1.66%
Food-away from home	CPI - Food Away Fr. Home	1.18%
Chemicals	PPI - Industrial Chem.	2.10%
Medical Instruments	PPI - Medical instruments and equipment	1.93%
Photo Supplies	PPI - Photo Supplies	0.18%
Rubber & Plastics	PPI - Rub. & Plast. Prod.	2.00%
Paper Products	PPI - Convert. Paper And Paperboard	1.91%
Apparel	PPI - Apparel	0.39%
Machinery & equipment	PPI - Machinery & equipment	0.57%
Miscellaneous products	PPI - Finished goods less food and energy	2.56%
All Other Services		11.32%
Telephone	CPI - Telephone Services	0.46%
Postage	CPI - Postage	1.30%
All Other: Labor Instensive	ECI - Service Occupations (Private)	4.23%
All Other: Non Labor Intensive	CPI - All Items (Urban)	5.34%

CHART 1: PCHMA Adjustment Example

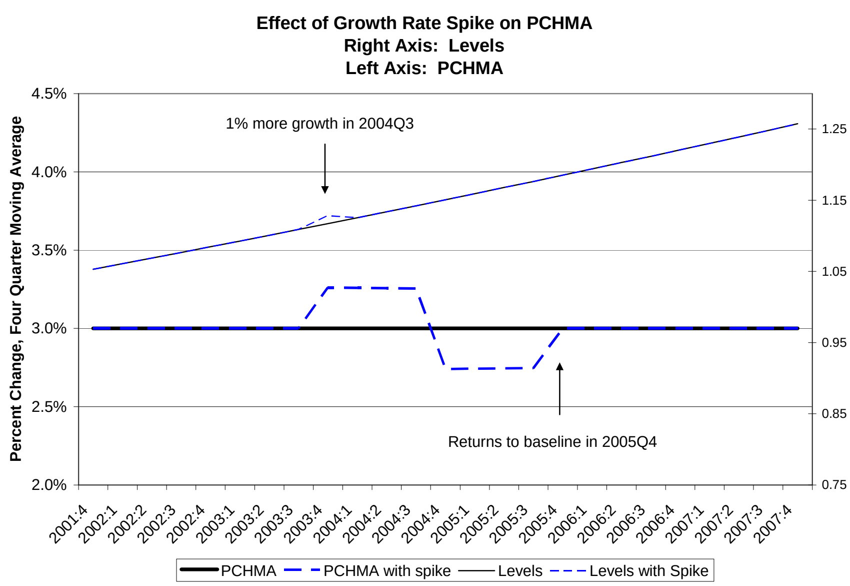

CHART 2: Price as a Function of Cost and Market Activity

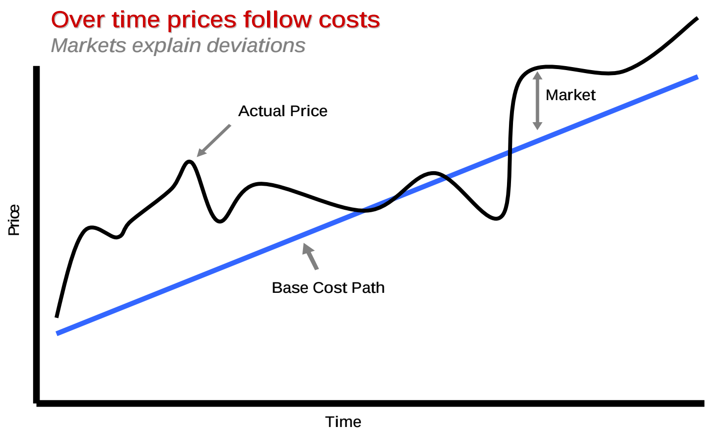

TABLE 4: Excerpt from PPI Detailed Report February, 2008

Industry Code / Product Code	Product and Industry Name
324110	Petroleum refineries
324110-P	Primary products
324110-A	Liquefied refinery gases, including other aliphatics (feed stock and other uses)
324110-1	Gasoline, including finished base stocks and blending agents
324110-13	Motor gasoline, including finished base stocks and blending agents
324110-134	Regular gasoline
324110-135	Mid-premium gasoline
324110-136	Premium gasoline
324110-2	Jet fuel
324110-3	Kerosene, except jet fuel
324110-4	Light fuel oils
324110-411	Home heating oil and other distillates, NEC
324110-413	Diesel fuel
324110-5	Heavy fuel oils, including No. 5, No. 6, heavy diesel, gas enrichment oils, etc.
324110-9	Asphalt

Source: PPI Detailed Report: Data for February 2008, Bureau of Labor Statistics
http://www.bls.gov/ppi/ppidr200802.pdf

CHART 3: Effect of Primary and Secondary Components on the IPPS Market Basket

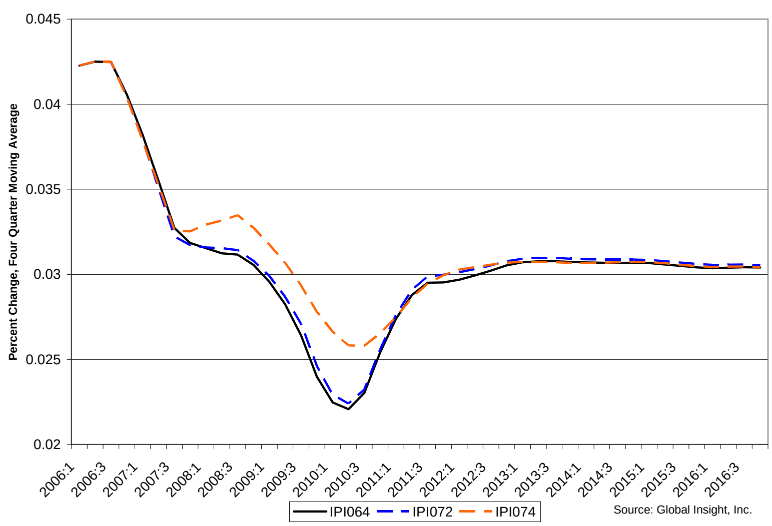

CHART 4: Effect of Primary Components on the Hospital Market Basket

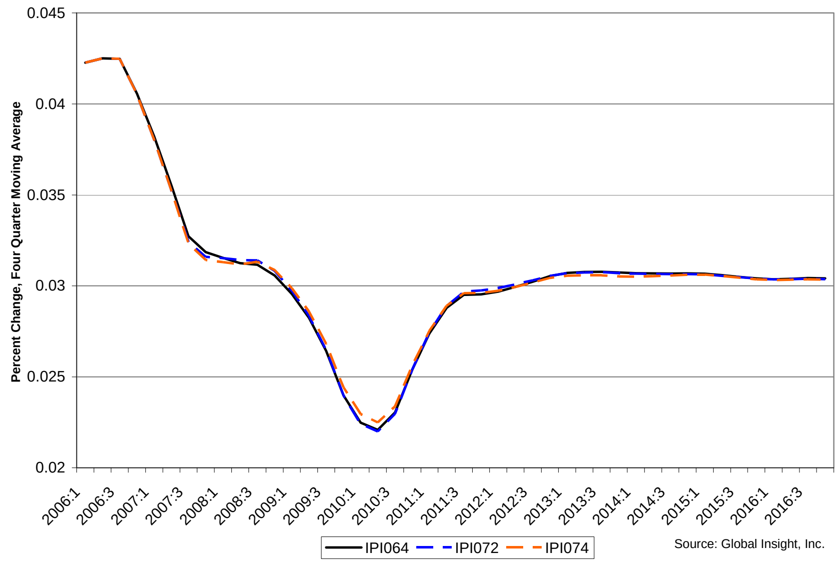

CHART 5: Effect of Secondary Components on the Hospital Market Basket

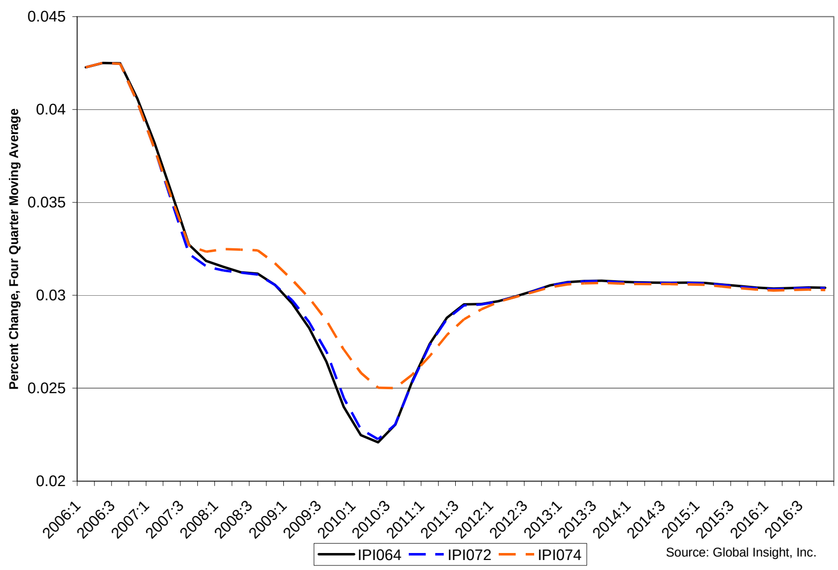

CHART 6: Null Solve for Chemicals

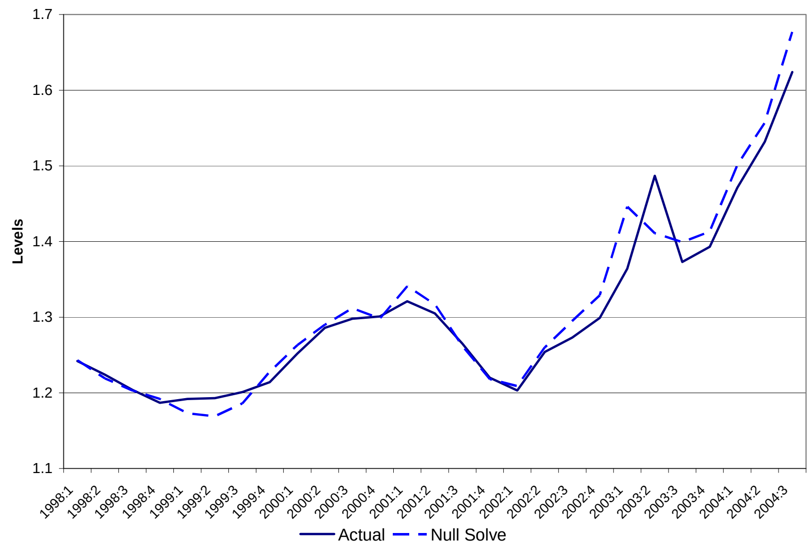

Chart 7: Difference in Percent Change

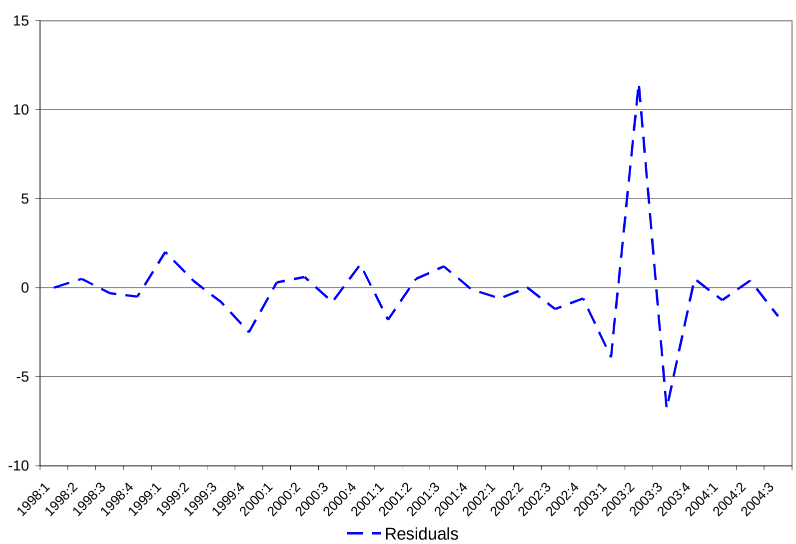

TABLE 5: Forecast Error Table – IPPS Market Basket[16]

	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998
PPS02	0	-0.5	-0.9	-0.4	-0.4	0.4	-0.7	-0.7	-0.1	-0.1
Drugs	+	-	-	-	-	+	+	+	-	-
Chemicals	+	-	-	-	-	+	+	-	+	+
Wages	-	+	-	+	-	+	-	-	-	-
Benefits	+	+	-	-	-	-	-	-	+	+
Natural Gas	-	+	-	-	-	+	-	-	+	-

[16] Table 5 shows the top 5 components that contributed most to the top line forecast error. Contribution takes into account of the weight and magnitude of the error. The plus signs indicate over-forecasting, and the minus signs indicate under-forecasting.

Evaluating Census Forecasts

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* I wish to thank Bryan Boulier for comments on an earlier draft. Research assistance was provided by Devin Morgan, through funding from the Center for Economic Research, Department of Economics, George Washington University.

Abstract

The Census Bureau makes periodic long-term forecasts of both the total US population and the population of each of the states. Previous evaluations of these forecasts were based on the *magnitude* of the discrepancies between the projected and actual population figures. However, it might be inappropriate to evaluate these long-term projections with the specific quantitative statistics that have been useful in judging short-term forecasts. One of the purposes of a long range projection of each state's population is to provide a picture of the distribution of the aggregate US population among the various states. Thus the evaluation should compare the projected distribution of the total US population by states to the actual distribution. This paper uses the dissimilarity index to evaluate the accuracy of the Census projected percentage distributions of population by states.

Evaluating Census Forecasts

The Census Bureau makes periodic forecasts of the population of the United States 5, 10 or more years into the future. These forecasts are both for the total population and for the number of inhabitants of each of the states. There have been many evaluations of these forecasts. (For example, see Smith and Sinich, 1990, 1992; Wang 2002). The questions that were examined in these studies included whether the accuracy of these forecasts was affected by (1) the length of the base period used in estimating relationships and (2) the complexity of the forecasting technique. In all cases, the error measures were based on the *magnitude* of the discrepancies between the projected and actual population figures.

In addition to statistics that measure the quantitative errors, there are alternative procedures for evaluating these long-term projections. One of the purposes of a long range projection of each state's population is to provide a picture of the **distribution** of the aggregate US population among the various states. There are many reasons why users of Census data might be concerned with the distribution of the population. Resources, such as highway construction funds, might be allocated on the basis of the expected future populations; politicians might be interested in knowing how many Congressional House seats will be allocated among the states; etc.

In these cases, the users of the population projections might not be concerned with the actual number of inhabitants of each state but rather with trends: whether the population of specific states was growing relative to that of other states or whether the population in a specific state was an increasing (decreasing) percent of the total national population. If one were only interested in knowing whether the projections captured the important trends that actually occurred, one might not be concerned with the magnitude of the errors. The accuracy of the quantitative projections of each state's total population is then not as relevant as an accurate depiction of major trends.

It is possible that the **share** of the nation's population that was in each state was predicted correctly, but that the national total and the estimates for each of the states were inaccurate by the same proportion. In that case, the projected distribution of the state populations would have exactly matched the observed distribution. Thus, the evaluation procedure that is suggested here does not focus on the specific numbers in the projections or the magnitude of the misestimates. Rather this evaluation asks whether the projected **share** of the total US population by states was similar to the actual distribution. Such an analysis enables one to determine whether the state distribution of the aggregate population was accurate even if the aggregate estimate is inaccurate.

The same issue, involved in evaluating long-run forecasts, has been examined in a different context: the accuracy of long-term labor-market forecasts. (Kolb and Stekler, 1992; Stekler and Thomas, 2005). Both studies used statistics that directly measured whether major trends were predicted accurately. In evaluating the long-run projections, the first study used an information content statistic; the second used dissimilarity indexes.
This paper uses the dissimilarity index approach to evaluate the accuracy of the Census projected

percentage distributions of population by states. The next section explains the methodology. This is followed by a description of the data, the results, and our interpretations and conclusions.

I. Methodology

A. Decomposing the Errors

Assume that $\boldsymbol{x_t^a}$ is the actual aggregate population of the US at time t and $\boldsymbol{x_t^f}$ is the value that was projected for time t. The error in the aggregate projection is $e_t = \boldsymbol{x_t^a} - \boldsymbol{x_t^f}$. In addition it is also possible to examine the errors associated with the population projections for each of the i states. Accordingly the proportions (p_i) of the predicted and actual (a_i) aggregated population associated with each of the i states are:

$$\boldsymbol{x_{i,t}^f} = (p_{i,t})\, \boldsymbol{x_t^f} \;; \quad \boldsymbol{x_{i,t}^a} = (a_{i,t})\, \boldsymbol{x_t^a} \;; \quad \sum p_{i,t} = 1, \quad \sum a_{i,t} = 1,$$

and the forecast error for each state is

$$e_{i,t} = (a_{i,t})\, \boldsymbol{x_t^a} - (p_{i,t})\, \boldsymbol{x_t^f} .$$

If the aggregate forecast is absolutely accurate, the quantitative error for each state would be

$$e_{i,t} = (a_{i,t} - p_{i,t})\ \boldsymbol{x_{i,t}^a} ,$$

which is the difference between the actual and forecast proportions of the aggregate population which is in each state. The same holds true if the aggregate forecast is inaccurate. If $\boldsymbol{x_t^a} \neq \boldsymbol{x_t^f}$,

$$e_{i,t} = (a_{i,t} - p_{i,t})\ \boldsymbol{x_t^a} + p_{i,t}(\boldsymbol{x_t^a} - \boldsymbol{x_t^f})$$

Thus the quantitative forecast error for each state, $e_{i,t}$, is the sum of two components. The first represents the error in predicting the proportion of the population in each state. The second measures the error in failing to predict the aggregate correctly. In order to evaluate these long term population forecasts, we will focus on the first term, using the dissimilarity measure as our statistic.

B. Dissimilarity Index

Suppose that one has the following data: the population of each state and the national total. Then one can calculate the percentage of the national population that resided in each state. This calculation can be made for both the projections and the actual numbers, yielding two distributions of population by states. A dissimilarity index can be used to compare the projected and actual distributions.

Specifically, the dissimilarity index measures the amount by which the projected distribution would have to change to be identical to the actual distribution. Using our notation, the formula for the dissimilarity index for every period is:

$$D_t = 0.5 \sum | (\boldsymbol{x_{i,t}^f} / \boldsymbol{x_t^f}) - (\boldsymbol{x_{i,t}^a} / \boldsymbol{x_t^a}) |, \text{ or } D_t = 0.5 \sum | p_{i,t} - a_{i,t} |$$

D is bounded in the interval 0 to 100 percent.[1] The smaller the value of D, the smaller is the difference between the predicted and actual distributions, i.e. the more accurate is the forecast.

C. Benchmark Comparisons

For purposes of evaluation, the Census projections are compared with a benchmark. The selected benchmark must only use data that were available at time t, the date when the projection was issued. In this case, we selected a naïve model: the naïve projection of the state distribution of the US population for year t+h was assumed to be identical to the Census count or population estimate in year t.

II. Data

We evaluate the Census state population projections that were made between 1970 and 1996 for the years 1975-2005. There are seven such sets of projections. The length of the forecasting horizon varied between 3 and 25 years. The naïve projections were made using the same starting points and horizons. These projections were compared either with the actual Census counts for 1980, 1990, and 2000 and or with the population estimates that the Census Bureau made for 1975, 1985, 1995 and 2005.

III. Results

The dissimilarity indexes derived from both the Census and naïve projections are presented in Table 1. The longer was the projection horizon, the larger was the size of the dissimilarity index that was associated with the projections, i.e. the less accurate the projected distribution. This result is similar to findings about the relationship between quantitative errors and the length of the forecast horizon. As indicated above, the size of these indexes measures the amount by which the projected distribution would have to change to be identical to the actual

[1]Percentages are used, in interpreting the results, even though p_i and a_i are defined as proportions. The dissimilarity index is bounded in the interval 0 to1 for proportions.

distribution. This was less than 1% for the very short projections to more than 5% for some of the longer horizons.

Moreover, the projections seem to have improved over time. For the 5 year projections, the values of the dissimilarity indexes declined from more than 1.5% to less than 1%. The magnitude of the index for the 10 year projection made in 1970 was almost 4%; the similar numbers for the projections made in the late 1980s and 1990s were all less than 1.5%. A similar trend was observed in the more recent 20 year projections.

Nevertheless, the Census forecasts associated with the distributions of the state population forecasts are inferior to the naïve forecasts (See Table 1). In all but one case, the dissimilarity indexes associated with the naïve forecasts are smaller than the ones derived from the comparable Census projections.[2] While the conventional way for comparing two sets of forecasts is to test whether there is statistically significant difference, this would be difficult in this case because the distribution of the dissimilarity index is not known. Bootstrapping would have provided an alternative procedure for testing the significance of the results, but this was not necessary in this case because the naïve forecasts were an order of magnitude superior to the Census projections.

IV. Conclusions

The customary method for evaluating disaggregated long-term population projections has been concerned with the magnitude of the errors made in forecasting each state's population. This paper has presented an alternative evaluation method based on the difference between the predicted and actual distributions of the state projections. We showed that naïve forecasts were much superior to the Census projections at all horizons. This result is consistent with previous findings that simple methods for making long-term population projections were more accurate than complex procedures. (Smith and Sinich, 1992).

[2] The exception is the five year projection made in 1975.

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Table 1
Values of Dissimilarity Index (percentage points)
Census and Naive Forecasts

Date
Projections Date of Projection
Made

	1975	1980	1985	1990	1995	2000	2005
1970	a 1.7 b 1.7 [0.2]	a 3.9 b 3.9 [0.4]	a 5.5 b 5.5 [0.7]	a 6.5 b 6.4 [0.8]			
1975		1.8 [2.7]		3.7 [0.7]		5.3 [0.9]	
1980				2.5 [0.4]		4.2 [0.7]	
1986				1.0 [0.2]	1.2 [0.3]	1.9 [0.4]	2.3 [0.4]
1988				a 0.6 b 0.8 [0.1]		a 2.5 b 1.7 [0.4]	
1992					0.4 [0.1]	1.4 [0.2]	2.0 [0.4]
1996						0.8 [0.2]	1.2 [0.3]

Notes: Numbers in [ ] are for naive (benchmark) projections.
There were two sets of projections issued in 1970 and 1988. They are denoted a and b.

The Relationship between Oil Markets and Shipping Tanker Rates: Forecasting Spot Tanker Prices for the West African-U.S. Gulf of Mexico Market

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ABSTRACT
We investigate a dynamic model explaining spot tanker rates. The West African-U.S Gulf Tanker Rates, West Texas Intermediate spot and 3 month futures contract, and U.S Weekly Petroleum Inventories are analyzed using cointegration and Granger causality analysis, from 1997 through 2007, in order to examine the lead-lag relationship between oil prices and tanker freight rates. We find a significant relationship between spot and future crude oil prices, crude oil inventories and tanker rates. The significant increase of freight rates, and the simultaneous increase in oil prices, during the recent years, provides an intriguing economic environment to identify relationships between shipping market rates and oil prices. These relationships have significant implications for the markets. At the practical level forecasts may provide greater understanding of the relationships and improve operational management and budget planning decisions. We conclude with a simple dynamic forecasting exercise at the 1-week ahead and 4-week ahead horizons.

Keywords: Oil markets, tanker market, cointegration, Granger causality, lead-lag relationship.

Acknowledgements: The authors would like to thank Ilias D. Visvikis and participants at the International Association of Maritime Economists conference in Sidney, July 2006. In addition, they benefitted from comments at the Energy Economics Seminar at the University of Alberta, and the Federal Forecasters Conference in Washington DC 2008. Also, Poten & Partners assisted in obtaining data on the spot tanker markets.

A longer version of this paper without the forecasting application is under a revise and resubmit at ***Maritime Policy & Management*** under the title," Exploring the link between oil prices and tanker rates."

INTRODUCTION

Oil is the paramount energy source in the global economy and its pricing has profound macroeconomic, political and social effects. An important element of the world oil market is the tanker industry, which moves oil from producer areas to consumer markets. Spot tanker prices are strongly influenced by the crude oil market, specifically spot prices, future contract prices, and petroleum inventories.

Crude oil is commodity traded on global markets. It is subject to relative demand shifts from economic growth globally and by regions. Supply disruptions and shocks in oil exporting countries lead to price volatility. The pricing of crude and petroleum products reflects changing supply and demand including the impact of special entities such as OPEC and even Russia. The final end use price depends on production costs, refining, marketing, and transportation costs of crude oil and petroleum products from producing countries to consumer markets.

In the U.S. about one-fourth of all energy consumption is for transportation. This is almost entirely supplied by petroleum products. In fact, three quarters of petroleum consumption is related to transportation and is expected to increase over the next twenty five years (Annual Energy Outlook 2006, US DoE/EIA). Motor gasoline is about fifty percent, diesel or distillate fuel about fifteen percent, and jet fuel about ten percent.

Our study focuses on the relationship between spot tanker rates, crude oil prices and inventories in the U.S. for shipping from West Africa to the U.S. Gulf between 1998 and 2005. We use the Baltic dirty tanker index for very large crude carriers (260,000mt), the spot West Texas Intermediate Crude Oil Price, the NYMEX future contract 3, and crude oil stocks in the analysis. The frequency of observations is the closing price for each week on the Baltic index.

West Africa contributed about fourteen percent of the U.S. total petroleum products imported in 2004. This was about 1.6 million barrels per day and eight percent of total consumption. Over 95% came from three countries: Nigeria, Angola, and Gabon. West Africa is expected to become an even more important source of imports in the future increasing deep water off-shore oil production in the region. Also, rising demand for oil by southern and eastern Asia is likely to come from the Middle East.

Our results suggests that the spot tanker market is related to the intertemporal relationship between current and future crude oil prices, such that relatively higher expected prices put upward pressure on spot tanker rates. In addition, higher inventories and movements in inventories put downward pressure on spot tanker rates.

This paper is structured into six sections. We begin with a brief description of the literature on the tanker market and its relationship with the oil market. Next, present the data series used in the analysis. Third, we describe the economic model and econometric methodology. Fourth, we present the empirical results from the analysis. A simple forecasting exercise is conducted in section five. This is followed by a discussion of the results and the conclusion.

1. A Review of the Relationship between the Tanker and Oil Markets

There is a long history of research examining the determinants of tanker prices and their relationship oil prices (Koopmans, 1939; Svendsen, 1958; Zannetos, 1966; Devaney, 1971; Hawdon,1978; Wergerland, 1981; Evans-Marlow, 1985; and Beenstock, 1985; Li and Parsons, 1997; and Lyridis, 2004). Kavussanos (2002) and Kumar (1995) provide a good discussion of the tanker market supply and demand determinants.

The quest for understanding tanker price movements has become more significant because, of the substantial rise in oil tanker prices. Poten & Partners (2004), a leading ship broker in New York, have noted that VLCC rates are at the highest they have been in over ten years. Tanker rates, which averaged less than 40 Worldscale (WS) in July 2002 and WS 50 in July 2003 jumped up to a far higher average in the mid-100 WS range in July 2004. According to Poten & Partners, the factors which have put upward pressure on the VLCC, Aframax and Suezmax market have been increased oil demand by the developing economies, especially India and China.

Other factors which have impacted the pricing of the oil and tank ships over the past few years include the strength of the U.S economy, increasingly turbulent weather including the disruption of Gulf Port facilities by a series of Hurricanes such as Hurricane Katrina, Charles, Frances and Ivan, the reduction of Iraqi oil production due to hostilities there, political instability in Venezuela, supply disruptions in Nigeria, and the reduction of Russian oil production owing to the legal problems of Yukos and its CEO.

On the oil side, worldwide oil demand is the highest it has ever been in 10 years. In just the first and second quarters of 2004, worldwide oil production was at its highest in fourteen years, at 82.2 million bpd, according to Energy Information Administration data, with demand reaching 82.5 million bpd in the fourth quarter.[1]

A complete picture of the factors that determine the variability of tanker prices would include references to oil exports, particularly from the Arabian Gulf (AG). In October of 2004, VLCC rates were at a historical high of WS 220, and AG/East and fixture activity was also up 33% since 2002 while at the same time, the oil industry was experiencing an upward shift in oil prices to $55 per barrel. The Poten study demonstrated that the run up in Aframax rates in 2004 correlated with the increase in the change in export shipments in barrels per day change from the Arabian Gulf. More specifically, they concluded that a million barrel per day change in AG exports generated a 25 point change in VLCC rates. Poten (2005) also emphasize the importance of oil inventories and tanker rates.

Kavussanos (1996a, 1996b, 1996c) provides a theoretical framework for determining the conditional means of freight and time charter rates. He demonstrates that volatility is high during and just after periods of large external shocks to the industry, such as the, the 1973 – 1974 and 1980 -1981 oil crises, 1990 invasion of Kuwait by Iraq. He finds a positive relation between coefficients of variation and size such that freight rates for larger tankers show higher variations than for smaller size ones indicate that there is elasticity with size of tanker.

These findings are consistent with empirical studies which link freight rates to the level of crude oil prices in the US (Mayr and Tamvakis, 1999). Mayr et. al. observed that the increase in demand for imported crude oil, such as Brent and Bonny, increased the demand for sea transportation and also had a beneficial impact on the level of freight rates. Alizadeh and Nomikos (2004) find evidence for the existence of a long-run relationship between freight rates and oil prices in the US. However, they do not find evidence that freight rates are related to physical crude and WTI future price differentials.

This study looks at how the oil tanker prices have responded to the unprecedented demand for oil and the related record high oil prices. In this environment, we observe that an upward shift in the demand for oil causes increased oil prices and an upward shift in the demand for tanker capacity, causing an increase in the price for tanker capacity. A factor complicating the study is that while the demand for most products is elastic the demand for oil is inelastic. Normally when prices rise volume falls, but that expectation fails because demand for oil in this macro-environment has been proven to be inelastic.

2. The Data

We focus on the spot oil tanker market between West African and the U.S. Gulf of Mexico. The sample period for our analysis is from January 26th, 1998 through January 2nd, 2006. We use the last trading closing in each week on the Baltic exchange which yields a total of 409 observations. table 1 provides a list of the data series with acronyms, descriptions, units and sources.

The West Africa-US Gulf Tanker spot price on the World Scale index (BDTI4) was obtained from the Baltic Exchange. The Baltic Exchange reports the transactions from a number of different indices for the tanker market. The base year for this index is 1998. The West Texas intermediate crude spot price (RWTC) and 3-month futures contract rates (RCLC3) in dollars per barrel were obtained from Bloomberg, the New York Mercantile Exchange, and the Energy Information Agency. The US weekly petroleum inventories in 1000s of barrels (WCESTUS1) are provided by the Energy Information Agency. Unless otherwise indicated, we have transformed all series into natural logarithms for the analysis.

Figure 1 charts the three price series. The first chart is the Baltic Dirty Tanker Index. Spot prices were stagnant and falling in 1989 and 1999. They tripled in 2000 before falling to their previous level; There is a 9/11 effect, which lasts until about the fourth quarter of 2002. Then spot prices begin a roller coaster rider with cycles of near tripling and falling in prices. Prices peaked in November 2004 *(why?)*. These peaks coincided with periods when OECD commercial inventories were below their five year average band. Forward cover, days supply dropped below fifty days in these periods. The volatility of prices appears to have increased in this period. It appears that at the end of the 1990s oil demand was depressed by recessionary economic conditions in Western Europe and Japan, compounded by the increasing calls for using alternative energy sources (nuclear power, hydroelectric power, coal). Subsequently, oil prices increased on the basis of a large shift in demand for oil imports by industrializing China and India and heightened demand by the United States. The increased demand effect was compounded by oil supply disruptions and shortfalls in Venezuela, Nigeria, and later the invasion and occupation of Iraq.

The second and third charts show the WTI spot price and the 3-month contract price. We observe similar patterns in the movements in oil prices and tanker price. The collapse of oil prices is seen in 1998 followed by a gradual rise through 2000. Who can recall oil prices at $11-$12/barrel in January through March of 1999? Prices had recovered to the $25 to $30 range by the end of 2000. There is a collapse in prices following 9/11 to about $20 through early 2002. Then they rise to above $30 and have peak in the winter of 2003 when inventories were critical. Prices then began the climb to above $50 in October 2004.

Since the American invasion and occupation of Iraq in 2002, there has been a steady increase in oil prices because of shortfalls in Iraqi oil (destabilization of the Middle East). Uncertainty about the stability and security of supply has been a hallmark of the oil market since 2000. Exacerbating the impact of Iraq have been a series of exceptionally destructive hurricanes, especially in the U.S Gulf Region, an unprecedented tsunami which especially impacted the oil country of Indonesia, and production cutbacks occasioned by the arrest of the CEO of Russia's largest oil company Yukos. The equilibrium price of oil also reflects the interaction of supply and demand. Supply is the result of production from existing wells plus intensified extraction from those wells plus production of new wells.

Figure 2 contains the US Weekly Inventory measure. Through mid 1999 inventories were above 330MB. They decline dramatically and remain about 290MB through 2000. The recession in 2001-2002 may have lead to the expansion of inventories back up to about 310MB. Economic growth domestically and internationally and higher prices may have lead to the decline in inventories back under 300MB in 2003 and 2004. Speculators and the convenience yield led to the increase in inventories through 2005. Prices had risen from $45 to over $65 per barrel and the futures market was geared toward higher prices.

In figure 3, gives a comparison of the trend and dynamics for West Africa-US Gulf Tanker Rates and the West Texas Intermediate Spot Price is graphically displayed. The former s on the left hand scale and the later is on the right hand scale. The two prices appear to move together cyclically and in relative levels following the discussion above. There appears to be far greater volatility in the Baltic Dirty Tanker Index than oil prices. This might be driven by other demand and supply factors. One example might demand side effects from actual inventory levels and (future) desired inventory levels. Second, on the supply side there is tanker capacity. This depends on current capacity plus added new tankers minus older tankers scrapped. We were unable to obtain a measure or proxy of capacity, so our results are conditioned upon this fact.

In the earlier part of the period, the two rates fluctuate reflecting the impact of higher oil prices on tanker prices which makes sense from the viewpoint that higher oil prices would generally reflect to some degree a shortage of tanker capacity for the demand level.

However, after 2002, the relationship diminishes as oil prices increase steadily while tanker rates are highly volatile. It may be that by 2002 the tanker industry had adjusted more slowly than the oil market. Oil prices had moved to a much higher plateau, and the tanker market entered a period of high volatility including some major price cuts. Additional upward pressure on tanker rates was the market having entered a period of higher level of political/military risks due to heightened Middle Eastern instability, pushing up the rates was a significant increase in maritime insurance rates due to the perception of heightened risk, especially in the Persian Gulf area, where tankers would naturally congregate.

In figure 4, contains a chart of the West African – U.S Gulf of Mexico tanker rates and U.S Weekly Petroleum inventories are shown on a log basis for the period 1998 to 2005. There is a strong and consistent inverse relationship between West Africa and U.S Gulf tanker rates and U.S weekly petroleum inventories. We observe that when inventories are high, tanker spot rates are low, and when inventory is down, the tanker spot rate goes up. Lower inventories, would suggest upward pressure on current and future oil prices. Low inventories can indicate a strong demand for oil which translates partially into higher tanker rates. Tanker rates reflect an auction process based on changing supply and demand. When oil prices are high the tankers can raise their rates because the higher oil price in part reflects a scarcity of tanker supply and also the tanker price is essentially inelastic in time of high demand because of the willingness of shippers to pay the higher rates. The relationship between the tanker rates and inventories is more apparent than the relationship between tanker prices and WTI spot prices. This could be because lower inventories mean higher prices for tankers because the inventory level is an inverse surrogate for the oil price. That is, low inventories are synonymous with high oil prices and conversely, high oil inventories are synonymous with low oil prices. Since most oil is imported using tankers, a high oil price implies low inventories and high tanker prices.
Figure 5 shows the spread between the natural logarithms of the WTI spot price and the 3-month contract price. Alizadeh and Nomikos (2004) have used this variable as a cost of carry or convenience yield measure[2]. It captures the interest rate costs, storage costs, and transportation costs to the delivery point. We interpret this more as convenience yield measure in that US refiners are willing to hold inventory. Increases in the spread might suggest higher prices are expected or inventory build-ups are desired over the next few months. This leads to an increase in oil demand pushing up Tanker rates. Figure 6 demonstrates this relationship.

3. Econometric Modeling Issues

We employ the general-to-specific modeling approach advocated by Hendry (1986, 2000, and 2001). The general-to-specific modeling approach is a relatively recent strategy used in econometrics. It attempts to characterize the properties of the sample data in simple parametric relationships which remain reasonably constant over time, account for the findings of previous models, and are interpretable in an economic and financial sense. Rather than using econometrics to illustrate theory, the goal is to "discover" which alternative theoretical views are tenable and test them scientifically.

The approach begins with a general hypothesis about the relevant explanatory variables and dynamic process (i.e. the lag structure of the model). The general hypothesis is considered acceptable to all adversaries. Then the model is narrowed down by testing for simplifications or restrictions on the general model.

The first step involves examining the time series properties of the individual data series. We look at patterns and trends in the data and test for stationarity and the order of integration. Second, we form a Vector Autoregressive Regression (VAR) system. This step involves testing for the appropriate lag length of the system, including residual diagnostic tests and tests for model/system stability. Third, we examine the system for potential cointegration relationship(s). Data series which are integrated of the same order may be combined to form economically meaningful series which are integrated of lower order. Fourth, we interpret the cointegrating relations and test for weak exogeneity. Based on these results a conditional error correction model of the endogenous variables is specified, further reduction tests are performed and economic hypotheses tested.

4. Empirical Results

Time Series Properties of the Individual Series

We estimated the three forms of the augmented Dickey-Fuller (ADF) test where each form differs in the specification of the assumed deterministic component(s). All five series appear to be I(1) processes. We cannot reject the null of I(1) against I(0) or stationarity. The spread variable appears to reject the null hypothesis at the 5% level with only a constant. However, it does not reject the null when a trend is included in the model. The trend does add explanatory power the equation, so we conclude it is I(1). Nominal price and financial series are found to be non-stationary

[2] The discussion and construction of the convenience will be expanded in later drafts.

in their first differences or they are I(2). When we tested the series for I(2) the null hypothesis is rejected in all cases. Thus we conclude that the tanker spot price, WTI spot price, WTI 3-month contract price, the spread between the WTI spot and future price, and the weekly crude inventory measure are I(1) or first difference stationary.

Specification of the VAR Model

The choice of the variables is based on the analysis of the data in section 1. The causal relationship between the West Africa-US Gulf Tanker spot price (BDTI4), West Texas intermediate crude spot price (RWTC), 3-month futures contract rates (RCLC3), and the days supply of US weekly petroleum inventories (WCESTUS1) is analyzed using a vector autoregression model or system, VAR. We estimate the statistical model and test for dynamic relationships in both the short-run and long-run. The four variable VAR can be specified as:

$$\begin{bmatrix} \ln BDTI4_t \\ \ln RCLC3_t \\ \ln WTI_t \\ \ln WCESTUS1_t \end{bmatrix} = A(L)\begin{bmatrix} \ln BDTI4_t \\ \ln RCLC3_t \\ \ln WTI_t \\ \ln WCESTUS1_t \end{bmatrix} + B\begin{bmatrix} constant \\ timetrend_t \end{bmatrix} + \begin{bmatrix} \varepsilon_{t,1} \\ \varepsilon_{t,2} \\ \varepsilon_{t,3} \\ \varepsilon_{t,4} \end{bmatrix}$$

$$A(L) = A_1L + A_2L^2 + A_3L^3 + \ldots + A_pL^p$$

The price series and inventory measure have been transformed to natural logarithms to (partially) address heteroskedasticity issues. A constant and trend term are included in each equation; their role will be modified later. The two error terms are assumed to be white noise and can be contemporaneously correlated. The expression *A(L)* is a lag polynomial operator indicating that p lags of each price is used in the VAR. The individual A_i terms represent a 4x4 matrix of coefficients at the ith lag.

Lag Length Selection

The number of lags to use in model at the beginning is unknown. The methodology is to start with an initial trial of p lags assumed to be more than necessary. Estimate the VAR and test for serial correlation, heteroskedasticity, and stability of the model. The idea or goal is to obtain results that appear close to the assumption of white noise residuals. A large number of lags are likely to produce an over-parameterized model. However, any econometric analysis needs to start with a statistical model of the data generating process. Parsimony is achieved by testing for the fewest number of lags that meet can explain the dynamics in the data system.

The selection criteria for the appropriate lag length are used to avoid over-parameterizing the model and produce a parsimonious model. They include: Bayesian Schwartz Criterion (BSC), the Hannan-Quinn Criterion (HQ), and the Akaike Information Criterion (AIC) are often used as alternative criterion. The maximum possible lag length considered was ten (weeks). We concluded that three lags would be appropriate for the analysis.

System Residual Diagnostics

The residual diagnostics are examined in table 2. The columns represent the estimated residuals, a histogram with normal distribution, and the autocorrelation and partial autocorrelations respectively. There appear to be periods with very large errors or outliers in the three price series. Also, there appears to be an increase in the variance for the Tanker rates (LBDTI4, first column and first row). This leads to relatively sharp peaks in the frequency distributions and fat tails which are the norm with financial or price series. There does not appear to be any serial correlation in all four equations. Table 2 provides the residual diagnostic tests from the 4-variable system with three lags. We report both the individual equation tests and the system or vector tests. Column one explains the test in each row. The next four columns contain the statistics for LBDTI4, LRCLC3, LRWTI, and LWCESTUS1 respectively. The first set of rows look at whether the estimated residuals exhibit normality. They confirm the visual observations from the figure. There does not appear to be a problem with skewness, but there is problem with kurtosis which results in the rejections of the Jarque-Bera tests. The autocorrelation tests and Portmanteau tests by equation and for the system do not reject the null of no autocorrelation. The tests for homoskedasticity are next. Again, the visual evidence is confirmed. We find that the null of homoskedasticity for the Tanker rate equation is rejected, but not for the other equations. The final test is for the null of no conditional heteroskedasticity at lag one. Tanker rate and the oil spot price appear to have an ARCH process, but this result may be due to the large outliers.

Granger Causality Tests

Table 3 shows the Granger Causality tests for this 4-variable model. Each of the 4 variables appears to have explanatory power for one or more of the other variables in the system. The effects are direct, but often complex and indirect. In the first equation, it appears that neither of the crude prices provides explanatory power for the Tanker rate and inventories only at the 10% level. However, if all these series are omitted for the equation, there is a loss of power at nearly 1%. There must be a multifaceted relationship between these series leading to an explanation of tanker rates. Futures contracts appear to be influenced by Tanker rates and inventories at 5% and 1% levels respectively. The WTI spot price is explained by past values of all three series. Inventories probably contain the information from spot prices and future prices. Financial theory would suggest that efficient markets already use the spot price. Spot prices are explained by all three other series. Inventories appear to be explained by the three price series at about the 5% level individually and jointly. The strength of this result was somewhat surprising, because we hypothesized that real supply and demand variables are important in explaining movements in inventories. Prices are no doubt correlated with those variables and that may explain the strong relationship.

The Cointegration Analysis of the Vector Autoregression Model

In this section the Johansen procedure is applied to test for the presence of cointegration. The VAR model in levels can be linearly transformed into one in first differences.

$$\begin{bmatrix} \Delta \ln BDTI4_t \\ \Delta \ln RCLC3_t \\ \Delta \ln WTI_t \\ \Delta \ln WESTUS1_t \end{bmatrix} = \Pi \begin{bmatrix} \ln BDTI4_{t-1} \\ \ln RCLC3_{t-1} \\ \ln WTI_{t-1} \\ \ln WESTUS1_{t-1} \end{bmatrix} + \Gamma(L) \begin{bmatrix} \Delta \ln BDTI4_{t-1} \\ \Delta \ln RCLC3_{t-1} \\ \Delta \ln WTI_{t-1} \\ \Delta \ln WESTUS1_{t-1} \end{bmatrix} + B \begin{bmatrix} constant \\ trend_t \end{bmatrix} + \begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \\ \varepsilon_{3,t} \\ \varepsilon_{4,t} \end{bmatrix}$$

$$\begin{aligned} where \quad & \Pi = \Pi_1 + \Pi_2 - I,\ \Gamma_1 = -\Pi_2 - \Pi_3 - \ldots - \Pi_p, \\ & \Gamma_2 = -\Pi_3 - \Pi_4 - \ldots - \Pi_p, \ldots,\ \Gamma_{p-1} = -\Pi_p \\ & \varepsilon \sim (0, \Omega), \end{aligned}$$

The crux of the Johansen test is to examine the mathematical properties of the **Π** matrix which contains important information about the dynamic stability of the system. Intuitively, the **Π** matrix above is an expression relating the levels of the endogenous variables in the system.

Engle and Granger (1987) demonstrate the one-to-one correspondence between cointegration and error correction models. Cointegrated variables imply an error correction (ECMs) representation for the econometric model and, conversely, models with valid ECMs impose cointegration. Evaluating the number of linearly independent equations in **Π** is done by testing for the number of non-zero characteristic roots, or eigenvalues, of the **Π** matrix, which equals the number of linearly independent rows.[3] The matrix can be rewritten as the product of two full column vectors, $\Pi = \alpha \beta'$.

The matrix β ' is referred to as the cointegrating vector and α as the weighting elements for the rth cointegrating relation in each equation of the VAR. The vector $\beta' Y_{t-1}$ is normalized on the variable of interest in the cointegrating relation and interpreted as the deviation from the "long-run" equilibrium condition. In this context, the column α represents the speed of adjustment coefficients from the "long-run" or equilibrium deviation in each equation. If the coefficient is zero in a particular equation, that variable is considered to weakly exogenous and the VAR can be conditioned on that variable. Weak exogeneity implies that the beta terms or long-run equilibrium relations do not provide explanatory power in a particular equation. If that is true, then valid inference can be conducted by

[3] The number of linearly independent rows in a matrix is called the rank.

dropping that equation from the system and estimating a conditional model.

The results of the Johansen cointegration test are presented in table 4 and are partitioned into three parts. The first part provides the test results for the null hypothesis of no cointegration. The eigenvalues of the **Π** matrix are sorted from largest to smallest. The tests are conducted sequentially, first examining the possibility of no cointegrating relation against the alternative that there is one cointegrating relations, and then the null of one cointegrating relation against the possibility of two cointegrating relations, e.g. Essentially, these are tests of whether the eigenvalue(s) is (are) significantly different from zero. We rejected the null of no cointegration or rank zero. The test for no cointegration (r=0) in the spot tanker rate model is rejected at less than 0.01 with the Trace test (80.4) and the Max(eigenvalue) test (50.3).

The second part shows the first standardized eigenvector or β vector on the BDTI4 spot tanker rate. We interpret the cointegrating relation as demand relation for tankers on the spot market for the West Africa – US Gulf trade.

$$0\,\mathit{Spot\ Tanker\ Price}_t = 50\left(3\ \mathit{mo.\ Future\ Price}_t - \mathit{WTI\ Spot\ Price}_t\right) - 28\ \mathit{Inventories}_t$$

The estimates for the β vector are presented in a row under each variable. The signs are reported as if the sum of the entire vector equals zero, thus the opposite signs. The associated standard errors are provided below. The β coefficients for the three month contract and WTI are roughly equal and of opposite sign. Thus, if future prices are expected to rise or the 3 month contract-spot spread is positive there will be upward pressure on tanker rates. If weekly inventories of days supply for US crude are increasing, then spot rates are falling. The cointegrating includes a small negative trend. Explaining this component is beyond the current research. One hypothesis is that it could reflect growing tanker capacity (on the spot market) over time easing the spot price. Figure 8 illustrates the error correction mechanism.

We report hypothesis tests on the α vector and the associated standard errors in the third part of the table. If the cointegrating or demand relation we have specified is appropriate (and stationary), then its own coefficient must be negative. In this case, the estimate is -0.0088 and significant. Thus, if the spot tanker rate was above the demand relation last week, the change in the spot rate this week should lower. We can test if the other α terms are significant, that is whether the equations for those variables are influenced by the cointegrating relation using the standard errors or the Chi-square tests for weak exogeneity. We find that the three month contract rate is not significant and is weakly exogenous with respect to the relation for the current spot rate. However, past tanker rates and inventories do help to explain the three month contract rate in the Granger Causal sense. The WTI is negatively, but marginally related to the spot rate demand cointegrating relation with a p-value of 0.09. Inventories may be related or partially explained by the relation; the p-value is less than 0.01.

5. The Forecasting Model

We form a single equation error correction model for the change in spot tanker prices to generate the forecasts. The results from the parsimonius reduction of the full error correction model are presented in Table 5. The estimation was performed in Autometrics in PCGive version 12. We allowed for inclusion of dummies for outliers exceeding a t-statistic greater than 3 in a one sided test. The final model includes lags of both the spot tanker price, spot WPT, and 3-month contract price. In addition, we found a strong influence from inventories in different forms. These included current change in inventories (days supply), the actual level and deviations of inventories from high and low spreads seasonally going back five years.

The Granger causality results suggest that there is strong exogeneity implying that forecasts of the other variables likely depend on previous values of the change in spot rates. The changes in oil prices and inventory measures are forecasted in a simple VAR framework with 5 lags including the previous changes in spot tanker prices.

We present two types of dynamic forecasts holding back the last 20 observations (weeks). The first is the one week ahead change and the second is four weeks ahead forecasts. These presented in figures 8 and 9 respectively. We find that except for two observations in September 2005, the actual values lie within the 95% confidence region of the forecasts.

6. Discussion and Conclusions

This paper examines the relationship between weekly spot tanker prices and the oil market over the past eight years (1998-2006). The focus is on the West African and U.S Gulf Coast tanker market. We find that past knowledge of spot tanker rates, three month future contracts, spot WTI prices, and the days supply of crude inventories explain current values in a Granger causal sense. In addition we are able to uncover a demand relation for tankers in the spot market using cointegration analysis. This finding may reflect the idea that the demand for tankers is a derivative for the demand for oil. If there is a strong demand for oil, there is a strong demand for tankers so it is possible for tanker companies to raise rates. The demand determinants suggest that when the spread or three month Cushing futures contract is trading above the current WTI spot price there is upward pressure on spot tanker rates. In addition, when the days supply of crude inventories increases the spot tanker rate declines. We find evidence of feedback between the spot tanker market, current prices and inventories. The estimated model is used to predict one month ahead and four weeks ahead.

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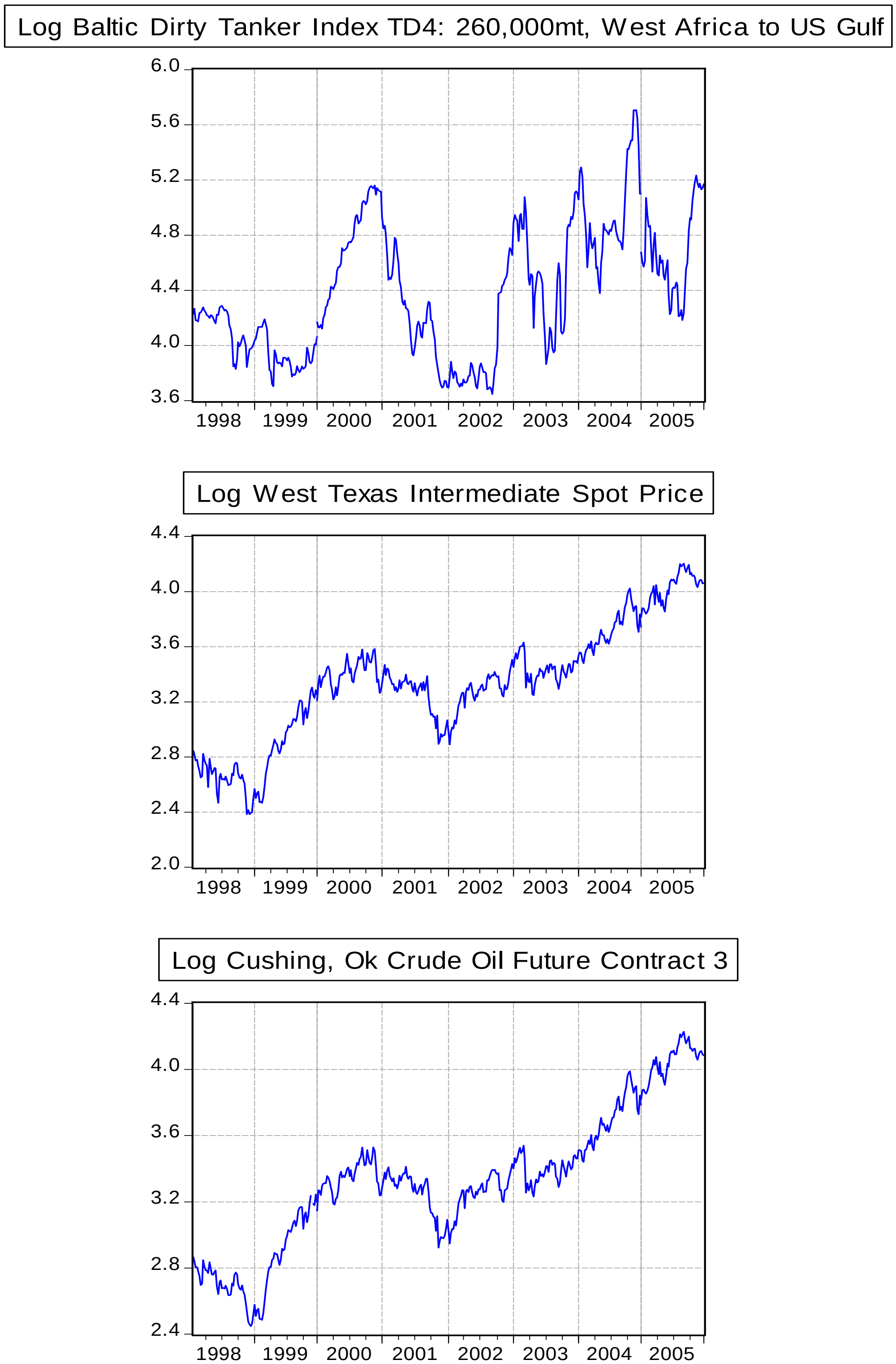
Figure 1



Log Baltic Dirty Tanker Index TD4: 260,000mt, West Africa to US Gulf
6.0
5.6
5.2
4.8
4.4
4.0
3.6
1998 1999 2000 2001 2002 2003 2004 2005
Log West Texas Intermediate Spot Price
4.4
4.0
3.6
3.2
2.8
2.4
2.0
1998 1999 2000 2001 2002 2003 2004 2005
Log Cushing, Ok Crude Oil Future Contract 3
4.4
4.0
3.6
3.2
2.8
2.4
1998 1999 2000 2001 2002 2003 2004 2005

Figure 2

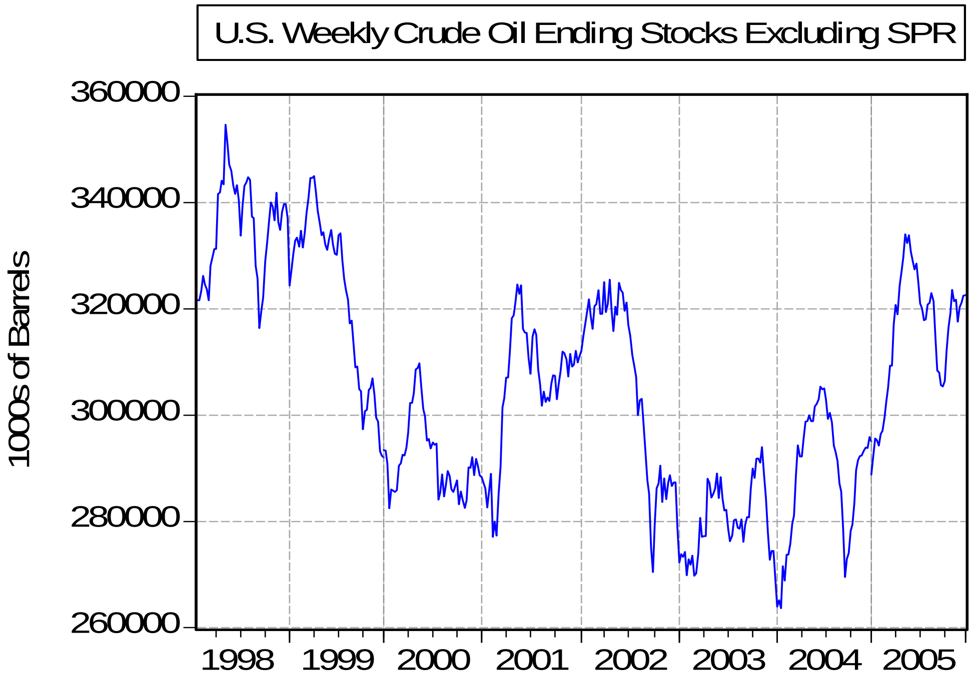


Figure 3

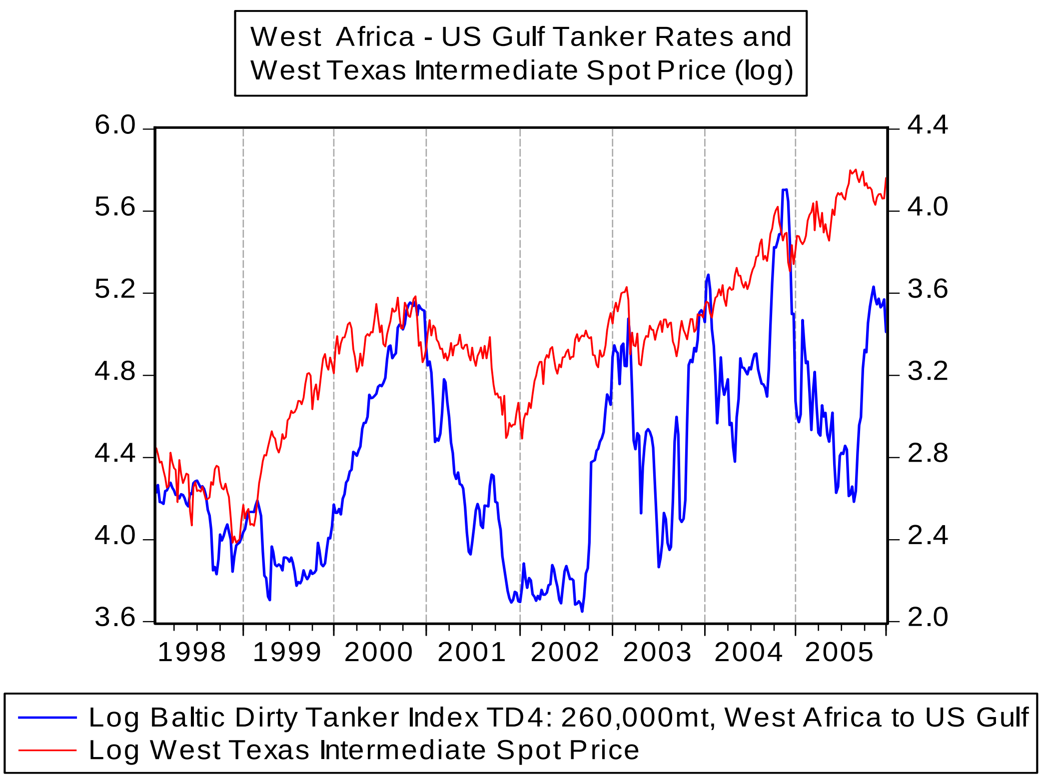


Figure 4

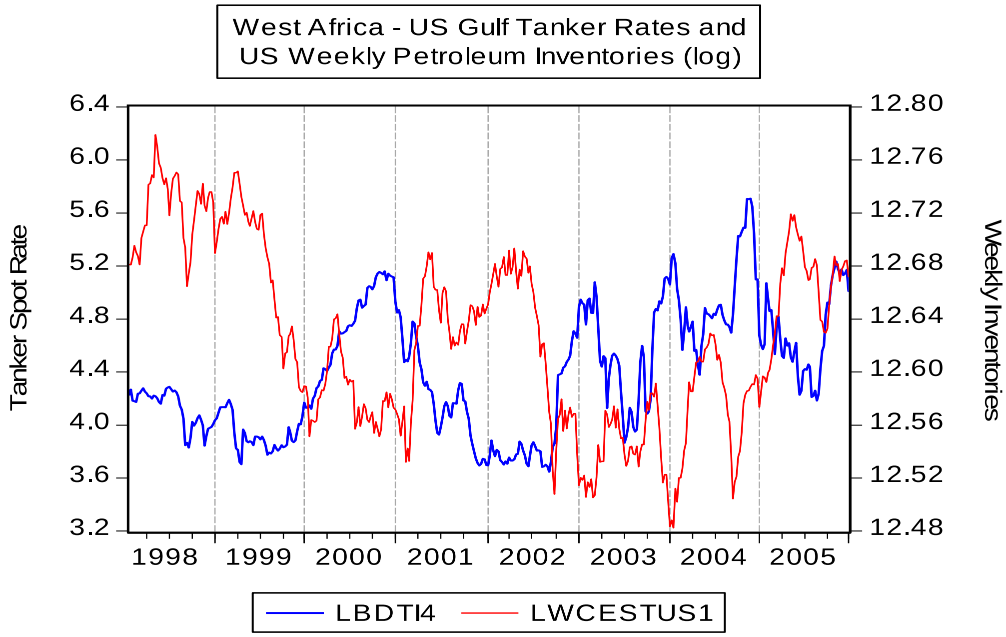


Figure 5

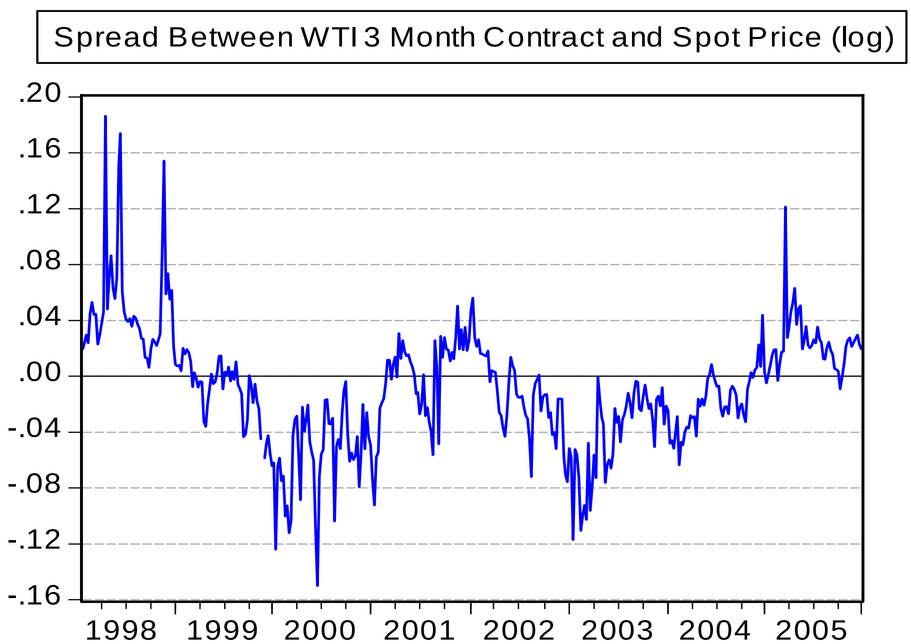


Figure 6

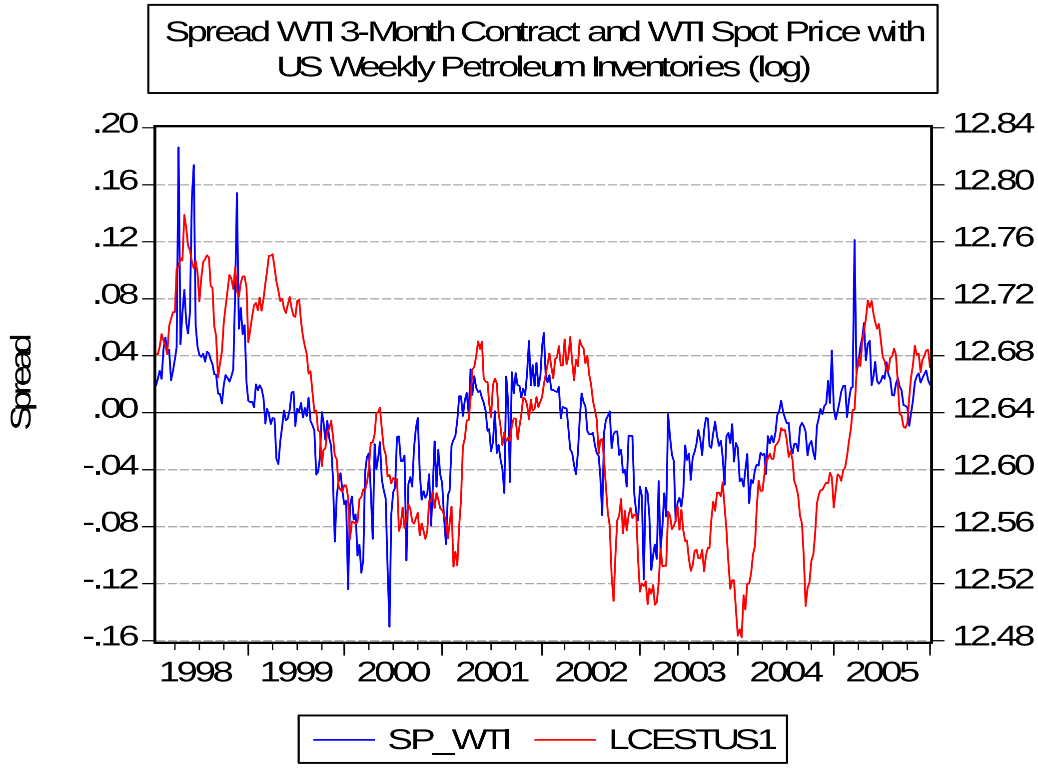


Figure 7

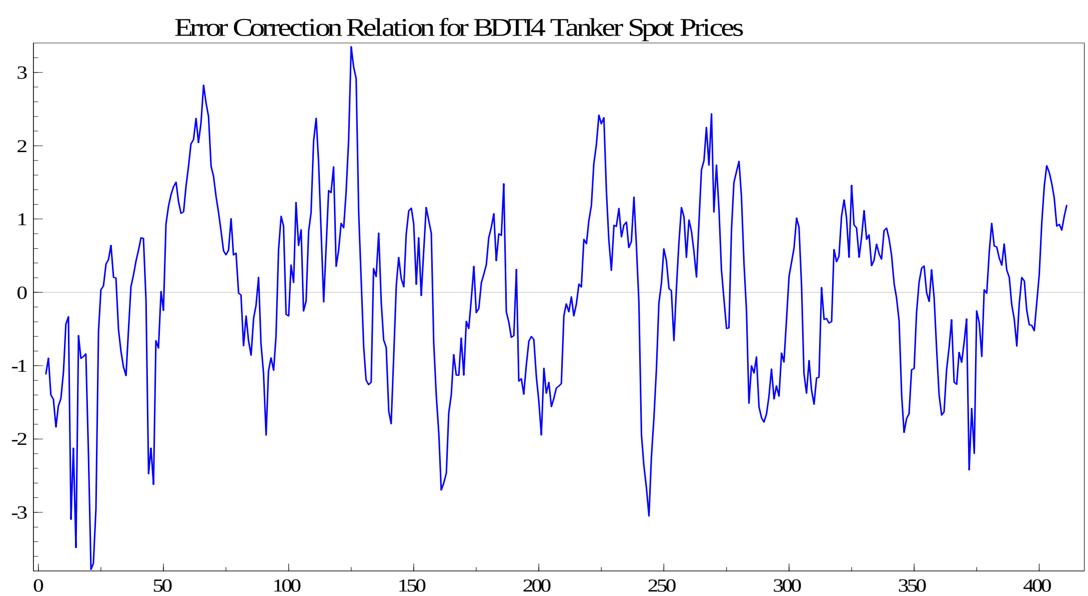


Figure 8

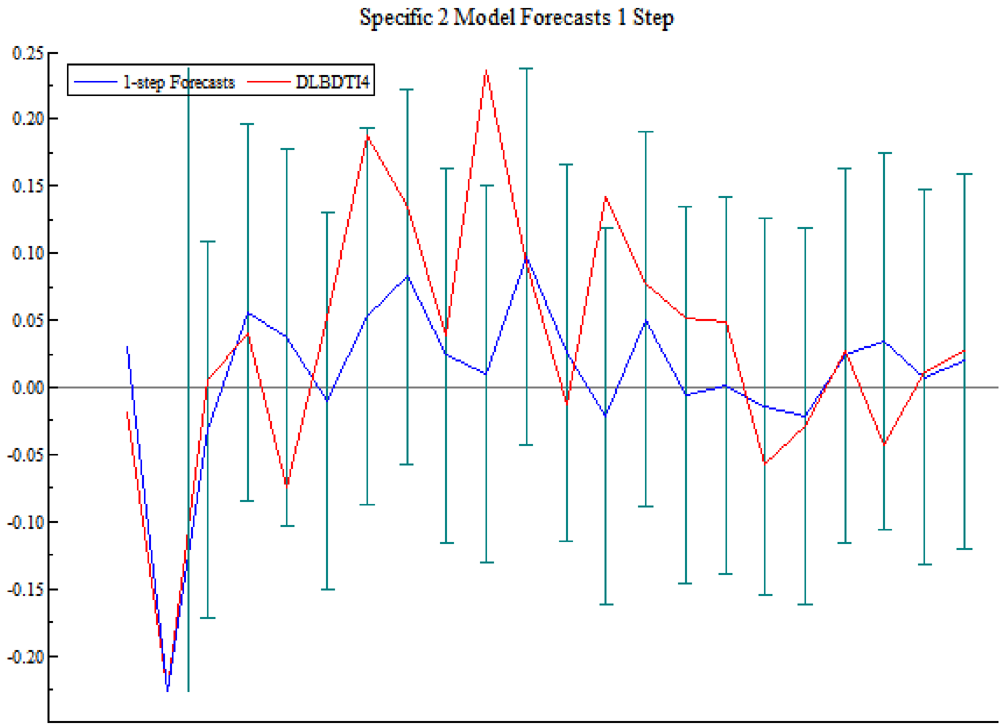


Figure 9

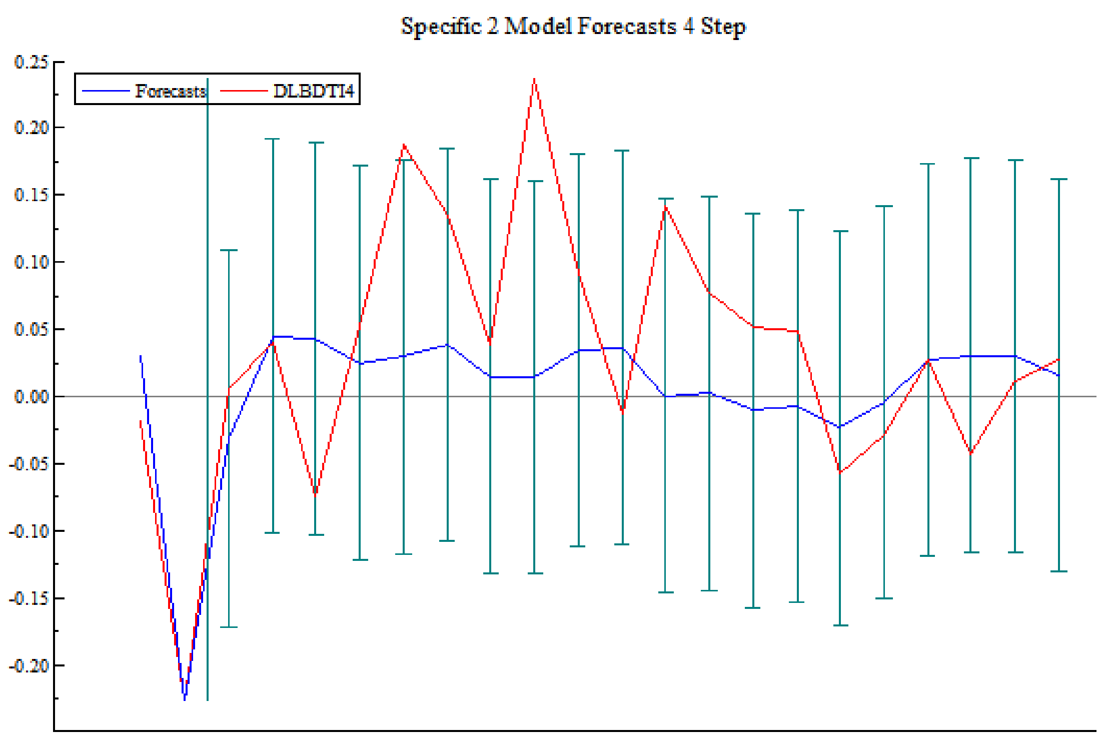


Table 1

Variable Name	Description	Units	Source
LBDTI4	Log Baltic Dirty Tanker Index TD4: 260,000mt, West Africa to US Gulf	Index	Baltic Exchange
LRCLC3	Log Cushing, Ok Crude Oil Future Contract 3	$ / Barrel	NYMEX Futures Prices
LRWTC	Log West Texas Intermediate Spot Price	$ / Barrel	NYMEX
LWCESTUS1	Log U.S. Weekly Crude Oil Ending Stocks Excluding SPR	1000s of Barrels	EIA
SP_WTI3	Spread between WTI Spot Price and 3-mo Future Contract	$ / Barrel	NYMEX
WCESTUS1	U.S. Weekly Crude Oil Ending Stocks Excluding SPR	1000s of Barrels	EIA

A capital "D" in the beginning of a variable means that it has been transformed into natural logarithms.

Table 2
Residual Diagnostic Tests
Normality Test for Residuals

	LBDTI4	**LRCLC3**	**LRWTI**	**LWCESTUS1**
Skewness	0.037708	-0.30912	-0.91646	-0.28527
Excess kurtosis	6.9724	4.3355	7.7874	3.7658
Skewness (transformed)	0.31632	-2.5386	-6.6543	-2.3499
Excess kurtosis (transformed)	11.572	4.0823	6.7315	2.3258
J-B test Chi^2(2)=	135.04 [0.0000]**	33.449 [0.0000]**	28.398 [0.0000]**	10.788 [0.0045]**
Vector Normality test: Chi^2(8) = 257.64 [0.0000]				
AR 1-2 test: F(2,392) =	2.1396 [0.1191]	0.77893 [0.4596]	0.78208 [0.4582]	0.66243 [0.5162]
Portmanteau test with 10 lags	6.22129	11.4148	13.5525	6.95853
Vector Portmanteau(10): 157.931				
hetero test: F(26,367)=	2.9969 [0.0000]**	0.66306 [0.8968]	1.1945 [0.2367]	1.3795 [0.1048]
Vector hetero test: F(260,3377)= 1.5772 [0.0000]				
ARCH 1-1 test:F(1,392)	6.1768 [0.0134]*	1.2373 [0.2667]	6.3164 [0.0124]*	0.77604 [0.3789]

Sample: January 26th, 1998 1/02/2006 , Included observations: 397
The VAR system includes four variables: LBDTI4, LRCLC3, LRWTI, and LWCESTUS1. There is a constant and trend in the VAR as well. Significant at 5% (*) and 1% (**).

Table 3

VAR Pairwise Granger Causality or Block Exogeneity Wald Tests

	Exclusion Restrictions				
Equations	**LBDTI4**	**LRCLC3**	**LRWTI**	**LWCESTUS1**	**All**
LBDTI4		3.985	4.496	7.451	20.902
		0.263	0.213	0.059*	0.013**
LRCLC3	7.981		1.185	6.470	15.279
	0.046**		0.757	0.091*	0.084*
LRWTI	9.553	16.806		13.146	34.884
	0.023**	0.001***		0.004***	0.000***
LWCESTUS1	7.285	7.684	8.033		18.298
	0.063*	0.053*	0.045**		0.032**

Sample: January 26th, 1998 1/02/2006
Included observations: 397
The VAR system includes four variables: LBDTI4, LRCLC3, LRWTI, and LWCESTUS1. There is a constant and trend in the VAR as well.
The Chi-square tests are reported in each cell with their associated p-values. There are 3 restrictions in the four columns and 9 restrictions in the last column.
Significant at 10% (*), 5% (**) and 1% (***).

Table 4
Johansen Cointegration Analysis of
BDTI4 Tanker Prices, WTI, WTI 3-mo contract, and US Weekly Petroleum Inventories

rank	**eigenvalue**	**Trace**	**p-value**	**Max Eigen.**	**p-value**
0	0.11563	80.35	0.001**	50.26	0.000**
1	0.04902	30.09	0.503	20.56	0.220
2	0.01395	9.53	0.936	5.75	0.954
3	0.00921	3.78	0.770	3.78	0.772
	Standardized eigenvalues, beta' values and standard errors				
	LBDTI4	LRCLC3	LRWTC	LWESTUS1	Trend
	1.00	-50.492	48.350	28.143	0.0102
	-	6.957	6.687	4.221	0.003
	Standardized alpha coefficients and standard errors				
	LBDTI4	LRCLC3	LRWTC	LWESTUS1	
	-0.0088	0.0018	-0.0038	-0.0016	
	0.004	0.0018	0.0023	0.0005	
Weak Exogeneity		0.19 (0.66)	2.86 (0.09)	9.12 (0.003)	

Sample: January 26th, 1998 1/02/2006
Included observations: 397
The VAR system includes four variables: LBDTI4, LRCLC3, LRWTI, and LWCESTUS1. There is a constant and trend in the VAR as well.
The weak exogeneity tests are Chi-squares with 1 degree of freedom. P-values are reported in parentheses.

Table 5 Final Conditional Vector Error Correction Model for the Change in Spot Tanker Prices

FINAL Model	Coefficient		Std.Error	t-value
DLBDTI4_1	0.29905		0.03955	7.56
DLBDTI4_2	-0.12576		0.04007	-3.14
Constant	2.75436		0.6205	4.44
DLRCLC3	-0.05044		0.2087	-0.242
DLRCLC3_2	0.150406		0.08555	1.76
DLRWTC	0.081459		0.168	0.485
DLRWTC_1	0.072196		0.06976	1.03
DLDAYSUP_US1	-0.33135		0.2363	-1.4
DLDAYSUP_US1_1	-0.15268		0.234	-0.652
DLDAYSUP_US1_2	-0.37318		0.2311	-1.61
DAYSUP_US1	0.010132		0.002299	4.41
DAYSUP_US_DEVH1	-0.00576		0.01418	-0.406
DAYSUP_US_DEVL1	-0.0056		0.00173	-3.23
	-0.04491		0.01097	-4.09
LRCLC3_1	0.260158		0.1509	1.72
LRWTC_1	-0.21422		0.1527	-1.4
LWCESTUS1_1	-0.61752		0.1152	-5.36
I:1999-04-30	0.284063		0.07128	3.99
I:2002-10-11	0.302494		0.07133	4.24
I:2003-01-03	0.235889		0.07094	3.33
DI:2003-05-02	0.344598		0.0506	6.81
I:2003-07-04	-0.20945		0.07136	-2.94
I:2003-09-26	-0.38211		0.07207	-5.3
I:2003-10-24	0.330098		0.07069	4.67
I:2004-05-07	0.226879		0.07084	3.2
I:2004-05-21	0.22224		0.07113	3.12
I:2004-11-05	0.252428		0.07169	3.52
I:2004-12-10	-0.2567		0.07314	-3.51
I:2004-12-24	-0.47434		0.07385	-6.42
DI:2005-01-28	-0.34387		0.05064	-6.79
I:2005-05-27	-0.27427		0.07904	-3.47
I:2005-07-22	-0.23509		0.08004	-2.94
sigma	0.070112	RSS		1.745051
R^2	0.54893	F(31,355) =		13.94 [0.000]**
log-likelihood	496.088	DW		1.95
no. of observations	387	no. of parameters		32

Forecasting Interments and Gravesites in VA National Cemeteries

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> *The National Cemetery Administration honors veterans with final resting places in national shrines and with lasting tributes that commemorate their service to our nation.* – NCA mission.

Approximately 650 thousand veterans are projected to die in FY 2008. More than 68 thousand veterans and more than 33 thousand of their dependents will be interred in 125 national cemeteries this fiscal year. To fulfill its mission, the National Cemetery Administration (NCA) strives to provide burial sites in VA administered national cemeteries to every veteran who wants one. To avoid a disruption in service to veterans, we must distribute limited resources to develop existing land for new gravesite areas, and to obtain additional land for cemetery expansion. To be successful, NCA needs accurate forecasts of future burial site needs, and accurate estimated depletion dates. NCA needs two distinct kinds of depletion dates: 1) life-of-the-cemetery depletion dates of established cemeteries, and 2) currently in-use developed burial areas depletion dates.

A new model to forecast interments and gravesites was first developed in FY 2005. Although immediately pressed into service, the process of developing this model is ongoing. The design of the new model will continue to change as new pertinent information becomes available either from examining historical changes in actual interments or from developing new data sources. The limits, determined by available land, on the number of total gravesites in individual national cemeteries present unique and challenging problems for any projection model that forecasts interments and gravesites. The new model uses ratio-correlation between interments and veteran deaths to forecast interments and gravesites, and perpetual inventory theory to estimate depletion dates.

This paper outlines, for the new model, the variables available, the methods of projection used, the algorithms used to determine closing dates, and the effect of one type of interment becoming unavailable on usage rates of other types of interments. It also describes the past model and outlines differences in work products between them. The scope of this paper is limited to established cemeteries. Forecasting interments and gravesites in new cemeteries will be examined in a future paper.

Definitions

There are four types of interments in national cemeteries:

1. Full-casket (FC), where the deceased is buried in a traditional casket in a full sized burial plot;
2. In-ground (IG) cremation, where the ashes of the deceased are placed in an urn and buried in a half-sized burial plot or an obstructed full-sized plot;
3. Columbaria cremation, where the ashes of the deceased are placed in an above ground columbaria niche; and
4. Scattered cremation, where the ashes of the deceased are scattered in a memorial garden.

Each of the first three types of interments is further divided into:

- ➯ first interments, the first deceased family member to be interred in a gravesite; and
- ➯ second and subsequent interments, interments of deceased family members in an occupied gravesite.

There are five types of gravesites in national cemeteries: 1) traditional FC, and 2) pre-placed crypt, which are both counted as full-casket sites in this forecasting model; 3) obstructed FC, and 4) half-sites, which are both counted as in-ground cremation sites, also called inurnments sites; and 5) columbaria cremation sites, also called niches.

There are different status categories for gravesites:

- Used sites, available for second and subsequent interments of family members of the veteran or dependent who is interred in the site.
- Unoccupied and Available sites.
- Reserved sites, which are unoccupied but have been reserved.
- Adjacent set-aside sites which are reserved for a veteran who is the widow/widower of a deceased veteran interred in the plot next to the adjacent set-aside site.

There are three different status categories for national cemeteries:

- o Open—cemeteries that have unoccupied, available full-casket sites.

- Cremation Only—cemeteries that have exhausted their supply of unused, available full-casket sites, but have unused in-ground cremation sites and/or columbaria niches available, and
- Closed—cemeteries with no unused sites available. Some closed cemeteries are still interring remains: second and subsequent interments in an occupied gravesite, and/or first interments in reserved gravesites.

For the purpose of the projections only, I have an unofficial status—"dead." Dead cemeteries average less than 3 interments per week.

Acreage is reported in two categories: developed and undeveloped. Undeveloped acres is further divided into developable and un-developable, but this is not reported in any organized way. A researcher must talk to people with knowledge of individual cemeteries to find out if part of the cemetery can never be developed because it is swampy or sandy or mountainous, has an historical building or an archeological dig on it, or is home to an endangered species and the number of affected acres.

MSN stands for Memorial Service Network. The country is divided into five MSNs: Philadelphia, Atlanta, Denver, Indianapolis, and Oakland.

MSN deaths are the number of projected deaths to veterans in the states that comprise each of the MSNs. (All states except Virginia fall entirely in one MSN. Virginia falls primarily in MSN I; only counties located along the lower boundary of the state and one closed cemetery fall in MSN II. The closed cemetery is administered by a cemetery in MSN II. For the purposes of this model, all Virginia veteran deaths are counted in MSN I.) Service area deaths are the number of projected deaths to veterans in counties within a 75 mile radius of the cemetery. A county is counted in the 75 mile radius if all or most of the county lies within the radius, or if the largest population center lies within the 75 mile radius.

MADSS, The Management And Decision Support System, is an NCA business intelligence application that, for each cemetery and MSN, keeps track of numbers of interments by type; graves maintained; gravesites added, lost, used, reserved; visitors; volunteer hours; FTE; energy consumption; etc. Some of the information is input directly into MADSS; some of the information comes from another data base: BOSS, which stands for Burial Operations Support System. BOSS is, in part, a data base of individual records covered by privacy rules, and was not readily available to this researcher when the model was being developed. Much of the information in BOSS is duplicated in MADSS. MADSS is the primary data source for this model.

Variables

The basic data for the model comes from two sources: MADSS and the Vet Pop model.

MADSS provides administrative data on 1) interments by type (full-casket, in-ground cremation, columbaria cremation, and scattered cremated remains); 2) available and used gravesites by type; and 3) interments by veteran status and, for veterans, period of military service—WWI, WWII, Korean conflict, Vietnam Era, Gulf War by full-casket and total cremations. (Veterans who served in more than one war period are counted in the first war period they served in. Veterans who served in peacetime only are counted in a general peacetime category spanning the years from before WWI through July 1990.) There is also information on gravesites used, gravesites maintained, and gravesites available by type of gravesite.

The Vet Pop model, produced by the VA Office of the Actuary, provides a projection of veteran deaths by age, sex, and period of service by state; and by age and sex by county.

Method

The basic model for projecting interments and gravesites is straightforward: 1) calculate historical usage ratios based on historical interments divided by historical veteran's deaths; 2) project the usage ratios; and 3) derive projected interments by multiplying *a)* projected usage ratios by *b)* projected veteran's deaths. The Vet Pop state and national projections are developed using a cohort survival rate method. The county Vet Pop projections produced periodically since 1983, are developed using a censal-ratio method. (Sorensen Technical Appendix Projections of the United States and Puerto Rico Veteran Populations: 1990 – 2020)

Historical	Projected
$Y_t/D_t = R_t$	$\dot{R}_t * \dot{D}_t = \dot{Y}_t$

Interments are projected independently for each cemetery. I project interments by seven categories (if all are available at the cemetery):

1. 1st Full-Casket
2. 2nd and subsequent Full-Casket
3. 1st In-Ground Cremation
4. 2nd and subsequent In-Ground Cremation

5. 1st Columbaria Cremation
6. 2nd and subsequent Columbaria Cremation
7. Scattered Cremated remains

Only 26 cemeteries had Columbaria available in FY 2007; even fewer, 10 cemeteries, had Scatter gardens, and so these categories are not part of the projections in most cemeteries.

I used projected deaths of veterans in counties falling completely or primarily within a 75 mile radius of the cemetery as the driver in this model. For "dead" cemeteries, I used the MSN deaths as a driver. Although interments are composed of, in addition to veterans, active duty military, 20 year plus reservists, and dependents, the projected number of veteran deaths is a good indicator variable for interments because:

1. the majority of interments, approximately 70 percent, are veterans,
2. approximately 30 percent of the interments are dependents of veterans, and the number of interments of dependents of veterans are correlated to the number of deaths to veterans because:
   a. the number of dependent interments is correlated to the number of dependent deaths,
   b. the number of dependent deaths is correlated to the number and age of dependents,
   c. the number and age of dependents is correlated to the size and age of the veteran cohort (the bigger the veteran cohort the more dependents it has; the smaller the veteran cohort the fewer dependents it has.), and
   d. the size and age of the veteran cohort is correlated to the number of veteran deaths.
3. The number of 20 year reservists and active duty combined is less than ⅓ of one percent of the total interments, not significant enough to worry about. Also, most of the reservists are included in the vetpop projections.

There is some preparation work before developing a new set of gravesite and interment projections. The most recent fiscal year data or an estimate of the current fiscal year data on interments, gravesites, available and potential future sites must be entered into the model. For interments and gravesites, for each of the full-casket and cremation types, trend lines and the least square intercept, Ý, for the next fiscal year must be calculated. The trend lines and Ý must be examined for reasonableness. Ý is never allowed to be less than 0 for example, which can happen in a cemetery with close to 0 interments per year or with a sudden drop in interments in a specific category. The trend lines have typically used interment data from 1998 through the most recent fiscal year. In special case cemeteries, the Ý derived from fewer years results in a better fit. Examples of special case cemeteries are: a young cemetery that opened less than 15 years ago; a cemetery with a sudden drop or rise in interments because a new cemetery was built nearby; a cemetery that recently received a new donation of land resulting in more burial options, changing the status of the cemetery from cremation only to open; or a closed cemetery that recently got a new columbarium changing its status from closed to cremation only.

Projection of Full-Casket Interments

For all types of cemeteries, 1st and 2nd full-casket interments are projected separately by the following process. 1) historical interments are smoothed, 2) historical usage ratios of smoothed interments to service area or MSN deaths are calculated, 3) the usage ratios are projected forward, and 4) the projected usage ratios are multiplied by the projected deaths to get projected 1st and 2nd interments. The projected 1st and 2nd interments are added to get total FC interments. The details of this process are given below:

$Y^{1F}{}_t$ = historical first full-casket interments
$Y^{2F}{}_t$ = historical second full-casket interments
$D^s{}_t$ = historical Service area deaths
$D^m{}_t$ = historical MSN deaths
$\dot{Y}^{1F}{}_t$ = projected first full-casket interments
$\dot{Y}^{2F}{}_t$ = projected second full-casket interments
$\dot{D}^s{}_t$ = projected Service area deaths
$\dot{D}^m{}_t$ = projected MSN deaths

For the first step, smoothing the historical interments, three year averages are calculated. The historical usage ratios are based on the three year averages rather than the actual interments in a given year to lessen the vagaries of yearly interments. This creates a problem for the last actual year of interments—as with all smoothing techniques, you lose the first and last year(s) of history because there aren't enough data points to calculate the first and last average(s) in the historical series. To finesse this problem, the model uses a least squares regression formula to project interments one year and then uses the number of interments derived from that procedure as the 3rd point in calculating the three year average for the current year.

1st full-casket interments

First full-casket interments, per se, are not reported in MADSS. The number of full-casket gravesites used during the year is reported. I use this number as a stand-in for the number of 1st full-casket interments. It should be exactly the same number and usually is.

Three year average: $T_t = \frac{1}{3} * (Y^{1F}_{t-1} + Y^{1F}_{t} + Y^{1F}_{t+1})$
Three year average for the most recent fiscal year: $T_t = \frac{1}{3} * (Y^{1F}_{t-1} + Y^{1F}_{t} + \acute{Y}^{1F}_{t+1})$, where $\acute{Y}$ equals the least squares intercept for the first projected year.
Usage Ratios: $R_t = T_t/D^s_t$ or $R_t = T_t/D^m_t$

Projecting the usage ratios is key to projecting the 1st FC interments. Different techniques, given below, are used for different conditions.

In our initial projections, I used a four year weighted average of the historical usage ratios to project future interments; however, in most cemeteries, the historical usage ratios are a random walk with drift, resulting in a low projection for cemeteries with an increasing trend and a high projection for cemeteries with a decreasing trend. To avoid our projection of interments lagging behind the trend, I developed a method of projecting the usage ratios.

The model calculates 1) the percent change in the historical usage ratios for each of the last four years and 2) the average of the yearly percent changes:

Percent change in historical usage ratios, $H = (R_t - R_{t-1}) / R_{t-1}$
Average of percent changes in historical usage ratios: $H_A = \frac{1}{4} * (H_{t-3} + H_{t-2} + H_{t-1} + H_{to})$.

For cemeteries where the historical usage ratios are a random walk with drift, (defined as $|H_A| > .00010$) I use the past percent changes in the usage ratios to project future changes in the usage ratios, but to be conservative, I moderate the trend line by declining the percent change each year of the projection. How much to decline the percent change each year requires judgment and a careful review of past changes. You want to avoid carrying forward an anomalous precipitous change. (An example of a change that should not be carried forward is a sudden drop in interments caused by the opening of a new VA national cemetery 100 miles away. The default declension rate is ⅓ per year. Anomalous individual historical yearly changes in the usage ratios may be omitted from the calculation of H_A.

The default projected changes in the usage ratios for each of these cemeteries for year 1 is,

$$\dot{H}_t = .667 * H_A;$$

for each year after,

$$\dot{H}_{t+1} = .667 * \dot{H}_t$$

The projected usage ratios, $\dot{R}_t = (1+\dot{H}_t) * \dot{R}_{t-1,}$ or $\dot{R}_{t-1} + (\dot{H}_t * \dot{R}_{t-1})$.
(both of these formulas work)

The projected interments, $\dot{Y}^{1F}_t = \dot{R}_t * \dot{D}^s_t$

For cemeteries where the historical usage ratios are a random walk without drift, the model continues to use a four year weighted average as the projected future usage ratios, as expressed in the following formula to project interments:

$\dot{Y}^{1F}_t = ((Y^{1F}_{t_{o-3}} + (1.5 * Y^{1F}_{t_{o-2}}) + (2 * Y^{1F}_{t_{o-1}}) + (2.5 * Y^{1F}_{t_o}))/ (D^s_{t_{o-3}} + (1.5 * D^s_{t_{o-2}}) + (2 * D^s_{t_{o-1}}) + (2.5 * D^s_{t_o}))) * \dot{D}^s_t$, where $_{t_o}$ equals the most recent historical year and $_t$ equals the projected year.

For cemeteries averaging less than 3 interments per week, the weighted average is always used and MSN deaths instead of service area deaths are used as the denominator in the usage ratio. These cemeteries are nearly always closed. They have no available full-casket sites. Any 1st full-casket interments are in reserved or set aside sites. I use the following formula to project 1st full-casket interments in "dead" cemeteries.

$\dot{Y}^{1F}_t = ((Y^{1F}_{t_{o-3}} + (1.5 * Y^{1F}_{t_{o-2}}) + (2 * Y^{1F}_{t_{o-1}}) + (2.5 * Y^{1F}_{t_o}))/ (D^m_{t_{o-3}} + (1.5 * D^m_{t_{o-2}}) + (2 * D^m_{t_{o-1}}) + (2.5 * D^m_{t_o}))) * \dot{D}^m_t$, where $_{t_o}$ equals the most recent historical year and $_t$ equals the projected year.

For example, for a projection done in the fall of 2007, first full-casket interments for the projected year, 2012 equal ((FY 2003 1st FC interments plus 1.5 times FY 2004 1st FC interments plus 2 times FY 2005 1st FC interments plus 2.5 times FY 2006 1st FC interments) divided by (FY 2003 projected veteran deaths in the MSN plus 1.5 times FY 2004 projected veteran deaths in the MSN plus 2 times FY 2005 projected veteran deaths in the MSN plus 2.5 times FY 2006 projected veteran deaths in the MSN)) multiplied by FY 2012 projected MSN veteran deaths.

The projection of first full-casket interments is also the projection of full-casket gravesites.

2nd full-casket interments

Second and subsequent interments are not reported in MADSS. The number of second and subsequent (seconds) FC interments is approximated by subtracting the number of FC Gravesites from the total FC interments. They are projected using the same algorithms, with a slight variation, as 1st FC interments. The only difference is that I lag the deaths used in the formulas. The basis for the lag is that there is a gap in time between the 1st and 2nd interments; and, though not always, the second is more often a dependent than for 1st interments, therefore, they should be correlated to the number of veterans dying in an earlier year. How many years is the question. For the projections developed in fall 2006 and fall 2007, I lagged the deaths two years. I intend to use a four year lag in the fall 2008 projections; and to study this issue further and experiment with and continue to adjust the years of lag in future projections if necessary. The formulas will be different depending on the number of years of lag built into the assumptions. For example, if a four-year lag were used, the changes to the basic formulas given in the first full-casket section would be as follows:

Three year average: $T_t = ⅓ * (Y^{2F}_{t-1} + Y^{2F}_{t} + Y^{2F}_{t+1})$
Three year average for the most recent fiscal year: $T_t = ⅓ * (Y^{2F}_{t-1} + Y^{2F}_{t} + \acute{Y}^{2F}_{t+1})$, where $\acute{Y}$ equals the least squares intercept for the first projected year.

For cemeteries where the historical usage ratios are a random walk with drift,

Usage ratios: $R_t = T_t/D^{s}_{t-4}$
Projected Interments: $\dot{Y}_t = \dot{R}_t * \dot{D}^{s}_{t-4}$

For cemeteries where the historical usage ratios are a random walk without drift,

$\dot{Y}^{2F}_{t} = ((Y^{2F}_{t_o-3} + (1.5 * Y^{2F}_{t_o-2}) + (2 * Y^{2F}_{t_o-1}) + (2.5 * Y^{2F}_{t_o}))/(D^{s}_{t_o-7} + (1.5 * D^{s}_{t_o-6}) + (2 * D^{s}_{t_o-5}) + (2.5 * D^{s}_{t_o-4}))) * \dot{D}^{s}_{t-4}$, where t_o equals the most recent historical year and t equals the projected year.

For cemeteries averaging less than 3 interments per week,

$\dot{Y}^{2F}_{t} = ((Y^{2F}_{t_o-3} + (1.5 * Y^{2F}_{t_o-2}) + (2 * Y^{2F}_{t_o-1}) + (2.5 * Y^{2F}_{t_o}))/ (D^{m}_{t_o-7} + (1.5 * D^{m}_{t_o-6}) + (2 * D^{m}_{t_o-5}) + (2.5 * D^{m}_{t_o-4}))) * \dot{D}^{m}_{t-4}$, where t_o equals the most recent historical year and t equals the projected year.

The effect of lagging the deaths in projecting seconds is that the seconds will peak at a later year than the firsts. This agrees with what we are actually seeing—the seconds continued to increase even as the firsts leveled off when the number of veteran deaths plateaued. I think that we will be able to determine the best fit for the number of years of lag by watching the seconds in the cemeteries where the 1st FC interments peaked earliest. The number of years of difference in the peaks of the 1st FC and 2nd FC should be fairly standard across cemeteries. As shown in the table below, nationally, while still increasing, seconds appear to be leveling off. This table looks only at cemeteries established prior to 1998 and with no new columbaria burial option added after 2000. I excluded those cemeteries because new cemeteries and a new columbaria burial option in an existing cemetery would be almost exclusively firsts and would skew the results. The details of the difference between the peak in first interments and seconds will be closely examined to determine the optimum number of years of lag to be used in future projections.

Percent Changes in Interments by 1st/2nd Status for Cemeteries Established prior to FY 1998 and with No New Columbaria Projects after FY 2000

Year	Total	% Δ	1sts	% Δ	2nds	% Δ
2000	61,021		45,736		15,285	
2001	61,069	0.1	45,351	-0.8	15,718	2.8
2002	63,685	4.3	46,555	2.7	17,130	9.0
2003	63,421	-0.4	45,848	-1.5	17,573	2.6
2004	66,324	4.6	47,044	2.6	19,280	9.7
2005	64,945	-2.1	44,718	-4.9	20,227	4.9
2006	65,089	0.2	45,145	1.0	19,944	-1.4
2007	64,285	-1.0	43,408	-2.9	20,877	3.2

Projection of In-Ground and Columbaria Interments

Cremation inurnments, columbaria and in-ground, are treated as one, and are treated independently. (For details, see the *Columbaria and In-Ground: Connected yet Independent* section below) As with full-casket interments, cremation interments are not reported as first and second interments. I used "cremation gravesites used" as a stand-in for first cremations, and the difference between total cremation interments and "cremation gravesites used" as a stand-in for second cremations. For total cremation gravesites used and for its equivalent, total first cremations, I used the sum of "half-sites used," "obstructed FC sites used," "niches used," and "scattered cremations." For total second cremations, I used the difference between total cremation interments and the total first cremations. Scattered cremations were counted as first cremations although they did not use a gravesite, and were not used in the calculation of cemetery closing dates in either the in-ground or columbaria categories. Total first cremations and total second cremations are projected following the same method used to project first and second FC interments.

Calculate three year averages

Three year average: $T_t = ⅓ * (Y^{1C}_{t-1} + Y^{1C}_{t} + Y^{1C}_{t+1})$
Three year average for the most recent fiscal year: $T_t = ⅓ * (Y^{1C}_{t-1} + Y^{1C}_{t} + \acute{Y}^{1C}_{t+1})$, where $\acute{Y}$ equals the least squares intercept for the first projected year.

Calculate historical usage ratios

Historical usage ratios,
for firsts:
$R_t = T_t / D^s_t$ for cemeteries where service area veterans deaths are used, or
$R_t = T_t / D^m_t$ for cemeteries where MSN veteran deaths are used.
for seconds, using a 4 year lag:
$R_t = T_t / D^s_{t-4}$ for cemeteries where service area veterans deaths are used, or
$R_t = T_t / D^m_{t-4}$ for cemeteries where MSN veteran deaths are used.

Calculate the percent changes in historical usage ratios, $H = (R_t – R_{t-1}) / R_{t-1}$ for the last four years.
Calculate the average of the percent changes in historical usage ratios:
$H_A = ¼ * (H_{t-3} + H_{t-2} + H_{t-1} + H_t)$

$\hat{Y}^{1C}$ = initial projection of total first cremation interments
$\hat{Y}^{2C}$ = initial projection of total second cremation interments

For usage ratio series with drift,

The projected changes in the usage ratios for these cemeteries for year 1 is,

$\dot{H}_t = .667 * H_A;$

for each year after,

$\dot{H}_{t+1} = .667 * \dot{H}_t$

The projected usage ratios, $\dot{R}_t = (1+\dot{H}_t) * \dot{R}_{t-1}$, or $\dot{R}_{t-1} + (\dot{H}_t * \dot{R}_{t-1})$.

The projected interments are,

$\hat{Y}^{1C}_t = \dot{R}_t * \dot{D}^s_t$ for first cremations, and

$\hat{Y}^{2C}_t = \dot{R}_t * \dot{D}^s_{t-4}$ for second cremations.

For usage ratio series without drift, $|H_A| > .00010$,

Use a four year weighted average for the projected usage ratios. The formula for first cremations is:

$\hat{Y}^{1C}_t = ((Y^{1C}_{t_{o-3}} + (1.5 * Y^{1C}_{t_{o-2}}) + (2 * Y^{1C}_{t_{o-1}}) + (2.5 * Y^{1C}_{t_o}))/ (D^s_{t_{o-3}} + (1.5 * D^s_{t_{o-2}}) + (2 * D^s_{t_{o-1}}) + (2.5 * D^s_{t_o}))) * \dot{D}^s_t$, where $_{t_o}$ equals the most recent historical year and $_t$ equals the projected year.

The formula for second cremations with a four year lag is:

$\hat{Y}^{2C}_t = ((Y^{2C}_{t_{o-3}} + (1.5 * Y^{2C}_{t_{o-2}}) + (2 * Y^{2C}_{t_{o-1}}) + (2.5 * Y^{2C}_{t_o}))/ (D^s_{t_{o-7}} + (1.5 * D^s_{t_{o-6}}) + (2 * D^s_{t_{o-5}}) + (2.5 * D^s_{t_{o-4}}))) * \dot{D}^s_{t-4}$, where $_{t_o}$ equals the most recent historical year and $_t$ equals the projected year.

For dead cemeteries,

Use a four year weighted average and the MSN deaths to veterans for the projected usage ratios. The formula for first cremations is:

$\hat{Y}^{1C}_t = ((Y^{1C}_{t_{o-3}} + (1.5 * Y^{1C}_{t_{o-2}}) + (2 * Y^{1C}_{t_{o-1}}) + (2.5 * Y^{1C}_{t_o}))/ (D^m_{t_{o-3}} + (1.5 * D^m_{t_{o-2}}) + (2 * D^m_{t_{o-1}}) + (2.5 * D^m_{t_o}))) * \dot{D}^m_t$, where $_{t_o}$ equals the most recent historical year and $_t$ equals the projected year.

The formula for second cremations with a four year lag is:

$\hat{Y}^{2C}_t = ((Y^{2C}_{t_{o-3}} + (1.5 * Y^{2C}_{t_{o-2}}) + (2 * Y^{2C}_{t_{o-1}}) + (2.5 * Y^{2C}_{t_o}))/ (D^m_{t_{o-7}} + (1.5 * D^m_{t_{o-6}}) + (2 * D^m_{t_{o-5}}) + (2.5 * D^m_{t_{o-4}}))) * \dot{D}^m_{t-4}$, where $_{t_o}$ equals the most recent historical year and $_t$ equals the projected year.

Columbaria and In-Ground: Connected yet Independent

First and second in-ground, first and second columbaria, and total scattered cremains are projected independently. A simple average is used to project scattered cremated remains: the average number of scattered remains for the last 4 years is projected for each future year of the projection. There have been fewer than 50 scattered interments per year in the entire National cemetery system since 2002 when we began keeping a separate count of them.

$\hat{Y}^{1IG}$ = initial projection of 1st IG interments
$\hat{Y}^{1N}$ = initial projection of 1st Columbaria niche interments
$\hat{Y}^{s}$ = initial projection of Scattered cremain interments
$\hat{Y}^{2IG}$ = initial projection of second IG interments
$\hat{Y}^{2N}$ = initial projection of second columbaria niche interments

I won't give the formulas to calculate $\hat{Y}^{1IG}$, $\hat{Y}^{1N}$, $\hat{Y}^{2IG}$, and $\hat{Y}^{2N}$ here because, except for substituting IGs or Ns for Cs, they are identical to the formulas used to calculate $\hat{Y}^{1C}$ and $\hat{Y}^{2C}$ given above. The formula for projecting scattered interments is:

$$\hat{Y}^{s} = \tfrac{1}{4} * (Y^{s}_{t_o} + Y^{s}_{t_{o-1}} + Y^{s}_{t_{o-2}} + Y^{s}_{t_{o-3}})$$

After projecting the totals, ($\hat{Y}^{1C}$ & $\hat{Y}^{2C}$), and parts, ($\hat{Y}^{1IG}$,$\hat{Y}^{1N}$, $\hat{Y}^{s}$,$\hat{Y}^{2IG}$, & $\hat{Y}^{2N}$), independently, a raking procedure is used to adjust the number of independently projected first IG, first columbaria, and scattered cremains so that they sum to the projected total first cremations. A second raking procedure is used to adjust the number of independently projected second IG and second columbaria so that they sum to the projected number of second cremations.

$\check{Y}^{1C}$ = Sum of the independently projected first cremation interments and scattered interments = $\hat{Y}^{1IG}_t + \hat{Y}^{1N}_t + \hat{Y}^{s}_t$
$\check{Y}^{2C}$ = Sum of the independently projected second cremation interments = $\hat{Y}^{2IG}_t + \hat{Y}^{2N}_t$
K^1 = raking ratio for 1st cremations, = $\hat{Y}^{1C}_t / \check{Y}^{1C}_t$
K^2 = raking ratio for 2nd cremations, = $\hat{Y}^{2C}_t / \check{Y}^{2C}_t$
$\dot{Y}^{1IG}$ = raked 1st IG interments, $\dot{Y}^{1IG}_t = K^1_t * \hat{Y}^{1IG}_t$. The projection of first in-ground inurnments is also the projection of in-ground gravesites.
$\dot{Y}^{1N}$ = raked 1st columbaria niche interments $\dot{Y}^{1N}_t = K^1_t * \hat{Y}^{1N}_t$
$\dot{Y}^{s}$ = raked Scattered cremain interments $\dot{Y}^{s}_t = K^1_t * \hat{Y}^{s}_t$
$\dot{Y}^{2IG}$ = raked second IG interments, $\dot{Y}^{2IG}_t = K^2_t * \hat{Y}^{2IG}_t$
$\dot{Y}^{2N}$ = raked second columbaria niche interments, $\dot{Y}^{2N}_t = K^2_t * \hat{Y}^{2N}_t$

Individual cemeteries offer different arrays of cremation burial options. The algorithms for projecting cremated interments in cemeteries with more options are more complex than the algorithms for projecting cremated interments with only one option. Eighty-four percent of existing national cemeteries interred at least one cremated remains in FY 2007. Of those 105 cemeteries, 104 interred at least one in-ground cremain. Twenty-one percent of the cemeteries interred cremains in columbaria niches; and 5.6 percent of the national cemeteries scattered cremated remains in memorial gardens. In cemeteries where only in-ground cremation plots are available, the raking ratios equal 1.00000.

For cemeteries with more than one cremation burial option, projecting cremated interments is more complicated. They are tied to each other in complex ways. If a cemetery with both in-ground and columbaria options suddenly and temporarily runs out of one option, say in-ground, demand for the other option, columbaria in our example, will increase; when the in-ground option is restored, the demand for columbaria will decrease to its previous level and the demand for in-ground will return to its previous level. It sounds simple and it is, except that not everyone will choose the other option, some will keep the ashes on their mantel until the option of their choice is restored. This practice can result in 1) the columbaria not increasing in exact measure of the loss of in-ground, and 2) a brief jump in restored option interments, in-ground in our example, which you should not project into the future. Situations such as the one just described, help to create a very challenging forecasting problem where the analyst should include making adjustments and allowances for stops and starts and new options and discontinuations of options part of the process.

Depletion Date Estimates

Accurate projections of interments and gravesites meet only part of the need. NCA also needs good estimates of depletion dates: both life-of-the-cemetery depletion dates and depletion dates for currently in-use developed burial areas.

Cemeteries have limited space. Some of them will run out of sites during the years of the projection. To estimate life-of-the-cemetery depletion dates, I used a variation of a perpetual inventory method: I subtracted, for each open or cremation only cemetery, projected first interments, by type of interment, from the sum of available sites (by type of site) in developed acres plus an estimate of potential sites (by type of site) in undeveloped acres. The simple story of estimating depletion dates is that when an open cemetery runs out of full-casket sites, it becomes a cremation only cemetery, and when a cremation only cemetery runs out of cremation sites, it becomes a closed cemetery. But there are quite a number of possible variations and embellishments to each cemetery's story.

The number of available sites comes from MADSS. The available sites are specific to type of site: full-casket site, in-ground half-site for cremation inurnments, in-ground obstructed full-casket sites appropriate for cremation inurnments but not for full-casket burials, and columbaria niches.

Estimates of sites in undeveloped acres generally come from cemetery master plans. In cases where there is no master plan, the number of sites is estimated using a formula that assumes that $1/10^{th}$ of the sites will be in-ground cremation sites, and 9/10ths will be full-casket sites.

Columbaria have been treated differently than in-ground interments. Since columbaria niches can be built on very small parcels of land or a cemetery can be encircled by columbaria, I don't estimate potential niches, but hold them to be as many as is needed unless and until I am told by the engineers that all of the odd nooks and spaces at an individual cemetery are filled in or will be with a definite and finite number of columbaria projects. In this situation, the number of columbaria is allowed to run out. The effect of this policy on depletion dates is that all cemeteries with columbaria are set to close at 2030 + until that cemetery is near depletion.

Projecting depletion dates is done in steps:

1. Iteratively calculating remaining sites by type per year;
2. Allowing for the effect of running out of one type of site on other types of sites; and
3. Identifying the depletion year for each type of gravesite.

Formulas to Calculate Rema ining sites in Cemeteries

Estimating life-of-the-cemetery depletion dates is a primary purpose of this process. To estimate depletion dates, I iteratively subtract for each year the number of projected gravesites by type from the remaining sites until there are no available or potential sites left. If necessary, I used FC sites for meet IG site demand at the rate of one FC site for every two IG needed. The year that the number of remaining sites is less than zero at the end of the year is the depletion date. If the cemetery status is Open, and FC is depleted before IG and/or columbaria, then the cemetery changes status from Open to Cremation only. If the cemetery is Open, and the FC and Cremation options run out in the same year, then the cemetery changes from Open to Closed. If the cemetery is cremation only, the cemetery changes to closed when the cremation options are depleted. The formulas for calculating remaining sites are given below.

The number of unoccupied full-casket sites at the beginning of the year is denoted by $A^F{}_t$

$A^F{}_{t_o}$ = the sum of 1) the available full-casket sites reported in MADSS and 2) the estimated potential full-casket sites. In cemeteries with no available undeveloped land, the estimated number of potential sites is zero.

$$A^F{}_t = A^F{}_{t-1} - \dot{Y}^{1F}{}_{t-1}$$

The number of unoccupied in-ground cremation sites at the beginning of the year is denoted by $A^{IG}{}_t$

$A^{IG}{}_{t_o}$ = the sum of 1) the available in-ground cremation sites (half-sites plus obstructed FC sites) reported in MADSS plus 2) the estimated potential in-ground cremation sites. In cemeteries with no available undeveloped land, the estimated number of potential sites is zero.

$$A^{IG}{}_t = A^{IG}{}_{t-1} - \dot{Y}^{1IG}{}_{t-1}$$

The number of unoccupied columbaria niches at the beginning of the year is denoted by $A^N{}_t$

$A^N{}_{t_o}$ = the sum of 1) the available niches reported in MADSS and 2) estimated potential niches sufficient to last well beyond the last year of the projection.

$$A^N{}_t = A^N{}_{t-1} - \dot{Y}^{1N}{}_{t-1}$$

Although the expected norm is that closed cemeteries have no first interments and cremation only cemeteries have no first full-casket interments, that is not always reality. Closed cemeteries sometimes have first interments; and cremation only cemeteries sometimes have first full-casket interments. This happens when the cemetery has sites that have been reserved and are not available. These reserved sites will run out over time, so I calculate the estimated depletion of reserved sites for closed and cremation only cemeteries.

$$A^{RF}{}_t = A^{RF}{}_{t-1} - \dot{Y}^{1F}{}_{t-1}$$

Where $A^{RF}{}_t$ = remaining reserved and full-casket sites.

There are a few reserved in-ground cremation sites. They were not reported separately until FY 2007 and are less than 1 percent of the total reserved and adjacent set-aside sites. No allowance was made for them in the original computer programs written for this model. The programs may be changed to allow for reserved adjacent set-aside in-ground sites in the future. Until then, a hand adjustment will be made to the few cemeteries this affects.

There are ten different categories of cemeteries, each requiring its own set of algorithms to forecast the effects of the depletion of available sites of one type of interments on other types of sites; and changes in status for the cemetery. I'll begin with the most complex category. But first, to accommodate adjustments to the projected interments that result from cemeteries running out of available sites, we need a new variable—$\bar{Y}$, which will stand for adjusted interments, and its variations:

$\bar{Y}^{1F}$ = adjusted first full=casket interments,
$\bar{Y}^{1IG}$ = adjusted in-ground interments, and
$\bar{Y}^{1N}$ = adjusted columbaria interments.

Listed below are algorithms to be used in different scenarios that may be encountered when estimating depletion dates.

Open Cemeteries

1. Open cemeteries with columbaria and with reserve and/or adjacent gravesite set-asides.

   There are four different conditions that can occur when forecasting these cemeteries:

   1) None of the different types of interment sites are depleted. This is the simplest condition. The depletion dates are set at the last fiscal year of the projection period plus, for recent projections—2030 +.

   2) Open cemeteries where full-casket sites run out first. If $A^{F}_{t+1} \leq 0$ and $A^{IG}_{t+1} > 0$ then, for the first year of this condition, set $\bar{Y}^{1F}_t = A^F_t$ and set $\bar{Y}^{1IG}_t = \dot{Y}^{1IG}_t + (.25 * (\dot{Y}^{1F}_t - \bar{Y}^{1F}_t))$. This formula makes an allowance for that portion of the decedents, whose family would have chosen a full-casket burial if it were available, but opted for an in-ground cremation inurnment instead of going to another cemetery. The .25 multiplier is under review and may be reduced in future projections. For the second and subsequent years of this condition, set $\bar{Y}^{1F}_t = .025 * A^{RF}_{t_o}$ and set $\bar{Y}^{1IG}_t = \dot{Y}^{1IG}_t + (.25 * \dot{Y}^{1F}_t)$. Set the adjusted columbaria, $\bar{Y}^{1N} = \dot{Y}^{1N}$ until $A^{1IG} < 0$. If, before the last year of the projection, $A^{1IG} < 0$ then for the first year of this condition, set $\bar{Y}^{1IG}_t = 0$ and $\bar{Y}^{1N}_t = \dot{Y}^{1N}_t + (.25 * \dot{Y}^{1F}_t) + (.3 * (\bar{Y}^{1IG}_t - \dot{Y}^{1IG}_t))$. For the second and subsequent years of this condition, set $\bar{Y}^{1N}_t = \dot{Y}^{1N}_t + (.25 * \dot{Y}^{1F}_t) + (.3 * \dot{Y}^{1IG}_t)$. Begin calculating A^{RF}_t. If, during the remaining life of this projection, $A^{RF}_t < 0$, then for the first year of this condition, set $\bar{Y}^{1F}_t = A^{RF}_t$ and for second and subsequent years of this condition, set $\bar{Y}^{1F}_t = 0$.
   In the special situations, where niches are allowed to run out, if $A^N_{t+1} \leq 0$, then in the first year of this condition, set $\bar{Y}^{1N} = A^N_t$, and in the second and subsequent years of this condition, set $\bar{Y}^{1N} = 0$.

   3) Open cemeteries where full-casket and in-ground sites run out during the same fiscal year. If $A^F_{t+1} \leq 0$ and $A^{IG}_{t+1} \leq 0$ then, for the first year of this condition, set $\bar{Y}^{1F}_t = A^F_t$ and set $\bar{Y}^{1IG}_t = A^{IG}_t$ and set $\bar{Y}^{1N}_t = \dot{Y}^{1N}_t + (.25 * (\dot{Y}^{1F}_t - \bar{Y}^{1F}_t)) + (.3 * (\bar{Y}^{1IG}_t - \dot{Y}^{1IG}_t))$. For the second and subsequent years of this condition, set $\bar{Y}^{1F}_t = .025 * A^{RF}_{t_o}$ and set $\bar{Y}^{1IG}_t = 0$ and $\bar{Y}^{1N}_t = \dot{Y}^{1N}_t + (.25 * \dot{Y}^{1F}_t) + (.3 * \dot{Y}^{1IG}_t)$.
   The procedures given above were followed to project depletion dates for niches and reserved sites.

   4) Open cemeteries where in-ground sites run out first. For projections with this condition, the model assumes that a number of full-casket gravesite sections will be converted to in-ground sites sufficient to keep the cemetery open to in-ground cremation inurnments for as many years as it is open to full-casket interments. If $A^F_{t+1} > 0$ and $A^{IG}_{t+1} \leq 0$ then, for the first year of this condition, set $\bar{Y}^{1F}_t = \dot{Y}^{1F}_t$, and reset $A^F_{t+1} = A^F_t - (\dot{Y}^{1F}_t + (.5 * (\dot{Y}^{1IG}_t - \bar{Y}^{1IG}_t)))$ for the second year of this condition, set $\bar{Y}^{1F}_t = \dot{Y}^{1F}_t$, and reset $A^F_{t+1} = A^F_t - (\dot{Y}^{1F}_t + (.5 * \dot{Y}^{1IG}_t))$ If, during the course of the projection, $A^F_{t+1} \leq 0$ and $A^{IG}_{t+1} \leq 0$ then, follow the procedures given above in section 1. 3).

2. Open cemeteries with columbaria but with no reserve and/or adjacent gravesite set-asides.

   There are four different conditions that can occur when forecasting these cemeteries:

   1) None of the different types of interment sites are depleted. The depletion dates are set at the last fiscal year of the projection period plus, for recent projections—2030 +.

   2) Open cemeteries where full-casket sites run out first. The procedures followed when this is the condition are exactly the same as those given above in section 1. 2), except that in second and subsequent years, set $\bar{Y}^{1F}_t = 0$.

3) Open cemeteries where full-casket and in-ground sites run out during the same fiscal year. The procedures followed when this is the condition are exactly the same as those given above in section 1. 3), except that in second and subsequent years, set $\bar{Y}^{1F}_t = 0$.

4) Open cemeteries where in-ground sites run out first. The procedures followed when this is the condition are exactly the same as those given above in section 1. 4), except that in cases where full-casket and in-ground cremation sites are depleted, set $\bar{Y}^{1F}_t = 0$ in the second and subsequent years of that condition.

3. Open cemeteries with no columbaria but with reserve and/or adjacent gravesite set-asides.

There are four different conditions that can occur when forecasting these cemeteries:

1) None of the different types of interment sites are depleted. The depletion dates are set at the last fiscal year of the projection period plus, for recent projections—2030 +.

2) Open cemeteries where full-casket sites run out first. If $A^F_{t+1} \leq 0$ and $A^{IG}_{t+1} > 0$ then, for the first year of this condition, set $\bar{Y}^{1F}_t = A^F_t$ and set $\bar{Y}^{1IG}_t = \dot{Y}^{1IG}_t + (.25 * (\dot{Y}^{1F}_t - \bar{Y}^{1F}_t))$. This formula makes an allowance for that portion of the decedents, whose family would have chosen a full-casket burial if it were available, but opted for an in-ground cremation inurnment instead of going to another cemetery. The .25 multiplier is under review and may be reduced in future projections. For the second and subsequent years of this condition, set $\bar{Y}^{1F}_t = .025 * A^{RF}_{t_o}$ and set $\bar{Y}^{1IG}_t = \dot{Y}^{1IG}_t + (.25 * Y^{1F}_t)$. Begin calculating A^{RF}_t. If, during the remaining life of this projection, $A^{RF}_t < 0$, then for the first year of this condition, set $\bar{Y}^{1F}_t = A^{RF}_t$ and for second and subsequent years of this condition, set $\bar{Y}^{1F}_t = 0$.

3) Open cemeteries where full-casket and in-ground sites run out during the same fiscal year. If $A^F_{t+1} \leq 0$ and $A^{IG}_{t+1} \leq 0$ then, for the first year of this condition, set $\bar{Y}^{1F}_t = A^F_t$ and set $\bar{Y}^{1IG}_t = A^{IG}_t$ and set $\bar{Y}^{1N}_t = \dot{Y}^{1N}_t + (.25 * (\dot{Y}^{1F}_t - \bar{Y}^{1F}_t)) + (.3 * (\bar{Y}^{1IG}_t - \dot{Y}^{1IG}_t))$. For the second and subsequent years of this condition, set $\bar{Y}^{1F}_t = .025 * A^{RF}_{t_o}$ and set $\bar{Y}^{1IG}_t = 0$ and $\bar{Y}^{1N}_t = \dot{Y}^{1N}_t + (.25 * \dot{Y}^{1F}_t) + (.3 * \dot{Y}^{1IG}_t)$.

The procedures given above were followed to project depletion dates for reserved sites.

4) Open cemeteries where in-ground sites run out first. For projections with this condition, the model assumes that a number of full-casket gravesite sections will be converted to in-ground sites sufficient to keep the cemetery open to in-ground cremation inurnments for as many years as it is open to full-casket interments. If $A^F_{t+1} > 0$ and $A^{IG}_{t+1} \leq 0$ then, for the first year of this condition, set $\bar{Y}^{1F}_t = \dot{Y}^{1F}_t$, and reset $A^F_{t+1} = A^F_t - (\dot{Y}^{1F}_t + (.5 * (\dot{Y}^{1IG}_t - \bar{Y}^{1IG}_t)))$ for the second year of this condition, set $\bar{Y}^{1F}_t = \dot{Y}^{1F}_t$, and reset $A^F_{t+1} = A^F_t - (\dot{Y}^{1F}_t + (.5 * \dot{Y}^{1IG}_t))$ If, during the course of the projection, $A^F_{t+1} \leq 0$ and $A^{IG}_{t+1} \leq 0$ then, follow the procedures given above in section 3. 3).

4. Open cemeteries with no columbaria and with no reserve and/or adjacent gravesite set-asides.

There are four different conditions that can occur when forecasting these cemeteries:

1) None of the different types of interment sites are depleted. The depletion dates are set at the last fiscal year of the projection period plus, for recent projections—2030 +.

2) Open cemeteries where full-casket sites run out first. The procedures followed when this is the condition are exactly the same as those given above in section 3. 2), except that in second and subsequent years, set $\bar{Y}^{1F}_t = 0$.

3) Open cemeteries where full-casket and in-ground sites run out during the same fiscal year. The procedures followed when this is the condition are exactly the same as those given above in section 3. 3), except that in second and subsequent years, set $\bar{Y}^{1F}_t = 0$.

4) Open cemeteries where in-ground sites run out first. The procedures followed when this is the condition are exactly the same as those given above in section 3. 4), except that in cases where full-casket and in-ground cremation sites are depleted, set $\bar{Y}^{1F}_t = 0$ in the second and subsequent years of that condition.

Cremation Only Cemeteries

5. Cremation only cemeteries with columbaria and with reserve and/or adjacent gravesite set-asides.

   There are two different conditions plus a special case that can occur when forecasting these cemeteries:

   1) In-ground cremation sites are not depleted. The depletion date for in-ground is set at the last fiscal year of the projection period plus, for recent projections—2030+. No adjustment is made to the in-ground, or columbaria projection. If $A^{RF}_t \leq 0$ then in the first year of this condition set $\bar{Y}^{1F}_t = A^{RF}_{t-1}$; and in second and subsequent years of this condition set $\bar{Y}^{1F}_t = 0$.

   2) In-ground cremation sites are depleted. If $A^{IG}_{t+1} \leq 0$ then, for the first year of this condition, set $\bar{Y}^{1IG}_t = A^{IG}_t$ and set $\bar{Y}^{1N}_t = \dot{Y}^{1N}_t + (.3 * (\bar{Y}^{1IG}_t - \dot{Y}^{1IG}_t)$; and in second and subsequent years of this condition set $\bar{Y}^{1IG}_t = 0$ and $\bar{Y}^{1N}_t = \dot{Y}^{1N}_t + (.3 * \dot{Y}^{1IG}_t)$. If $A^{RF}_t \leq 0$ follow the procedures given above in section 5.1).

   Special cases where columbaria are allowed to run out. If $A^{IG}_{t+1} \leq 0$ and $A^{N}_{t+1} \leq 0$ then for the first year of this condition, set $\bar{Y}^{1N}_t = A^{N}_{t+1}$. For second and subsequent years of this condition, set $\bar{Y}^{1N}_t = 0$. Follow the procedures given above in 5.2) for in-ground cremation inurnments. If, in the extremely rare situation, $A^{IG}_{t+1} \geq 0$ and $A^{N}_{t+1} \leq 0$, I used the raking procedure described in the *Projection of In-Ground and Columbaria Interments* section under Methods to increase the projected in-ground cremation interments to the level of total projected 1st cremation interments.

6. Cremation only cemeteries with columbaria but with no reserve and/or adjacent gravesite set-asides.

   Follow the procedures given above in section 5; except, that $\bar{Y}^{1F}_t = \dot{Y}^{1F}_t$, which will be 0 or near 0.

7. Cremation only cemeteries with no columbaria but with reserve and/or adjacent gravesite set-asides.

   Follow the procedures given above in section 5 except that there is no adjustment to the columbaria. The projected number of niches used will remain at 0.

8. Cremation only cemeteries with no columbaria and with no reserve and/or adjacent gravesite set-asides.

   Follow the procedures given above in section 6 except that there is no adjustment to the columbaria. The projected number of niches used will remain at 0.

Closed Cemeteries

9. Closed cemeteries with reserve and/or adjacent gravesite set-asides. If $A^{RF}_t \leq 0$ then in the first year of this condition set $\bar{Y}^{1F}_t = A^{RF}_{t-1}$; and in second and subsequent years of this condition set $\bar{Y}^{1F}_t = 0$. For first cremation interments, if interments are still occurring in this category, the cemetery must have adjacent gravesite set-aside (AGS) in-ground or niche sites. If during the years of the projection, the total number of projected first in-ground or columbaria niches exceeds the number of AGS then set $\bar{Y}^{1IG}_t = 0$ or $\bar{Y}^{1N}_t = 0$, as appropriate.

10. Closed cemeteries with no reserve and/or adjacent gravesite set-asides. The projected first interments will be 0 for all types of interments in these cemeteries.

Each cemetery has its own story. The details of how I handled the different situations in each of the national cemeteries when calculating life-of-the-cemetery depletion dates and how the new model estimates the percent of customers who will choose another burial option in the national cemetery if they are faced with the option of their choice not being available are shown in the algorithms given for each of the scenarios outlined above.

Estimating a second set of depletion dates for currently in-use developed burial areas is one of many critical steps in the budget process and to NCA accomplishing its mission. NCA does not develop all of the land that comprises a cemetery when it first opens. Typically, NCA develops sufficient land to provide approximately 10 years of available gravesites with each development project. To ensure uninterrupted service to veterans, NCA needs estimates of depletion dates for the burial areas that are currently in use.

These depletion dates are straight forward to calculate. They are calculated separately for full-casket, in-ground cremation, and niches. Begin with the number of available sites (do not include estimates of potential sites) and iteratively subtract the projected 1st interments. No allowances are made for conversion of available sites from one category to another because that would require a project. And the purpose of this exercise is to determine when development or redevelopment projects will be needed.

Currently in-use developed burial areas depletion dates are calculated more precisely than life-of-the-cemetery depletion dates. They are calculated for month and year. After the depletion year has been calculated, an estimate of the month is determined by 1) calculating the percent of the year number of available sites remaining at the beginning of the year will cover; and 2) using a simple pro-rata method to determine the month that percent fall in. For example, 40 percent would fall in February of that fiscal year.

Comparison to Earlier Model

The model previously used to project interments and gravesites in National Cemeteries was a simple workload model that, for each cemetery, beginning with the most recent fiscal year multiplied total interments by a number close to 1, a multiplier, to get the next projected year: $Y_{t+1} = Y_t * M$. The previous three years were examined by the eyeball method, and the multipliers were chosen by the forecaster based on their personal judgment and experience. Total gravesites for each cemetery were projected by multiplying the total projected interments by the percent gravesites in the last fiscal year. To estimate the depletion dates, the total yearly gravesites were cumulated for each year of the projection. The year that the cumulative gravesites exceeded the sum of the available and potential gravesites was the depletion date.

The new model provides products not delivered by the earlier model:

1) Projections of gravesites that are independent of the interment projections. The earlier model held the percent of total interments that were total first interments constant for the life of the projection, with an adjustment in the year that a cemetery was projected to close. No allowance for growth in percent seconds was made for young cemeteries.

2) Independent depletion date estimates for full-casket, in-ground cremation, and columbaria. In the earlier model, there was no separation of available sites by type; all of them were thrown together, and the cemetery closed to both full-casket and cremation when they were all depleted.

3) Projections of interments by type. Prior to the introduction of this model, projections of interments by type at the national level were produced by adding up the total interments for each cemetery and by assuming a slight change in the percent distribution of interments by type. Now, they are produced by adding up the projections of the individual cemeteries for each type of interment.

Next Steps

The overall model should be tested and validated; in addition, many of the assumptions that were built into the model need to be examined and tested and, if necessary, refined or replaced. Since the model was pressed into immediate service as it was being designed many of the model assumptions are based on expert knowledge or a best guess rather than on hard data.

- The increases and decreases in full-casket, in-ground, and columbaria interments when one type of interment is suddenly closed or opened.
- The projection of yearly reserved site usage beyond the depletion data of the available sites needs to be tested and refined.
- The method of projecting the ratios of interments to service area deaths.

In addition to testing the assumptions built into the model, the new field, reserved and adjacent set aside IG sites needs to be incorporated into the model.

Acknowledgements

Special thanks to Karen Hamrick, of the Economic Research Service, Dept. of Agriculture, for her encouragement and advise in the development of this model; Dan Tucker, NCA Office of Finance and Planning, for giving me free rein to develop a new model and for his suggestion that I design a technique for projecting the usage ratios; Jack Gaegler, Policy and Planning Service, VA, for his expert knowledge used in model assumptions; Shelton Pope and Jeff Potts, NCA Policy and Planning Service, Mark Russell, VA, Fred Joutz, and his colleagues at the Center for Economic Research, George Washington University for reading early drafts of this paper and giving me excellent suggestions and critiques; Ron Walters for his support and advise; and Paige Lowther for her constant encouragement and for editing the final draft.

Forecasting Impacts of Government Policy

Session Chair: Michelle Chu, Internal Revenue Service

Forecasting Federal Estate Tax Return Filings

Taukir Hussain, Internal Revenue Service

The estate tax is one component of the federal transfer tax system together with the gift and generation-skipping tax. The Economic Growth and Tax Relief Reconciliation Act (EGTRRA) of 2001 introduced major changes to the estate tax structure. The law provides for a gradual increment in the exemption amount for decedents, based on year of death. The filing threshold was $1 million in 2002, and will reach $3.5 million by 2009. The tax is then repealed for deaths occurring in 2010, but reinstated for deaths in 2011 and beyond, with a $1 million exemption. In this paper, we develop a methodology to forecast the number of estate tax returns to be filed taking into account the peculiarities of EGTRRA as it applies to the federal estate tax.

Economic Implications of Future Years Defense Spending

Soyong Chong, Program Analysis and Evaluation Directorate Office of the Secretary of Defense

On December 2007, the Chairman of the Joint Chiefs of Staff, Admiral Michael Mullen, told the press that the nation needs to permanently set U.S. defense spending at 4.0 percent of the national gross domestic product (GDP). If Chairman's statement gets accepted, it translates into $894 billion in defense spending by FY 2018 using CBO's GDP projection. This being said, both inside and outside the Pentagon, defense policy analysts, businessmen and economists are interested in the economic implications of these defense purchases. To measure the economic implications of defense spending, I use the Defense Employment and Purchases Projection System (DEPPS) to estimate demand for subassemblies, parts, and materials that the Defense Department generates through its purchases.

National Health Expenditure Forecasts Through 2030: A Full Coverage Scenario

Charles Roehrig, George Miller, and Mike McLendon, Altarum Institute

This paper will provide forecasts through 2030 of national health expenditures under the assumption of universal coverage achieved through an individual mandate combined with federally subsidized premiums to make insurance affordable for all. It will include alternative scenarios in terms of health inflation and GDP growth rates. Expenditures will be presented by source of funds so that the total federal component of spending can be identified. This will provide an important extension of forecasts developed by GAO and CBO that focus on Medicare and Medicaid spending requirements. Forecasts will be generated using the Altarum Health Sector Model.

National Health Expenditure Forecasts Through 2030: A Full Coverage Scenario

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Background

Long term forecasts of government health expenditures have received increased attention recently as organizations such as the Congressional Budget Office and Government Accountability Office have focused on the unsustainable nature of rapid increases in health expenditures. These dire forecasts actually understate the full problem because they do not consider government costs associated with addressing the uninsured population that will continue to increase in number without some form of government intervention. The purpose of this study is to develop a forecasting methodology, and some preliminary findings, regarding the likely government costs associated with an intervention to achieve full coverage.

Specifically, our objective is to develop forecasts of government health expenditures through the year 2030 under a full coverage scenario involving subsidized premiums, and to examine the sensitivity of these forecasts to underlying assumptions. Our work to date consists of an initial set of methods and example applications. The associated scenario definitions and underlying assumptions are for illustrative purposes and do not represent firm predictions or recommendations.

We began by developing a baseline forecast of expenditures in 2010 without expanded coverage that is consistent with the latest projections from the National Health Statistics Group. We then developed a forecast of 2010 expenditures under full coverage using private insurance and subsidized premiums (with a binding individual mandate). Next, we projected this full coverage scenario to 2030 under alternative scenarios in which we varied assumptions regarding growth rates in median income and health care costs. Finally, we compared government health care spending under these alternative scenarios.

Methods

Our approach to develop the 2010 and 2030 forecasts comprised three steps:

- Forecast the numbers of uninsured – those who would lack insurance in the future under current coverage conditions – by income level. Income levels are defined as multiples of the federal poverty level (FPL).
- Allocate the uninsured to subsidy categories that are defined in terms of multiples of the FPL. This involves defining base year (2006) subsidy category boundaries, forecasting how these boundaries change over time, and forecasting the resultant distribution of the uninsured across subsidy categories.
- Input the numbers of uninsured by subsidy category into the Altarum Health Sector Model (AHSM) to produce expenditure forecasts.

Forecasting Numbers of Uninsured

Gilmer and Kronick (2005) describe methods for projecting the total number of uninsured using evidence that the historical percent of uninsured among workers in the US has been closely related to the ratio of per-capita health care spending to median income. We employed this relationship to forecast uninsured workers and then used Gilmer and Kronick's methods to translate the percent of uninsured workers to total percent uninsured among adults and among children. Baseline forecasts were generated under the following assumptions:

- real per-capita gross domestic product (GDP) grows at 1.4% per year,
- future real per-capita health care spending would grow at the rate of 3.3% (due to increased prices and per-capita utilization, net of population aging), as inferred from projections of the National Health Expenditure Accounts (NHEA) from 2006 to 2010 (CMS, 2008), and
- future median income would continue to grow at its recent historical rate of one percentage point below the GDP growth rate, or 0.4%.

(In excursions from our baseline computations, we varied these growth rates as indicated below.) We applied these projected growth rates to the relationships inferred from Gilmer and Kronick (2005) to estimate future percent of the population of adults and of children constituting the uninsured in 2010 and 2030.

We applied these percentages to US Census projections of the adult and child populations in 2010 and 2030 to estimate corresponding numbers of uninsured. We then subdivided these projections into ten age groups (as required for input to AHSM) using information on the uninsured by age in 2006 taken from the Current Population Survey (CPS) conducted by the US Census Bureau (2007). The resulting numbers of uninsured in 2010 were used as input to AHSM to generate the baseline projection of health care costs. The numbers were also used to estimate the subsidies required in subsequent full-coverage scenarios, as discussed below.

Partitioning the Uninsured by Subsidy Category

To estimate subsidy levels for covering the uninsured, we adopted the following affordability assumptions as of 2006:

- Families whose incomes are less than 150% of the federal poverty level (FPL) would receive a full premium subsidy and would incur no copays or deductibles.
- Families whose incomes are greater than 400% of the FPL would receive no premium subsidies and would incur normal copays and deductibles.
- Families whose incomes are between 150% and 400% of the FPL would receive partial premium subsidies (decreasing linearly with FPL multiple from full subsidy at 150% to no subsidy at 400%) and would incur reduced copays and deductibles.

These thresholds are based, in part, upon the Massachusetts health reform program which initially proposed 100% and 300% as the threshold boundaries but later moved to 150% and 400% (with various exceptions that are not represented in our simplified algorithm).

Figure 1 illustrates our implementation of these assumptions. The red curve represents average family health care expenditures in 2006, expressed as a percent of income as a function of FPL income multiple. The black line indicates the percent of income to be paid by a family under the subsidies associated with the above assumptions – zero at or below the 150% FPL point, rising to full payment at the point at which average health care expenditures cross the 400% FPL limit. This point corresponds to approximately 16% of income.

As health care costs grow (in constant dollars) over time, the upper threshold increases as the need for subsidies moves into incomes above 400% FPL. For example, by 2030, under our baseline assumption of 3.3% annual growth in health care costs, the cost curve shifts upward to the blue line in Figure 1. The resulting new upper subsidy limit of approximately 550% FPL is where the curve intersects the extension of the subsidy policy line. This can be solved analytically as the solution of a quadratic equation that results from setting the equation of the straight line representing the subsidy policy equal to the curve representing 2030 average health care expenditures.

Applying these subsidy levels to the uninsured required that we develop a distribution of uninsured by family income level. Using CPS data for 2006, we tabulated the number of uninsured in each age group by multiples of the FPL. We then fit each of these distributions to a cubic equation (R^2>.999 for each age group) to get a closed-form representation of the cumulative fraction of the uninsured in each age group below a given multiple of the 2006 poverty level. As median income grows over time (e.g., at our baseline rate of 0.4% per year) these curves retain their original shapes but shift downward and to the right as fewer families have incomes below any given FPL multiple (we assume that FPL definitions are constant in real terms throughout the forecast period).

We then applied the subsidy thresholds to these income distributions to determine the percentage of uninsured in each age group who are fully subsidized, partially subsidized, or receive no subsidies. Results for an example age group in 2006 and 2030 are shown in Figure 2, using our baseline growth rates of 3.3% and 0.4% for health care costs and median income, respectively. As median income grows from 2006 to 2030, the percent of this population that is fully subsidized decreases somewhat as more of the uninsured are able to pay a portion of their health care costs. On the other hand, the percent of the population requiring partial subsidization increases as health care costs grow faster than median income, causing the shift to the right of the upper subsidy limit to more than compensate for the downward shift in the income distribution. The average subsidy level for those who are partially subsidized can be computed as the integral of the product of the percent subsidy line (a linear relationship that equals 100% at the lower subsidy boundary and 0% at the upper boundary) and the derivative of the (cubic) equation describing the cumulative income distribution. These average partial subsidy rates vary by age group and subsidy thresholds, but are typically on the order of 63%.

The resulting uninsured by age and subsidy rate were input to AHSM to generate expenditure estimates for our full-coverage scenario and excursions.

Forecasting Costs

Figure 3 provides an overview of the basic computational stages used in AHSM. Populations by age and insurance category have healthcare needs based upon the prevalence of medical conditions and prevailing treatment patterns. The amount of care actually acquired depends upon access to care and the amount paid depends upon the type of insurance. (Further information is available at www.altarum.org.)

In these simulations, the uninsured are shifted into private insurance. Their needs are unchanged but they receive more care and generate greater payments because their access to care and payment rates increase to the levels experienced by privately insured population. (This assumes that the health care delivery system develops the additional capacity required to meet the increased demand for care.)

AHSM incorporates the impact on tax revenues of the tax-advantaged treatment of health-related expenditures such as premiums for employer-sponsored insurance. In our full-coverage scenarios, we assume that payments for premiums purchased in the individual market are made tax deductable.

Results

Growth Rate Assumptions and Their Effects

Figure 4 shows our projected growth in the uninsured for our baseline assumptions (real per capita health care costs grow at 3.3% per year and median income grows at 0.4% per year) and two excursions: one in which median income grows at 1.4% per year after 2010 (the same as the GDP growth rate) and a second with both this higher growth rate in median income and a lower growth rate of health care costs of 2.4% per year after 2010 (GDP plus 1%). Figure 5 shows how the upper subsidy boundary grows over time for these same three cases. Note that growth in the uninsured is sensitive to both median income and health care costs, whereas the upper subsidy boundary is affected by health care costs but not median income.

2010 Projections

Table 1 displays AHSM's baseline 2010 forecast in the absence of expanded coverage (all results are in constant 2006 dollars). The table shows a breakout of national personal health expenditures using the same expenditure categories as used by CMS (2008) to display this component of NHE A. This baseline forecast is similar to that of CMS.

In Table 2, we again show AHSM's projection of personal health expenditures, this time under an assumption of full coverage. Under full coverage, personal health expenditures and the net cost of private insurance increase by $171 billion and $27 billion, respectively. (In this full-coverage scenario, we shifted the small number of elderly uninsured into Medicare, causing a small increase in Medicare and Medicaid expenses.)

Table 3 indicates some of the impacts of shifting from the baseline to the full coverage scenario in 2010. Under the assumption that provider capacity expands to meet new demand, full coverage increases provider costs for delivery of additional care by about $105 billion. However, payments to providers increase by $171 billion, resulting in a $66 billion increase in provider margins.[1]

While these extra margins may allow improvements in quality of care for some providers, the government could argue that it should reclaim this revenue in order to reduce taxpayer costs. Commercial payers also have a claim since they currently pay well above costs. We investigated a scenario in which all payers pay at cost. This results in rate increases for Medicare and Medicaid and reductions in rates for commercial payers. Table 4 compares the results of this excursion with the previously-presented full coverage results with un-equalized payment rates. As intended, provider margins no longer increase. Government payments to providers increase by $64 billion because of the increase in Medicare and Medicaid payment rates. This is partially offset by a $23 billion dollar reduction in government premium subsidies associated with the reduction in commercial payment rates that lead to lower premiums for everyone with private insurance. The reduction in private sector premiums (with their tax-advantaged status) also increases government tax revenues by an estimated $40 billion. The shift to equal payments is roughly budget neutral to the government once tax revenues are taken into account.

2030 Projections

National health expenditures associated with extending the full coverage, equal payment rate scenario to 2030 are shown in Table 5. Personal health expenditures increase by $3,264 billion from 2010 to 2030 and, as shown in Table 6, government payments to providers (via Medicare and Medicaid) increase much faster than other sources of provider payments. Government premium subsidies grow even faster and represent a

[1] This is the result of two factors. First, uncompensated care associated with the uninsured is eliminated under full coverage but, under this scenario, providers continue to receive the funding that was previously used to cover uncompensated care. Second, the newly insured now pay at above-cost commercial rates.

17% increase in government spending over and above Medicare and Medicaid.

Tables 7 and 8 show payment patterns under somewhat more optimistic assumptions than Tables 5 and 6. In Table 7, we compare the previously-shown 2030 projections with those for an excursion in which we assume median income grows at the same rate as per-capita GDP. Under this scenario, health care spending is unchanged, but government premium subsidies fall by 22% because of higher incomes at the lower end of the income scale. Table 8 compares the original 2030 projections with those for an excursion in which median income grows at the rate of GDP and health care costs grow at GDP plus 1% (for a growth rate of 2.4%, compared with our baseline growth rate of 3.3%). When increased median income growth is combined with lower health care cost growth, premium subsidies fall by 43%.

Discussion

Within the current environment, the number of uninsured will continue to increase. The rate of increase will dependent importantly upon growth in health care costs and in median incomes. Covering this growing number of individuals who would otherwise be uninsured will require additional government expenditures that should be considered in long term forecasts of government health care expenditures. As our results show, the impact could be significant, with premium subsidies amounting to 17% of Medicare and Medicaid spending by 2030 in our baseline scenario.

One important observation from these preliminary findings is the importance of growth in median incomes. Continued stagnation at the lower end of the income scale is a major determinant of government health care spending requirements in the coming years. As we look for ways to solve the long term fiscal problems associated with health care expenditures, we should not just focus on health care costs but should also consider programs aimed at increasing the earning power of lower income populations.

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US Census Bureau. Current Population Survey (CPS). 2007. Available: http://www.census.gov/cps/

Figure 1. Subsidy Boundaries

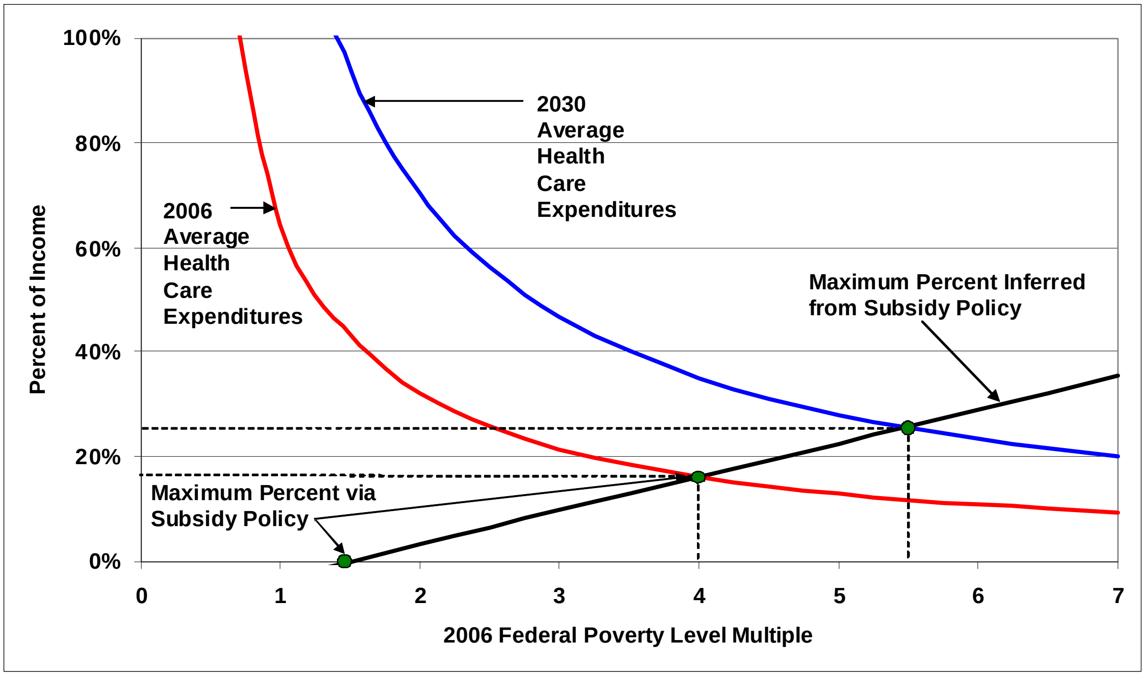

Figure 2. Uninsured by Subsidy Category

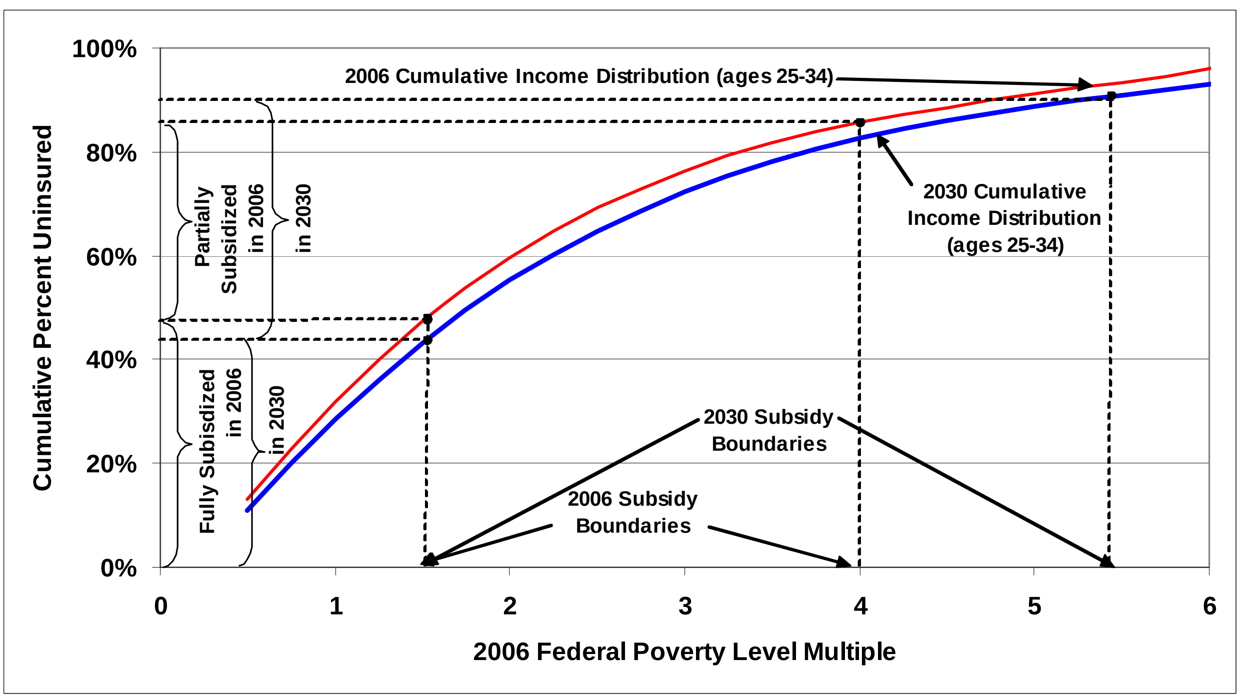

Figure 3. AHSM Overview

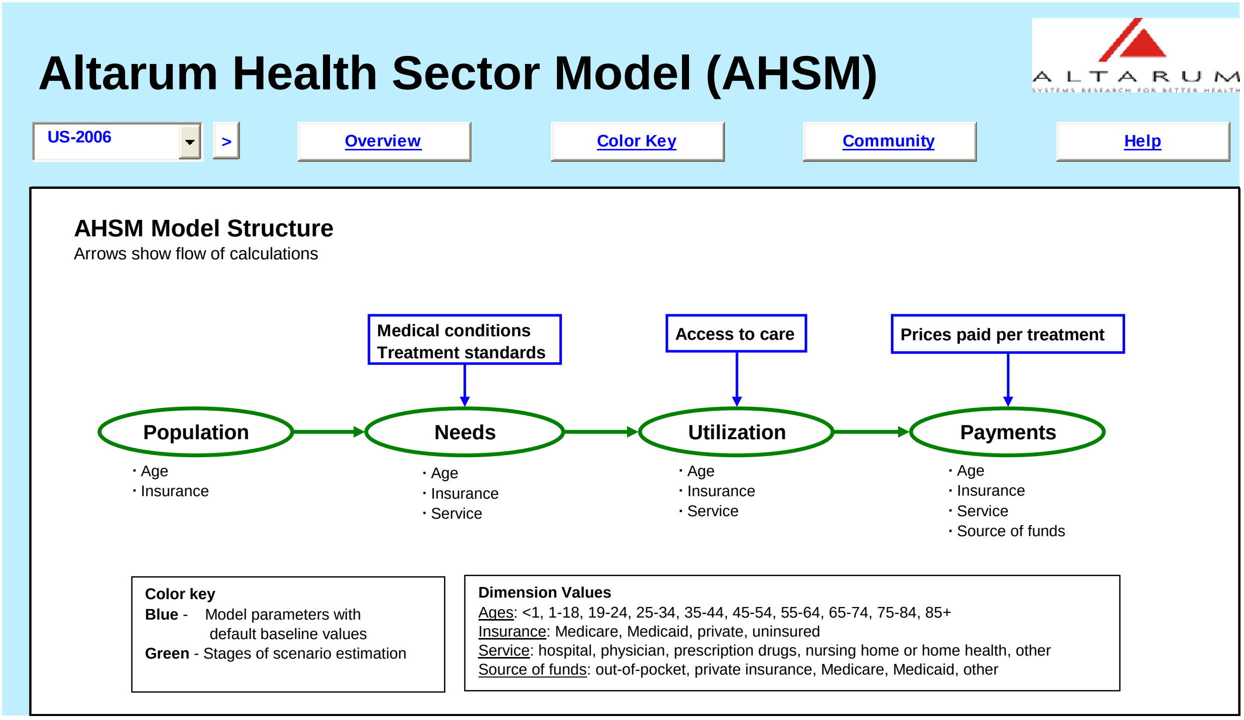

Figure 4. Growth in Uninsured

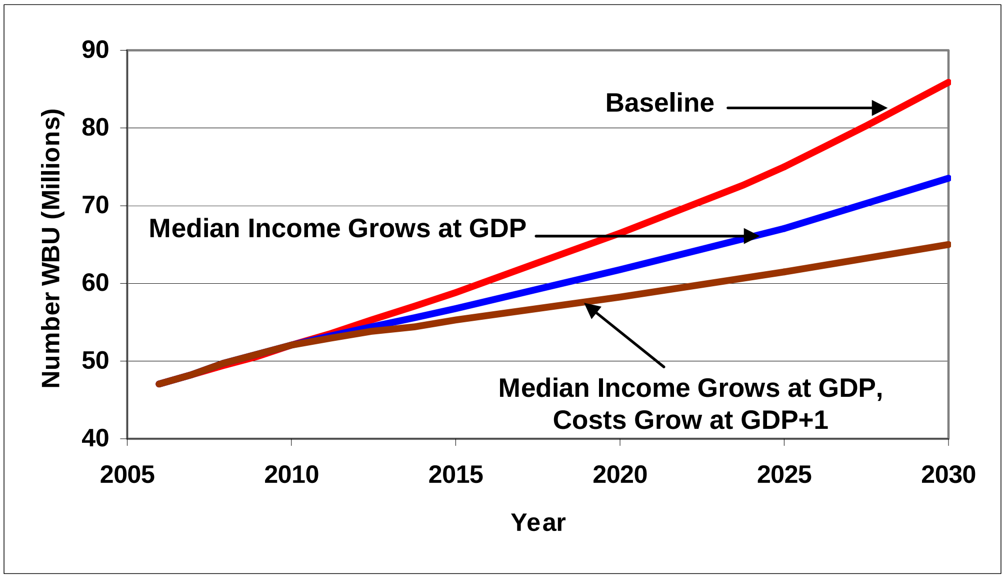

Figure 5. Shift in Upper Subsidy Boundary

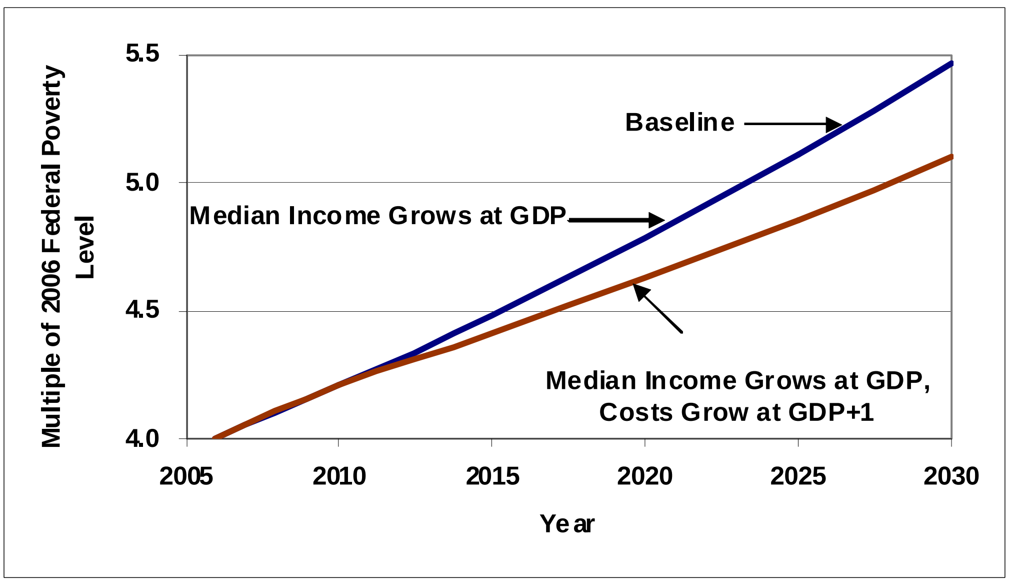

Table 1. Personal Health Expenditures in 2010 Baseline (2006 dollars)

	Source of Funds					
	Out of Pocket	Private Insurance	Medicare	Medicaid	Other	Total
Personal Health Expenditures	289.8	744.4	465.4	358.2	217.3	**2075.2**
Hospital	26.2	283.8	225.4	138.1	100.0	**773.6**
Physician & Clincal Services	55.1	257.6	112.6	37.9	61.2	**524.4**
Prescription Drugs	56.6	108.7	53.0	25.2	16.9	**260.5**
Nursing Homes & Home Health	39.9	16.6	49.9	84.4	11.6	**202.3**
Other	111.9	77.8	24.4	72.7	27.6	**314.4**
Govt Admin & Net Cost of Priv Insurance		104.2	24.7	29.2	13.8	**172.0**

Table 2. Personal Health Expenditures in 2010 with Full Coverage (2006 dollars)

	Source of Funds					
	Out of Pocket	Private Insurance	Medicare	Medicaid	Other	Total
Personal Health Expenditures	276.5	942.9	468.5	358.8	199.7	**2246.5**
Hospital	22.8	358.4	227.4	138.6	95.4	**842.5**
Physician & Clincal Services	50.2	330.6	113.2	37.9	57.1	**589.0**
Prescription Drugs	51.1	137.5	53.4	25.2	14.6	**281.7**
Nursing Homes & Home Health	39.6	18.2	49.9	84.4	11.7	**203.8**
Other	112.8	98.2	24.7	72.8	20.9	**329.4**
Govt Admin & Net Cost of Priv Insurance		132.0	24.9	29.3	12.7	**198.9**

Table 3. Impact on Providers of Shift to Full Coverage in 2010 (2006 dollars)

		Before	After	Change	% Change
Providers (all)	**Payments collected**	2075.2	2246.5	171.3	8%
	Cost of care	2075.2	2180.7	105.5	5%
	Margin	**0.0**	**65.8**	**65.8**	**NA**
Hospitals	**Payments collected**	773.6	842.5	69.0	9%
	Cost of care	773.6	804.9	31.3	4%
	Margin	**0.0**	**37.6**	**37.6**	**NA**
Physicians	**Payments collected**	524.4	589.0	64.6	12%
	Cost of care	524.4	573.2	48.9	9%
	Margin	**0.0**	**15.8**	**15.8**	**NA**
Prescription Drugs	**Payments collected**	260.5	281.7	21.2	8%
	Cost of care	260.5	281.2	20.7	8%
	Margin	**0.0**	**0.5**	**0.5**	**NA**
Nursing Homes & Home Health	**Payments collected**	202.3	203.8	1.5	1%
	Cost of care	202.3	202.5	0.2	0%
	Margin	**0.0**	**1.3**	**1.3**	**NA**
Other	**Payments collected**	314.4	329.4	15.0	5%
	Cost of care	314.4	318.8	4.4	1%
	Margin	**0.0**	**10.6**	**10.6**	**NA**

Table 4. Impact of Equalizing Payment Rates in 2010 (2006 dollars)

Payer		Unequalized	Equalized	Change	% Change
Individuals					
	Payments to providers	276.5	271.4	-5.2	-2%
	Insurance premiums	410.3	367.1	-43.2	-11%
	Total	**686.9**	**638.5**	**-48.4**	**-7%**
Employers					
	Insurance premiums	504.9	429.3	-75.5	-15%
Government					
	Payments to providers	827.3	891.0	63.7	8%
	Premiums subsidies	159.7	136.7	-23.0	-14%
	Taxes foregone	270.3	230.3	-40.1	-15%
	Total (real)	**1257.4**	**1258.0**	**0.6**	**0%**
Insurance					
	Premiums collected	**1074.9**	**933.2**	**-141.7**	**-13%**
	Payments to providers	942.9	818.6	-124.3	-13%
	Markup	132.0	114.6	-17.4	-13%
Other		199.7	199.7	0.0	0%
Total payments to providers		2246.5	2180.7	-65.8	-3%

Table 5. Personal Health Expenditures in 2030 with Full Coverage and Equal Payment Rates (2006 dollars)

	Source of Funds					
	Out of Pocket	Private Insurance	Medicare	Medicaid	Other	Total
Personal Health Expenditures	666.8	1827.2	1607.5	912.9	430.0	**5444.4**
Hospital	54.6	616.8	814.2	331.1	207.2	**2023.9**
Physician & Clincal Services	112.2	640.5	394.4	126.7	116.6	**1390.4**
Prescription Drugs	114.9	313.8	140.8	67.2	33.7	**670.5**
Nursing Homes & Home Health	126.1	50.3	164.2	240.8	29.3	**610.6**
Other	259.0	205.9	93.8	147.1	43.3	**749.1**
Govt Admin & Net Cost of Priv Insurance		255.8	85.4	74.5	27.3	**443.1**

Table 6. Changes from 2010 to 2030 with Full Coverage and Equal Payment Rates (2006 dollars)

Payer		2010	2030	Change	% Change
Individuals					
	Payments to providers	271.4	666.8	395.5	146%
	Insurance premiums	367.1	871.8	504.7	137%
	Total	**638.5**	**1538.6**	**900.1**	**141%**
Employers					
	Insurance premiums	429.3	775.2	345.9	81%
Government					
	Payments to providers	891.0	2520.3	1,629.3	183%
	Premiums subsidies	136.7	436.0	299.3	219%
	Taxes foregone	230.3	428.6	198.3	86%
	Total	**1258.0**	**3384.9**	**2,126.9**	**169%**
Insurance					
	Premiums collected	**933.2**	**2083.1**	**1,149.9**	**123%**
	Payments to providers	818.6	1827.2	1,008.7	123%
	Markup	114.6	255.8	141.2	123%
Other		199.7	430.1	230.4	115%
Total payments to providers		2180.7	5444.4	3,263.7	150%

Table 7. Impact of Increased Growth in Median Income in 2030 (2006 dollars)

Payer		Baseline Income	Income = GDP	Change	% Change
Individuals					
	Payments to providers	666.8	674.0	7.2	1%
	Insurance premiums	871.8	908.2	36.4	4%
	Total	**1538.6**	**1582.2**	**43.6**	**3%**
Employers					
	Insurance premiums	775.2	826.5	51.2	7%
Government					
	Payments to providers	2520.3	2520.3	0.0	0%
	Premiums subsidies	436.0	340.2	-95.8	-22%
	Taxes foregone	428.6	457.1	28.5	7%
	Total	**3384.9**	**3317.6**	**-67.3**	**-2%**
Insurance					
	Premiums collected	**2083.1**	**2074.9**	**-8.2**	**-0%**
	Payments to providers	1827.2	1820.1	-7.2	-0%
	Markup	255.8	254.8	-1.0	-0%
Other		430.0	430.0	0.0	0%
Total payments to providers		**5444.4**	**5444.4**	**0.0**	**0%**

Table 8. Impact of Higher Income and Lower Health Care Costs in 2030 (2006 dollars)

Payer		Baseline Income & Costs	Income = GDP, Costs = GDP+1	Change	% Change
Individuals					
	Payments to providers	666.8	568.4	-98.4	-15%
	Insurance premiums	871.8	765.6	-106.2	-12%
	Total	**1538.6**	**1334.0**	**-204.6**	**-13%**
Employers					
	Insurance premiums	775.2	723.5	-51.7	-7%
Government					
	Payments to providers	2520.3	2115.7	-404.6	-16%
	Premiums subsidies	436.0	249.6	-186.4	-43%
	Taxes foregone	428.6	396.1	-32.5	-8%
	Total	**3384.9**	**2761.4**	**-623.5**	**-18%**
Insurance					
	Premiums collected	**2083.1**	**1738.7**	**-344.4**	**-17%**
	Payments to providers	1827.2	1525.2	-302.1	-17%
	Markup	255.8	213.5	-42.3	-17%
Other		430.0	361.0	-69.0	-16%
Total payments to providers		5444.4	4570.3	-874.1	-16%

Evaluating Policy Forecasts

Session Chair: James Franklin, Bureau of Labor Statistics, U.S. Department of Labor

Federal Revenue Forecasting
(http://www.urban.org/publications/411442.html)

Rudolph G. Penner, Urban Institute

Federal revenue forecasts are crucial to debates about budget policy. But revenue forecasts are often very wrong despite being prepared by very talented analysts. This paper describes the forecasting process used by the Congressional Budget Office (CBO) and documents past errors. The errors tend to be serially correlated. That is to say, if CBO is too optimistic (pessimistic) one year, they are very likely to be too optimistic (pessimistic) the next year as well. The paper speculates about the reasons for this phenomenon. It concludes by arguing that the uncertainty of forecasts should play a much larger role in debates regarding budget policy.

Multivariate Forecast Errors and the Taylor Rule
(http://www.gwu.edu/~forcpgm/2008-002.pdf)

Edward N. Gamber, Tara M. Sinclair, H.O. Stekler, and Elizabeth Reid, The George Washington University

This paper introduces a new methodology for quantitative evaluation of policy forecast errors when there is more than one variable which is important for the policy decision. We apply this methodology to the Federal Reserve forecasts of U.S. real output growth and the inflation rate using the Taylor (1993) monetary policy rule. Our results suggest it is possible to calculate policy forecast errors using joint predictions for a number of variables. These policy forecast errors have a direct interpretation for the impact of forecasts on policy. In the case of the Federal Reserve, we find that on average, Fed policy based on the Taylor rule was nearly a full percentage point away from the intended target because of errors in forecasting growth and inflation.

Estimating Federal Reserve Behavior: An Augmented Reaction Function Using Real Time Data

Paul Sundell, U.S. Department of Agriculture Economic Research Service

Reaction functions based on the Taylor Rule have become the basic applied model for forecasting Federal Reserve behavior. In the basic backward looking Taylor rule, the federal funds rate is a function of inflation, the deviation of inflation from target, and the deviation of output from target while forward looking version of Taylor rule typically add forecasts of inflation and GDP growth relative to potential GDP growth. I augmented the forward looking Taylor rule reaction function to include additional variables that influence Federal Reserve behavior by providing information on the state of the economy and risks to the economy. In-sample and out-of sample forecasting results are presented in the paper.

Estimating Federal Reserve Behavior: An Augmented Reaction Function Using Real Time Data

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Introduction

Projecting the path of U.S. monetary policy is an important element of analyzing the U.S. outlook as well the outlook for world economies and financial markets. Using macroeconometric models to perform simulations of policy or macroeconomic shocks and their impacts on the economy requires credible modeling of the likely response of Federal Reserve policy to these economic events. This paper explains monetary policy during the Greenspan and Bernanke chairmanships of the Open Market Committee by expanding the partial adjustment forward looking Taylor rule estimated by Orphanides (2003) to include other current information that may impact monetary policy directly as well as through its impact on inflation and output gaps. The direct channel for current information is relevant in a reaction function because current economic information not only changes perceptions of the likely path for the inflation and the output gap but the perceived risk structure facing the economy and policymakers as well. Risk management allows for policy adjustments when economic risks are greater than normal or when risks are perceived to be nonsymmetrical in nature.

Monetary policy is influenced by real and financial conditions that influence the impact of monetary policy on economic activity and inflation. Changes in underlying economic conditions create economic environments that have led to greater discretion in the setting of monetary policy than that implied by a simple Taylor rule. For example, changes in risk premiums imbedded in the term structure of interest rates, credit quality premiums, and equity premiums will alter the cost and availability of capital for business firms encouraging an offsetting move in the federal funds rate. Likewise changes in the willingness of consumer and mortgage lenders to make loans to consumers will impact how expansionary or contractionary a given real federal funds rate is on overall economic activity.

In order to capture the importance of financial conditions and risk conditions on monetary policy, a combination of economic theory and ex-post Federal Reserve statements concerning policy setting were used in choosing potential additional information variables to add to the Orphanides model. If information appeared to have systematic component on monetary policy since 1987, such as credit market conditions and near term recession risks, additional time series information was added to the reaction function. Dummy variables were used to capture unique economic circumstances that could not be modeled in any other matter. The additional information variables that were found to explain the federal funds rate since the late 1980s included credit market conditions, the current period's change in the unemployment rate, the probability of negative economic growth in the following quarter, as well as unique risks posed by the developing country debt crises of the late 1990s. In addition, the intermediate term neutral federal funds rate was allowed to vary over time.

The model displayed excellent in sample fit with a very high adjusted R^2 and other than a small amount of autocorrelation in the residuals, the residuals were normal, homoscedastic, with no major residual outliers present. The model performed well out of sample in that the model predicted the recent sharp Federal Reserve easing over the 2007Q3 through 2008Q1 period. The model out performed the basic forward looking Taylor rule on both an in-sample and out-of-sample period basis further indicating the importance of current economic conditions and changing perceived economic risks in recent policy making.

Federal Reserve Reaction Functions: Brief Overview of Economic Rational and Recent Developments

Since the mid 1990s modeling monetary policy making has predominately followed the framework laid out by John Taylor. Taylor showed that a monetary rule where the Federal Reserve adjusted the federal funds rate in response to inflation and the output gap tracked the actual federal funds rate closely over the 1987 through 1992 period. Other researchers that estimated the Taylor rule over a larger time frame found that model performance varied depending upon the sample period and improved with a partial adjustment specification that allowed the federal funds rate to adjust more slowly to inflation and output deviations from target (Mehra 1999 and Judd and Rudebusch).

The logic of Taylor rule type reaction functions is that over time monetary policymakers will adjust the level of the real (inflation adjusted) federal funds rate to minimize the costs to society of deviations in inflation and output relative to their optimal target levels. Inflation considerably above or below targeted levels induces substantial costs on the economy. High inflation generally increases inflation uncertainty therefore raising risk premiums in financial markets and increasing difficulties for economic agents in determining real prices for goods and services (Lucas, and Shafir, Diamond, and Tversky). Near zero inflation rate in expansionary times increases the likelihood of destabilizing deflation in recessions which limits the ability of monetary policy to countercyclically lower real short-term interest. Very low inflation or deflation also reduces the effectiveness of countercyclical monetary policy by increasing the likelihood of borrower defaults and credit contraction on the part of lender's as asset values fall (Bernanke and Bernanke, Gertler, and Gilchrist).

Monetary policy also attempts over time to encourage a high level of resource utilization level consistent with low and stable inflation. Prolonged periods of output above long- term potential generate inflationary pressures. Likewise if output is substantially below potential output, deflationary pressures are generated. Extended periods of output substantially below potential makes business investment riskier and less profitable, thus lowering future potential real GDP.

Another goal of monetary policy is to avoid being an unnecessary source of price volatility in financial markets. High volatility in financial asset prices and yields will raise risk premiums in financial markets and therefore raise long-term capital costs, lowering private capital investment and long-term growth. To reduce market volatility from monetary policy changes, most economists believe the Federal Reserve does not adjust the federal funds rate immediately to its target level. Last period's federal funds rate is normally added to the reaction function, to capture the policymaker's sluggishness in adjusting the actual funds rate to its target.

Expectations of future economic conditions can be expected to influence policy setting. The use of forecasts of inflation and economic growth relative to potential allows policymakers to adjust policy proactively to expected changes in underlying tightness of resource utilization and inflation. Proactive monetary policy necessitates the inclusion of forecasts of future inflation and changes in the output gap in the setting of monetary policy as well as close monitoring of incoming data on contemporaneous economic performance. Empirically, forecasts of future inflation and the output gap have been found to be significant variables in Federal Reserve reaction functions estimated by Orphanides 2003, Mehra (1999, 2007), Boivin, and Clarida, Gali, and Gertler.

Rudebusch argues that a forward looking reaction function still contain serious misspecification in that the Taylor rule omits important variables related to current economic conditions and economic risks that influence the setting of monetary policy. Rudebusch examined residuals from Taylor rule models that both included and did not include the lagged federal funds rate. The magnitude and autocorrelation of the residuals from the models were strongly related to Federal Reserve pronouncement's concerning greater than normal inflation or deflation risks, domestic credit and financial market shocks, uncertainty over productivity shifts, and the developing country financial crises of the late 1990's (pp.95-99). In Rudebusch's opinion, the lagged dependent variable captures much of the information content of omitted information, especially for period's of perceived greater than normal risk. The omitted information produces a coefficient estimate on the lagged federal funds rate that is biased sharply upward indicating implausibly slow adjustment of the federal funds rate to its targeted level. Because of this misspecification, error out-of-sample forecasting performance especially at turning points is likely to be less than desirable.

This paper expands Rudebusch's work by formally including, in a forward looking Taylor rule reaction, variables related to the current state of the economy and risks facing the economy. Incoming data on real output, inflation, credit growth, quality spreads in bond markets, conditions in equity markets, as well exchange rates and foreign economic conditions provides information on the current state of the U.S. and world economy, Incoming data may indicate that risks to the economy are not symmetrical or are greater than normal necessitating a greater than normal offsetting policy response that deviates from the basic backward or forward looking Taylor rule.

Mishkin stated recently that credit problems in the second half of 2007 and early 2008 that had originated in the sub-prime mortgage market had spread to other credit markets. Rising loan loses on mortgage loans and securities at financial institutions were reducing credit availability for higher risk borrowers in other markets. The tightening of credit market conditions and falling home and equity prices generated large nonsymmetrical downside risk for the aggregate economy and contributed to fears of a possible wider spreading contraction of credit on the part of lenders in general. The large nonsymmetrical downside risk required a greater easing of policy than normal. In his 2004 American Economic Review article, Greenspan discussed in detail the importance of changing perceptions of economic risk in the setting of monetary policy during his 18.5 year tenure as Federal Reserve chairman. Risk based policymaking requires close monitoring of incoming information since perceived risk levels are likely to be highly dependent upon the state of the economy and current shocks in the economy.

Overview of Model Specification and Data

The augmented Taylor rule estimated in this paper is as below:

$$\mathbf{i_t = r^* + b\ infcorepce_{t-1} + c\ inf^{exp} + d\ ygap_{t-1} +}$$

$$\mathbf{e\ grygap^{exp} + f\ otherinform_t + g\ i_{t-1} + u_t}$$

The variables definition and the quarterly data used in this study are briefly defined below.

i_t = the effective federal funds rate

r* = equilibrium intermediate term federal funds rate

infcorepce = inflation as measured by core chain weighted personal consumption deflator over the last year

ygap = the output gap (actual GDP less potential GDP)

inf^{exp} = expected inflation measured by the GDP deflator

$grygap^{exp}$ = $\Delta(y - y^*)^{exp}$ = expected change in the GDP gap

Otherinform = other economic information or events that influence monetary policy

chlrrt = change in the unemployment rate

prrecess1qtr = the subjective probability of negative real GDP growth in the next (t+1) quarter

grrcred1yr = growth in real nonfinancial credit over the last year.

lrneutint = intermediate term real neutral one year t-bill interest rate

spbaatb10 = spread between the Moody's BAA corporate bond rate and the 10 year T-bond.

dumfordebtacrisis = dummy variable for the impact of the developing country debt crises of 1998 and 1999 on U.S. monetary policy.

The definitions and construction of these variables are defined in greater detail in the data appendix.

Given the well known importance of the core personal consumption deflator in measuring the underlying inflation, core PCE inflation rate over the previous year was chosen as the inflation measure. Since a lengthy survey based expectations series for the core PCE does not exist, Orphanides series on inflationary expectations as measured by the GDP deflator(or the GNP deflator for pre 1992 period) is used to measure inflationary expectations.

The above model expands the Taylor rule Federal Reserve reaction function by allowing a significant role for credit market conditions, risk, variability in the neutral short-term interest rate, and special conditions, such as the foreign debt crises of 1998 and 1999 to impact U.S. monetary policy. Including other variables in Taylor rule reaction functions has surprisingly not appeared frequently in empirical work but was used in reaction functions estimated by Mehra (1999) and Gamber and Hakes. Credit market conditions are captured by the growth of real domestic nonfinancial credit (the sum of household, nonfinancial business, plus government) and the spread between BAA (lower quality investment grade bonds) and the 10 year Treasury bond. Since adequate access to credit is necessary for everyday business functioning and expansion, credit flows and credit conditions have long been known to strongly influence economic growth (Friedman 1988, and Bernanke et al., 1999). Credit terms consists of both price (interest rate) and non price terms of credit (qualifying conditions and loan restrictions) which are both important in determining the general availability of credit.

A rise in credit spreads is symptomatic of either rising risk of private bond default or rising aversion to credit risk on the part of lenders and both have a contractionary impact on the economic growth. Abnormally tight credit terms create a financial environment where consumers and business firms have difficulty in obtaining external debt funding. These funding difficulties lower the effective demand for goods and services and raise the risk of growth being significantly below potential. Rising credit spreads are also an indicator of increased risk for the stock market since income flows to equity holders are a residual flow to stockholders after payments to all other real factors of production and debt holders are made. Moreover, like equities, the expected future cash flow from interest and principle of lower rated bonds is less certain than higher rated bonds and is more tied to general economic conditions. If credit spreads widen, we would expect in most circumstances for the Federal Reserve to ease to avoid a rise in the overall cost of capital to firms.

The model allows the estimated default free neutral short-term interest rate expected over the next five to ten years to change over time. This intermediate time frame neutral rate interest rate is consistent with a zero output gap and no upward or downward pressure on inflation over the course of at least the current business cycle. Interest rates are determined by the supply and demand for credit and it is unlikely that fundamental factors influencing the demand or supply for credit will be unchanged or cancelling from one business cycle to the next. Fundamental shifts in intermediate or long-term consumer savings behavior, productivity, private investment demand, government spending and taxes, and foreign trade and capital flows relative to GDP can be expected to alter the neutral interest rate over time. Changes in term structure and default premiums in debt markets and changes in risk premiums in equity markets will also change the neutral federal funds.

Most economists believe that the neutral real interest rate for the United States has fallen since 2000. This is due to the large growing trade surpluses of developing countries with their accompanying relatively high consumer savings rates and limited consumer credit demands coupled with the continued evolution of fewer restrictions on trade and capital flows. Furthermore, foreign trade, by increasing competition and reducing inflationary pressures and risks, has further lowered real interest rates by lowering risk premiums based on inflation uncertainty (Humpage and Wu).

The change in the unemployment rate is included in the model because of its great importance as an indicator of likely economic performance and its release early in the month. The change is the unemployment rate is a useful indicator of changing economic slack in the labor markets as well as likely growth in consumer income and spending. The model's fit was better with the change in the real time unemployment rate than with the change in real time payroll employment. The unemployment rate is likely a better measure of changes in overall labor market tightness than growth in employment. Strong growth in employment may not be inflationary if the labor force and productivity are also growing rapidly.

The probability of recession in the next quarter captures the risk of near term negative real economic growth on monetary policy. Given the other variables in the model, an increased probability of near term negative growth indicates increased risk of substantially lower economic growth relative to potential. As the probability of negative near term growth increases for any given level of the output gap, we would expect in general greater monetary easing by the Federal Reserve.

With the tremendous growth in foreign trade over the last two decades, difficult and unusual foreign economic conditions can be expected to have more of an impact on the outlook and risks facing the United States. Foreign impacts on the U.S. monetary policy can be expected to be highest when concerns of foreign economic conditions impacting on U.S. economic performance and risks are greatest. These risks may not be fully reflected in credit risk premiums facing U.S. borrowers. A case in point was the easing of U.S. monetary policy in the fall of 1998 because of the developing country financial crises centered in Russia and Asia. Despite relatively strong real U.S. growth in the second half of 1998, monetary policy was eased during the period to increase domestic and worldwide liquidity to reduce the risks of a sharp world wide economic slowdown and major disruptions to U.S. and world financial markets (Greenspan, p.37).

Empirical In-Sample Model Results and Analysis

In this section, we examine the in-sample and out-of-sample performance of the basic Taylor models and the augmented Taylor rule models. The augmented Taylor rule models outperformed its basic counterpart in terms of in-sample and out-of-sample performance. Much of the improvement was due to the much better capturing of underlying risks in the U.S. economy facing policymakers.

Table 1 presents the results for the basic backward and forward looking Taylor Rule model results. Econometric results showed significant coefficients on existing output gap and inflation as well as their expectations. For the backward looking equation, both the lagged core inflation and the output gap were significant. The forward looking versions produced significant coefficients for expectations of one year ahead GDP inflation and real GDP growth relative to potential. The level of the last quarter's output gap was highly significant as well. The coefficient on core PCE inflation over the previous year was not significant; however, the insignificance probably was due to the highly collinear relationship between core inflation and expected GDP measured inflation. If expected inflation in the GDP deflator was omitted from the equation, core PCE inflation became significant. The size and significance of the lagged federal funds rate indicated that the setting of the federal funds rate adjusts relatively slowly to changes in inflation and output gap information.

Table 2 presents estimation results for the augmented forward looking Taylor rule equation. All the added variables were significant at least at the five percent level and many of the additional variables were significant at the 1 and 2 percent level. The model displayed an extremely good in sample fit with a very high adjusted R^2 and other than a small amount of autocorrelation, the residuals were normal, homoskedastic, with no major residual outliers present. Estimation results indicated that credit conditions, the risk of near-term negative real growth in GDP, changing employment conditions, and special factors such as the late 1990s developing country debt crises also directly influenced monetary policy. When current conditions and special factors are included, the expectations for variables become insignificant. Possible interpretations of lack of significance of forecast terms include: (1) current conditions are likely a major influence on forecasts nine months ahead, (2) risk management is relatively more important than forecasts in monetary policy making or (3) forecasts get less weight because of their high degree of uncertainty, or that forecasts by Federal Reserve staff may at times not proxy well for FOMC member expectations (Romer and Romer).

The significance of the bond quality spread variable was especially notable. With a coefficient of -0.41 and a t statistic of -4.31 the bond credit spread variable was highly significant. The importance of the bond credit spread variable coupled with the significance of real credit growth illustrates the importance of credit market conditions, especially capital market conditions in monetary policy formation. As credit spreads widen, capital credit costs rise and credit availability declines for moderate and high risk borrowers. As real interest rates rise for these borrowers, lenders become increasingly concerned with borrower repayment capacity and the likelihood that borrowers will shift toward investment projects with higher expected return but higher risks (Stiglitz and Weiss). In financial market where credit spreads or required expected returns on equity are rising relative to default risk free Treasury bills and bonds, Federal Reserve easing is likely to avoid rising private capital costs.

The probability of negative real GDP growth next quarter was also significant at the one percent level. The probability of negative real growth in the future may be a better measure of the risk of near term negative growth than a near term point estimate growth estimate. If economic uncertainty increases, a central tendency point estimate may not adequately capture increased downside or upside risk to the economy. Economic uncertainty has increased sharply over the previous year as evidenced by the fall in the Survey of Professional Forecasters median one quarter ahead economic forecasts from 2.7 percent in 2007Q1 to 1.3 percent in 2008Q1, while the probability of one quarter ahead negative growth rose from 13 percent to 43 percent, the highest level since the end of the 2001 recession in 2001Q:4.

The estimated neutral real interest rate and the 1998 and 1999 foreign debt crisis variables were significant at the 3 percent level while the change in the unemployment rate was significant at the five percent levels. The 0.16 coefficient on the neutral real implied a 0.59 coefficient (0.16 / (1-0.73)) long-term coefficient for the on the neutral interest rate. Measuring the neutral interest rate with a high degree of precision is probably not possible whether a market based forecast, trend based measure, or an econometric model based solutions is used. Using a market based solution will allow to some degree the current phase of the business cycle to impact the real neutral rate estimate. Overall the neutral real rate estimate appears reasonable as it produces a sharp overall fall in the real neutral interest rate estimate since 2000 due to the development of large saving surpluses for developing countries and the U.S. productivity slowdown since 2003.

The developing country debt crises generated an impact on monetary policy beyond its impact on the other variables in the model over the 1998Q4 through 1992Q2. Growth remained strong in the U.S. in this period and most of the impact of the developing country debt crisis on the other variables in the model was felt through the approximately 50 basis points rise in the bond quality spread variable. The dummy variable estimated coefficient was -0.37 coefficient and significant at the 3 percent level.

The coefficient on the change in the real time unemployment rate was -0.26 and was significant at the five percent level. As mentioned earlier given the importance of employment growth and labor market conditions to the overall economic outlook and risk conditions and the release of the employment report early in the month, a large significant coefficient on the change in the unemployment rate is reasonable. The change in the unemployment rate provides an important channel for current and recent changes in economic conditions to impact monetary policy.

Out of Sample Simulation Results

Out of sample model performance is a very important criteria in evaluating the performance of an econometric model, especially models that contain lagged dependent variables that have large coefficients. The lagged dependent may serve to get a poorly specified model back on track for estimation purposes by capturing the impact of omitted variables that are autocorrelated in nature or picking up some of the effect of parameter variability. For this reason, models with large coefficients on the lagged dependent variables tend to perform in a poor manner in out-of-sample forecasts at turning points for the dependent variable.

To examine these issues, we performed dynamic out of sample dynamic forecasts for the forward looking Taylor model and the augmented Taylor rule model over the 2007Q2 to 2008Q1 period. This period captures the current sharp easing of monetary policy that began in September of 2007. To perform the simulations the models were reestimated over the 1987Q3 through 2007Q1 period.

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As shown below in the graph 1, for each data point, the augmented model produced a smaller absolute error. By every standard quantitative forecast evaluation criteria, the augmented forward looking Taylor rule outperformed the basic forward looking Taylor rule model. For the augmented Taylor rule, the root mean square, mean absolute error, mean absolute error percentage error, and Theil inequality coefficients for the augmented Taylor rule model were all roughly one half the magnitude of the basic Taylor rule

As discussed earlier, the coefficients on the expected change in the output gap and inflation were significant for the basic forward looking inflation but were small and insignificant for the augmented Taylor rule. Thus the basic forward looking Taylor rule model responds more strongly to changes in past and future expected inflation and output gap than the augmented Taylor equation, which also responds to other information on current economic conditions. Forecasts for the output gap and inflation fell relatively more than current economic conditions in 2007Q2 and 2007Q3. Thus the Taylor rule that omitted the current economic conditions variables predicted relatively more policy easing. In 2007Q4 and 2008Q1, current economic conditions deteriorated relatively more than economic forecasts that were predicting some bounce back in economic activity in the second half of 2008. Therefore, the impact of worsening current economic conditions in 2007Q4 and 2008Q1 included in the augmented Taylor rule led to greater predicted Federal Reserve easing for these two quarters.

Conclusions and Su ggestions for Additional Empirical Work

The Taylor rule is an excellent starting point for modeling Federal Reserve behavior. However, expanding the Taylor rule to include current information on credit conditions, the change in the unemployment rate, the probability of near term negative growth, an estimate of the intermediate term neutral interest rate, and accounting for unusually stressful conditions abroad improves the performance of the Taylor rule. A Taylor rule model that incorporated these modifications performed very well both in- and out-of-sample in that the model predicted accurately the recent sharp Federal Reserve easing over the 2007Q3 through 2008Q1 period. The inclusion of the additional variables to the Taylor rule model produced smaller forecasting errors for each of the last four quarters and reduced the mean square error, absolute error, percentage absolute error, and the Theil inequality coefficient by approximately 50 percent. The results indicate that contemporaneous information on economic conditions has a direct impact on monetary policy besides its indirect impact through its impact on inflation or the output gap.

It is well known that in general that OLS coefficient estimates are biased if the equation contains a lagged dependent variable with a serially correlated error term. A final issue briefly examined was if an instrumental variable estimator would out perform the OLS estimator on an in-sample or out-of-sample basis. An instrumental variable estimator will yield consistent estimates in large samples but may have poor small sample properties depending upon the quality of the instrumental variables used (Hahn and Hausman, 2002, 2003). Current and lagged values of the exogenous variables in the augmented Taylor rule model were used in the first stage regression to form the instrumental variable for the lagged federal funds rate. The model performance was not as good on an in-sample or out-of-sample basis in terms of fit, significant coefficients, and residual autocorrelation. A more detailed analysis of my model using instrumental variable estimation would be an interesting area for future research.

An examination of the coefficient stability of my augmented Taylor rule model indicated some variability in the coefficients over the sample period using various chow tests. Empirical work by Boivin and Gamber and Hakes also found variability in their estimated Taylor rule models. The coefficient variability may reflect changing policymaker concerns about inflation real growth, changes in the underlying real and financial structure of the economy, as well as the impact of presidential and chairman election and appointment cycles. This is also an area worthy of additional time and research.

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Data Appendix

COREPCE1YR = core personal consumption deflator over the previous four quarters.

INFEXP = Expected inflation as measured by GDP deflator over the t-1 through t+3 quarters. Measured by Federal Reserve Bank Greenbooks through 1997:4 and Survey of Professional Forecasters (SPF) post 1997:4. Data through 2002:4 is the data set than Orphanides constructed for his “Historical Monetary Policy Analysis and the Taylor Rule,” *Journal of Monetary Economics,* Vol. 50, 2003, pp.983-1022.

YGAP = last quarter’s output gap (real output less potential GDP) measured real output gap derived from expanding the Orphanides data set beyond 2002:4. Specifically, the GDP gap variable is defined as the gap between Philadelphia Federal Reserve Bank real time GDP data set and potential GDP obtained from Federal Reserve Green Books through 1997IV and Congressional Budget Office and (SPF) real time forecasts after 1997:4. Data through 2002:4 from “Historical Monetary Policy Analysis and the Taylor Rule,” *Journal of Monetary Economics,* Vol. 50 pp.983-1022, 2003.

GRYGAP = expected growth in actual GDP less potential GDP over the t-1 through t+3 quarters as measured by Federal Reserve Greenbook forecasts through 1997:4 and Survey of Professional Forecasters and CBO’s real time data set post 1997:4. Data through 2002:4 from Orphanides’ “Historical Monetary Policy Analysis and the Taylor Rule,” *Journal of Monetary Economics,* Vol. 50 pp.983-1022, 2003.

CHLRRT = change in the unemployment rate from the Philadelphia Federal Reserve’ real time data set

PRRECESS1QTR = the probability of negative real GDP growth in the next (t+1) quarter from the Survey of Professional Forecasters real time data set

GRRCRED1YR = growth in real domestic nonfinancial credit the sum of household, nonfinancial business, plus government divided by the chain weighted GDP deflator over the last year.

LRNEUINT = intermediate term neutral real one year t-bill = ten year treasury bond minus the SPF’s expected ten year inflationary expectation’s for the CPI and the trend real term premium for ten and one year T-bonds derived from applying the Hodrick-Prescott filter to the term premium.

SPBAATB10 = spread between the Moody’s BAA corporate bond rate and the ten year T-bond.

DUMFORDEBTCRISIS = dummy variable for risk impact on U.S. of Russia and Asia crisis on monetary policy. Takes on value of 1 for 98Q4 through 99Q2 and 0 for all other periods.

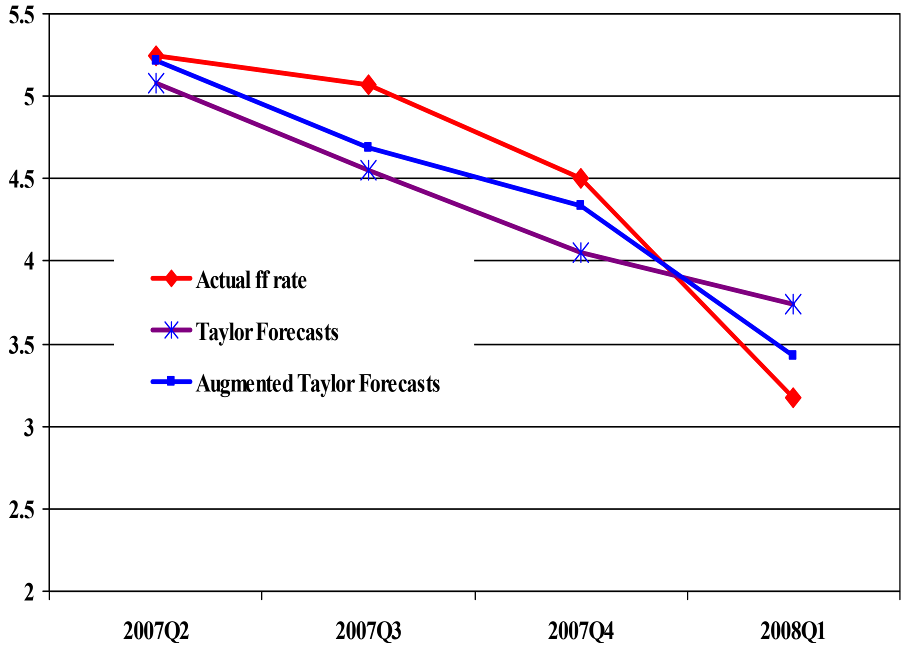
Table1. Econometric Results for Basic Backward and For ward looking T aylor Rules:

Variable	Coefficient	t-statistic	Coefficient	t-statistic
C	0.41	0.91	-0.14	-0.46
YGAP	0.21	3.99	0.19	4.03
$COREPCE1YR_{t-1}$	0.35	2.47	0.13	0.86
FFR_{t-1}	0.72	6.82	0.78	11.00
INFEXP			0.35	2.07
GRYGAP			0.28	4.05
AR(1)	0.76	5.63	0.68	5.98
R-squared	0.98		0.98	
Adjusted R-squared	0.98		0.98	
Durbin-Watson stat	1.76		1.86	
Breusch Godfrey LM Test F- Stat.*	0.32		0.00	
Sample period: 1987Q3 to 2008Q1				
*insignificant at the 10 percent level				

Table2. Econometric Results for Augmented Taylor Rules:

Variable	Coefficient	t-statistic
C	0.72	2.34
YGAP	0.16	4.61
$COREPCE1YR_{t-1}$	0.27	2.61
FFR_{t-1}	0.73	16.62
INFEXP	0.14	1.12
GRYGAP	-0.06	-0.79
$LRNEUINT_{t-1}$	0.16	2.33
SPBAATB10	-0.41	-4.31
CHLRRT	-0.26	-2
PRRECESS1QTR	-0.01	-3.19
$GRRCRED1YR_{t-1}$	0.07	2.36
DUMFORDEBTCRISIS	-0.37	-2.2
AR(1)	0.38	3.21
R-squared	0.99	
Adjusted R-squared	0.99	
Durbin-Watson stat	1.92	
Breusch-Godfrey LM Test :F- Stat.*	0.11	
sample period: 1987Q3 2008Q1		
*insignificant at the 10 percent level		

Graph 1: Augmented Taylor Equation Produced Excellent Dynamic Forecasts For 2007Q2 – 2008Q1



	Augmented Forward Taylor Rule	Forward Taylor Rule
Root Mean Square Error	0.243	0.452
Mean Absolute Error	0.207	0.424
Mean Abs. Percent Error	4.95	10.32
Theil Inequality Coefficient	0.027	0.050

Cycles, Investment, and Prices

Session Chair: Keith Ord, Georgetown University

Forecasting, Structural Change, and Empirical Confidence Intervals

Stephen MacDonald, Economic Research Service, U.S. Department of Agriculture

A history of past forecasts can be a rich source of information on the error characteristics of future forecasts. In a rapidly changing world, however, structural change can diminish the usefulness of this assumption. This paper will explore how the characteristics of past forecast errors can be used to predict the characteristics of future errors in an efficient, unbiased manner. Different measures of structural change, and different sources of information on structural change will be matched with appropriate adjustment methods to yield estimates of future forecast error distribution that exploit all available information: information both of past actual or hypothetical forecasts and of current variable characteristics that have been altered by structural change.

The Housing Bubble and the Resulting Impact on Employment

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

From the late 1990s through 2006, investment in residential construction grew at an unprecedented rate. This demand resulted in jobs not only in the construction industry but throughout the economy. Using the input output system developed by the Employment Projections program within the Bureau of Labor Statistics, we can estimate the employment by both industry and occupation that was generated to meet this run-up in demand. Historical data from 1996-2006 and projected data for 2016 will be examined for residential and nonresidential construction and compared to overall demand.

The Business Cycle, the Long Wave, and the Limits to Growth

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

The short-term business cycle is universally recognized as a dynamic process that can be modeled and forecast by the established methodology, a noise-driven damped linear system. Rather controversial is the “long wave,” a series of major financial crises that occur with a period that some analysts have identified as 54 years. By contrast, the “limits to growth” hypothesis can be demonstrated with quite basic mathematics. The challenge for forecasters and other analysts for the early twenty-first century is to predict, as well as possible, the interactions of these three phenomena. Some basic scenarios are presented.

The Housing Bubble and the Resulting Impacts on Employment

Kathryn Byun
Bureau of Labor Statistics

Research concerning the housing bubble often cites the Bureau of Labor Statistics (BLS) estimates of employment in the construction industry or specific construction related occupations. There are limitations to relying upon these data alone to estimate employment due to the housing bubble. First, building homes requires inputs including supplies, equipment, transportation, etc. Purchasing these intermediate goods generates jobs not only in the construction industry and related occupations, but throughout the economy. Second, these estimates include some jobs that were due to demand outside of the housing sector. The Current Employment Statistic's (CES) estimate of industry employment classifies companies based on their primary activity. Establishments classified as part of the Residential construction industry can also work on Nonresidential construction, heavy construction, and other miscellaneous projects. Likewise, the occupational data from the Office of Occupational Employment Statistics (OES) do not breakout Residential and Nonresidential construction workers from those who work on roads, bridges, utilities, etc.

The Office of Occupational Statistics and Employment Projections (OOSEP) publishes detailed historical final demand matrices as well as employment requirements tables and a staffing pattern matrix. Using these tools, I will estimate how demand for Residential and Nonresidential construction affected employment in detailed industries and occupations throughout the economy. I will be looking at which occupations benefited from the housing bubble and which lost jobs despite the run-up in demand. I will also examine the slowdown in demand for Nonresidential construction from 1985 to present. My historical estimates will be compared to CES and OES data. I will also discuss the forecasted employment due to demand for construction and how employment in these industries and occupations are expected to change from 2006 to 2016 as demand slows.

The research is based on OOSEP's 2016 projections which relied upon historical data from 1993-2006. The 2007 data will be discussed but was not available to OOSEP at the time of our publication. The research contained in this paper reflects my research alone and is not the official view of OOSEP or the BLS. The paper will be broken into three parts. First, the behavior of final demand for Residential and Nonresidential construction will be discussed. Next, total employment due to these sectors of demand will be estimated and compared to the trend as well as the CES Residential construction series. Finally, the employment will be broken out to detailed industries and occupations and examined.

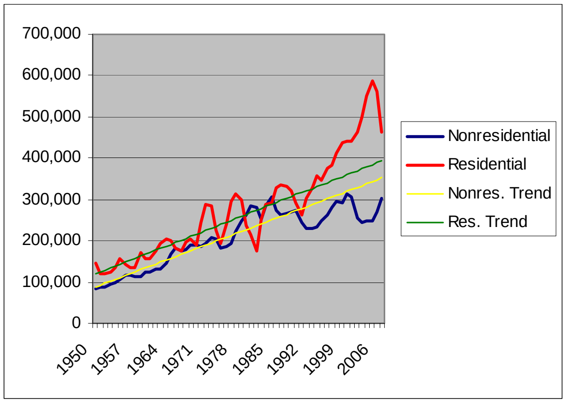
Historical Final Demand

Demand for Residential construction was well behaved between 1950 and 1970 closely following the 1950 to 1995 trend line (graph A). Between 1970 and 1995 it continues to fluctuate around this trend. Its behavior, however, is much more volatile. We see turbulent swings around the recessions of 1973-75, 80-82, and 90-91. Investment in Residential construction then experienced ten consecutive years of growth from 1995 to 2005. In fact, the growth continued right through the 2001-2003 recession. The expansionary period pushed demand well above the trend. While demand slowed a bit in 2006, the bubble finally started unravelling in 2007 when Residential construction plunged by 17.2%. This brought investment down considerably but still well above this trend line[1].

A less noticed phenomenon starting in the late 1980s was a marked slowdown of investment in Nonresidential construction (graph A). Until the mid 1970s, Nonresidential construction stays very near its 1950-1995 linear trend. Demand then flourished from the late 1970s through 1985. In 1985, it peaked at just over 305 billion dollars[2]. Since then, it surpassed this level only once from 2000 to 2001. Otherwise, it has consistently been lower than its 1985 peak as well as the 1950-95 trend.

[1] For BEA's detailed NIPA data for Residential Construction, see Appendix A, graph 1.
[2] All demand data are in chain weighted 2000 dollars

Graph A[3]: Final Demand and the 1950-95 Trend (chained 2000 dollars, millions)



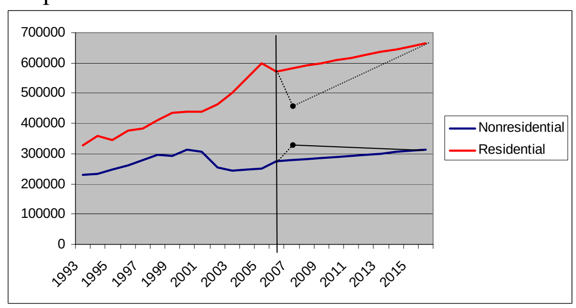
BEA provides some detail regarding the Nonresidential construction estimate (appendix A, graphs 2 and 3). The data do not give us a clear explanation of why demand dampened but do show that Commercial and health care structures were driving the behavior. Within this sector, Office buildings accounted for most of the movement from 1997 to 2007. They took a steep hit from 2000-2003 during the dotcom burst and the resulting depression. In 2000, final demand for Office buildings peaked at roughly 60 billion dollars and then tumbled to just over 30 billion by 2003. Since that time, it has only come back to 42.5 billion, no where near the pre-recession high.

Perhaps the early years of slowdown in demand for Nonresidential structures can be explained by an overinvestment in the late 70s and early 80s. Demand then started to come back and finally surpassed the 1985 value in 2000 and 2001 but was then hit again with the dotcom bust and resulting recession. Continued lack of growth may have been due to crowding out of work on Nonresidential structures while the workers were focusing on satisfying demand for Residential construction. This suspicion, however, is difficult to substantiate with available data.

Forecasted Final Demand

To arrive at the projections of Residential and Nonresidential construction, BLS relied upon a macroeconomic model provided by Macroeconomic Advisors (MA), LLC, a St. Louis, Missouri, based forecasting group [4]. For a detailed breakout of historical and forecasted final demand, see appendix A table 1. Using the MA model, OOSEP projected final demand for Residential construction to rise from 560 billion in 2006 to 664.2 billion in 2016 (graph b). The average annual rate of growth rate associated with this projection is 1.5% compared to the 5.6% experienced during the housing boom. The trend line for Residential construction shows 1.9% average annual growth. Since OOSEP's publication BEA has published the 2007 data. Demand for Residential construction plummeted to 463.7 billion in 2007. The 2016 projection together with the 2007 data imply an average annual growth rate of 4.1% from 2007 to 2016.

Graph B: Historical and Forecasted Final Demand



Nonresidential construction was projected to grow modestly from 268.6 billion in 2006 to 312.8 in 2016. Average annual growth was forecasted at 1.3% compared to the 0.2% it experienced from 1995-2005. The now available 2007 data show that Nonresidential construction helped to absorb some of the shock of the Residential decline. It increased by 34.8 billion or 12.9% to 303.4 billion. This indicates a 0.3% average annual growth rate from the 2007 data to the 2016 projection. Average annual growth rate for Nonresidential construction from 1950 to 1995 was 2.5%, higher than our projection and much higher than that implied with the 2007 data.

Construction Related Employment

OOSEP compiles estimates of intermediate costs along with their final demand data. In Residential construction, intermediates include all of the materials that companies buy in order to build a home

[3] The data contained in this graph is from the Bureau of Economic Analysis' (BEA) National Income and Product Accounts (NIPA).

[4] This model has been used to prepare BLS aggregate economic projections since May 2002. Macroeconomic Advisers developed and still supports the Washington University Macro Model, which the firm's team uses as a central analytical tool for its short- and long-term forecasts of the U.S. economy. The model operates and performs simulations on a Windows-based software program called WUMMSIM.

including the toilets, countertops, lumber, construction machinery, etc. They also include service costs such as the transportation costs of getting the supplies to the building site and the associated retail and wholesale trade values of the goods purchased. The key determinant when estimating employment is total output, final demand plus the intermediate goods necessary to satisfy this demand.

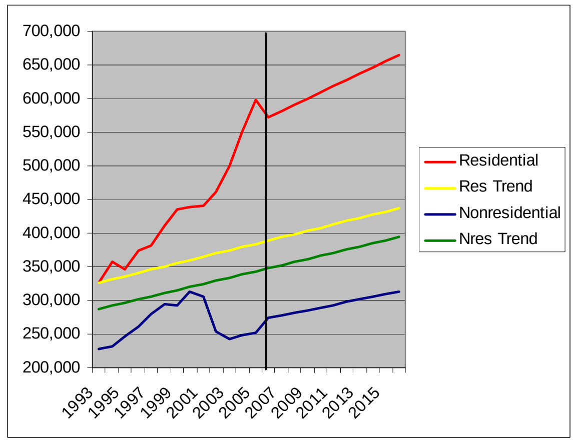
Employment data from the CES and CPS surveys coupled with total output enable OOSEP to estimate an employment requirements table for each historical year. These tables show how many jobs one million dollars of final demand and the resulting intermediate purchases create in each industry. For instance, in 2006 a dollar of final demand for construction creates not only 9.5 jobs in the Construction industry but also 0.43 jobs in Water, sewage, and other systems, 0.06 jobs in Metalworking machinery manufacturing, 0.06 jobs in Retail trade, 0.19 jobs in Pipeline transportation, and so on.

The employment requirements tables are created for final demand at the aggregate level. Therefore, in order to estimate the employment due to spending in a more detailed category, I will need to assume that the structure of the economy as a whole also holds for the given category. Since the employment requirements table only has one row for construction, I will also need to assume that a million dollars of demand for construction creates the same number of jobs per industry whether the demand is for Residential, Nonresidential, Utilities, etc. Given these assumptions, one can take a given vector of final demand and multiply it by the employment requirements table to estimate the industry employment that is needed in order to satisfy a single category of final demand.

According to this methodology, Nonresidential construction related employment slowed from 3.9 million jobs in 1995 to 3.4 million in 2005. It is forecasted to increase only slightly from 3.66 in 2006 to 3.68 million in 2016. Investment in Nonresidential construction supplied 3.0% of all jobs in 1995, 2.5% in 2006, and is projected to supply 2.2% of total employment in 2016. Meanwhile Residential construction related employment ballooned from 5.3 million jobs in 1995 to 7.8 million in 2005. It fell to 7.4 million jobs by 2006 and is projected to grow only slightly to 7.6 million in 2016. These jobs accounted for 4.1% of all jobs in 1995, 5.3% in 2005, 5.0% in 2006, and 4.6% of total projected employment in 2016.

From 1995 to 2005, total employment grew on average 1.2% a year, while the employment due to demand for Residential construction increased 4.0% and jobs related to Nonresidential construction fell by 1.4% (graph C). While total employment is expected to rise over the projection, the portion related to construction, both Residential and Nonresidential, is forecasted to stay relatively flat. Total employment is projected to rise at 1.0% a year, while the Residential construction related portion is forecasted to slow down dramatically to 0.2% and the Nonresidential construction component is expected to increase to 0.1%.

Graph C: Employment Related to Construction Spending Compared to Trend



Trend Employment

I also estimated what employment would have been if demand for Residential and Nonresidential construction had remained along their 1950-95 trends. In order to make this estimate, however, I assumed that the employment requirements tables would have been the same if demand was on trend. OOSEP relies upon a balanced set of input output matrices reflecting specific relationships between final and intermediate demand to estimate the employment requirements table. So if final demand had been different, the employment requirements table too would change. Therefore, I am assuming that the structure of the economy in each historical year would have been the same without the housing boom. Productivity would have changed in the same industries/commodities and by the same degree.

Moreover, this estimate of employment may not be reasonable if these trend lines no longer apply. There are several reasons why demand for Residential construction could have been higher than the trend line even without the housing bubble. These reasons include but are not limited to: more people owning multiple homes, additional single persons buying homes, and increased illegal immigrants purchasing homes. Since Nonresidential construction has sunk below its trend for about 20 years now, perhaps the 1950-95 trend line no longer well explains its behavior. Maybe the advent of the internet and the move from a manufacturing to a service based economy permanently changed the behavior of demand for Nonresidential construction.

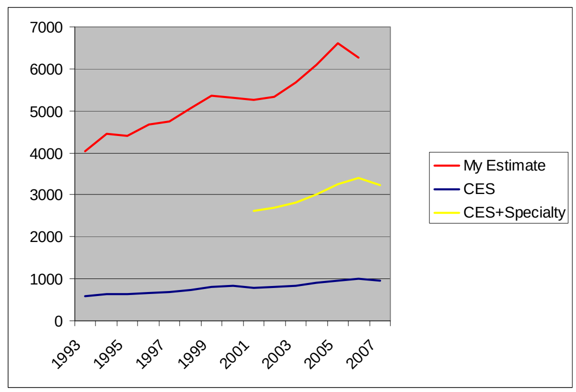
Nevertheless, making this estimate will give us some idea of the impact of the housing bubble and slowdown in Non residential structures on the job market. Employment due to Residential construction was very close to trend in the early years but crept up to 1 million jobs over trend by 1999, 1.7 million over by 2003, and peaked at 2.8 million over by 2005. In 2006, it declined by 0.4 million but stays well above trend. Meanwhile, if demand for Non residential construction had remained on its trend, it would have produced roughly one million additional jobs in each historical year except 1997-2001 when employment was much closer to the trend. The employment impacts of overinvestment in housing were partially offset by slower growth in Nonresidential construction.

CES Residential Employment

The CES estimate of employment in the Residential construction industry is often cited to show growth in jobs due to the housing bubble. However, demand for Residential construction requires many intermediate purchases and results in employment not only in the Construction industry but throughout the economy. In the previous section, my employment estimates included counts of self employed and unpaid workers. To be consistent with CES estimates, I will look only at wage and salary employment for this portion of the paper. CES data show 630 thousand jobs in the Residential construction industry in 1995 and 960 thousand in 2005 (graph D). I estimate 4.4 million jobs in 1995 and 6.6 million in 2005 were attributable to demand for Residential construction. My estimates show that nearly seven times as much employment was due to demand for housing than is captured in the Residential construction industry alone.

Part of this is difference is due to CES not breaking out specialty trade contractors into Nonresidential and Residential before 2001. These contractors include: Building foundation and exterior contractors, Building equipment contactors, Residential building finishing contractors, and Other residential trade contractors. Summing CES' estimate of Residential specialty trade contractors with their Residential construction gives employment of 2.6 million in 2001 and 3.3 million in 2005, an increase of 700 thousand over these four years (graph D). My estimate shows 5.3 million jobs in 2001 and 6.6 million in 2005 or a growth of 1.3 million. Combining these two CES industries explains about half of my estimate of employment due to demand for Residential construction. At least half of the jobs due to investment in housing were in industries outside of Residential construction and Residential specialty trade contractors.

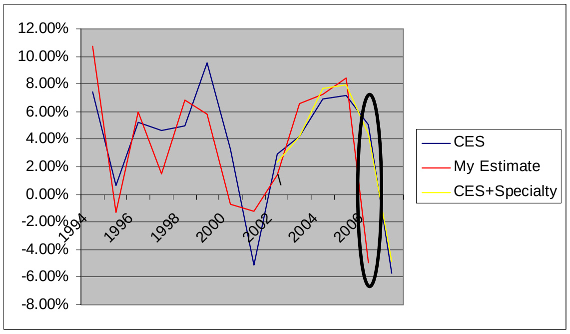
Graph D: CES Employment in the Residential Construction Industry and My Estimate of Employment due to the Demand for Residential Construction



While the level estimates differ, the annual growth rates of my estimate of employment generated due to increased demand for housing tracks very closely to the growth rate of CES' Residential construction series (Graph E)[5]. CES data indicates employment growth of 52.4% in the Residential construction industry from 1995-2005 while I estimate 49.7% growth in employment due to Residential construction spending. The growth rates are fairly close until 2006 where they diverge dramatically. CES shows an increase of about 5% while I show a decrease of roughly the same magnitude. Interestingly, the 2007 estimate from CES shows a decline of over 5% much like my decline for 2006. OOSEP has not yet published 2007 data.

Graph E: Annual Growth Rates

[5] The annual growth rate of CES' estimate of Residential construction and of Residential construction summed with Residential specialty trade contractors are nearly identical. Since Residential construction alone offers a longer time series, I will look at this series to discuss annual growth.



Industry Employment Related to Construction Spending

Investment in Nonresidential construction produced 28-30% of employment in the construction industry from 1993 to 2001. In 2002 this fell to 24% and bottomed out at 21% in 2005. Meanwhile, the employment in the construction industry due to demand for Residential construction was between 39-40% from 1993 to 2001. This grew to 42% in 2002 and continued increasing all the way up to almost 51% in 2005.

Not all jobs in the construction industry, however, are due to demand for structures. Demand for State and Local government for construction including utilities, road construction, bridges, etc. explains another 17% of the jobs in this industry. Most of the remaining jobs are due to indirect employment, jobs in a given industry aside from those that work on the commodity that the industry primarily produces. Personal consumption expenditures (PCE) generates the most indirect employment in the construction industry. Roughly 8% of the employment is due to PCE purchases. Maintenance and repair work on houses and businesses[6] could explain much of this employment.

Of the 2.5 million jobs due to increased demand for housing from 1995 to 2005, 1.9 million[7] were in the Construction industry (table 3). The forecast shows another increase of 155,000 jobs due to demand for Residential construction from 2006 to 2016. Real estate and Architectural, engineering, and related services increased by 127,000 and 104,000 respectively. They are expected to continue to post solid increases of 50,000 and 34,000 jobs by 2016.

Employment services and Services to buildings and dwellings added 82,000 and 59,000 over the history but are forecasted to slow growth to only 1,000 and 17,000 jobs from 2006 to 2016. Wholesale trade, Cement and concrete production manufacturing, Monetary authorities, credit intermediation, and related activities, and Architectural and structural metals each gained between 29,000 and 36,000 jobs over the history but are forecasted to lose some employment by 2016.

Not all industries gained employment due to the housing boom. I estimate the following industries lost employment due to demand for housing despite the surge in Residential construction investment from 1995 to 2005: Other wood product manufacturing, Household and institutional furniture and kitchen cabinet manufacturing, Commercial and service industry machinery manufacturing, Crop production, Logging, Other electrical equipment and component manufacturing, Clay product and refractory manufacturing, Semiconductor and other electronic component manufacturing, and Communications equipment manufacturing. I suspect these job losses are due to the use of more imported products in these sectors. All of these industries are forecasted to continue losing employment from 2006 to 2016.

I cannot explain why my estimate shows a loss of jobs in Retail trade due to spending on Residential construction during the housing boom. I also estimate a loss of jobs in this sector due to demand for Nonresidential structures over this same time period. OOSEP projections are made for aggregate demand. Industry employment by detailed final demand categories is not reviewed. Retail trade jobs, as a whole, show gains over this period.

Although demand for Nonresidential construction was less than two percent higher in 2005 than 1995, the resulting jobs in Support activities for mining increased by almost 64,000[8]. While total employment due to Nonresidential structures is projected to increase by 14% from 2006 to 2016, the resulting jobs in Support activities for mining are forecasted to lose almost 16,000 jobs. Other industries showing employment gains over the history were Amusement, gambling, and recreation industries, Management, scientific, and technical consulting services, Architectural, engineering, and related services, and Securities, commodity contracts, and other financial investments and related activities.

[6] These are classified as intermediate goods in BEA's I-O accounts.

[7] All employment counts in this paragraph and the next reference employment that occurs due to demand for Residential construction.

[8] All employment counts in this paragraph and the next reference employment that occurs due to demand for Nonresidential construction.

Each gained between 1,000 and 3,000 jobs and almost all are expected to show substantial growth over the projection period.

Aside from Retail trade, the industry posting the biggest loss in employment from 1995 to 2005 due to investment in Nonresidential structures was Construction. This industry lost nearly 94,000 jobs over this time period. Wholesale trade also lost over 11,000 jobs due to slowed demand for Nonresidential construction. Other industries with employment losses of more than 6,500 were: Plastics product manufacturing, Architectural and structural metals manufacturing, Household and institutional furniture and kitchen cabinet manufacturing, Management of companies and enterprises, Other wood product manufacturing, Telecommunications, and Other fabricated product manufacturing. Each of these industries is forecasted to continue job losses from 2006 to 2016.

Tables 4 and 6 list the industries with the most employment due to demand in Residential and Nonresidential construction. Construction, not surprisingly, tops off the list. It employs ten to fifteen times the amount of workers than any other industry. Most of the remaining industries are those one would expect to see and that have already been discussed in this section. I was, however, surprised to see the margin industries so high on this list. Retail trade is second due to Residential and third due to Nonresidential construction. Wholesale trade and Truck transportation also show up in both lists. I estimate that more jobs were created in each of these margin industries due to demand for housing than jobs in Monetary authorities, credit intermediation, and related activities.

Occupational Employment

An industry-occupation matrix is used by OOSEP to estimate occupational employment. The matrix shows occupational staffing patterns—each occupation as a percent of the work force in every industry. OOSEP only produces two such matrices, one for the last historical year and one for the projection year. Data for staffing patterns in 2006 come primarily from the BLS Occupational Employment Statistics surveys. The 2016 projected occupational staffing patterns for each industry are based on anticipated changes in the way goods and services are produced, and then are applied to projected industry employment. The resulting employment is summed across industries to get total wage and salary employment by occupation. I assume that the staffing pattern matrix that OOSEP develops for the nation as a whole, also applies to Residential and Nonresidential construction demand alone. In doing so, I estimate the top 20 occupations that employ people to satisfy demand for construction. The breakout for Residential and Nonresidential is very similar so all data are included in one table.

The occupations with the most employment due to demand for construction are Carpenters and Construction laborers. Next are First-line supervisors/managers of construction trades and extraction workers and Electricians. These two occupations employ nearly twice as many workers due to construction demand as any other occupation. Both are expected to post roughly 8.5% increases from 2006 to 2016.

Within the list are three types of supervisors. First-line supervisors/managers construction trades and extraction workers directly supervise and coordinate activities of construction or extraction workers. Construction managers plan, direct, coordinate, or budget, usually through subordinate supervisory personnel. They participate in the conceptual development of a construction project and oversee its organization, scheduling, and implementation. General and operations managers plan, direct, or coordinate the operations of companies or public and private sector organizations. The include owners and mangers who head small business establishments whose duties are primarily managerial.

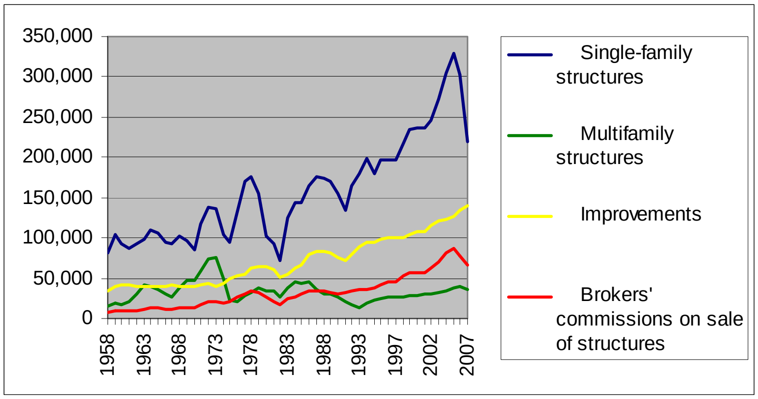
Some of the results were more surprising. For instance, I estimate that more Office clerks and Bookkeeping, accounting, and auditing clerks were needed to satisfy construction demand than Painters, construction, and maintenance workers. More Secretaries were employed than heating, air conditioning, and refrigeration mechanics and installers. Also, Farmers and ranchers showed up on the list. Building farm structures is included in nonresidential construction so these farmers could be building their own structures.

Conclusion

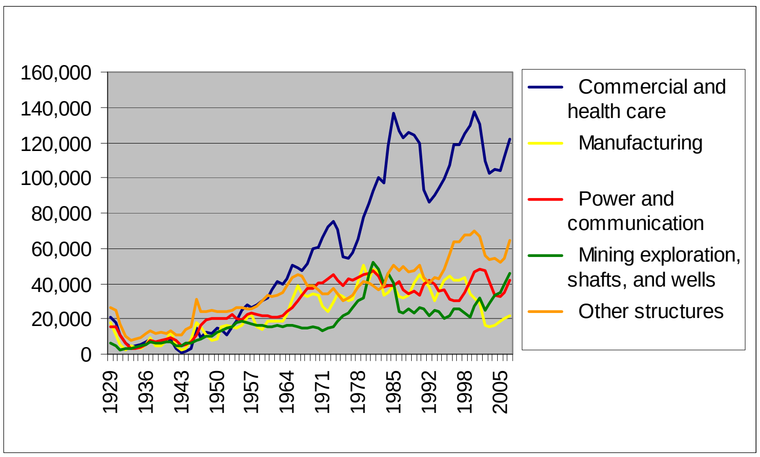
I estimate that increased demand for housing from 1995 to 2005, added over 2.5 million jobs in our economy. Using the CES estimates of employment in Residential construction and Residential specialty trade contractors only explains half of the employment due to this demand. However, these estimates well approximate the growth rates of total employment due to demand for housing. I suspect that the housing boom crowded out some investment in Nonresidential construction. Workers focused on building houses which were selling at ballooned prices. BEA's quarterly data show investment in Nonresidential construction rose in 2007 and 2008 as purchases of homes declined. This increase in demand, however, was insignificant in comparison to the decline in Residential construction. With OOSEP's 2008 publication, we will be able to examine how the bust in the housing market affected the job market.

Appendix A: Graphs

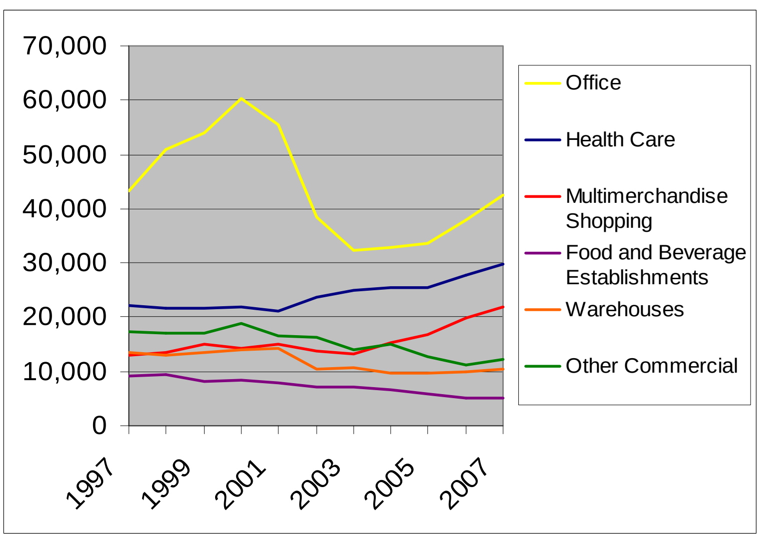
Graph 1: Residential Detail



Graph 2: Nonresidential Detail



Graph 3: Breakout of Commercial and Health Care data from Graph 2



Appendix B: Tables

Table 1: Construction Final Demand by type of commodity produced (chained 2000 dollars, millions)

	Nonresidential Construction				Residential Construction			
	1995 2005		2006 2016		1995 2005		2006 2016	
Support activities for mining	20,286 36,428		40,474 45,320		0	0	0	0
Construction	226,134 213,	802	231,846 265,	988	298,096 506,	767	492,369 563,	278
Other wood product manufacturing	333 268		281 311		8,421	3,849	3,049	4,181
Wholesale trade	58	79 91		100 91		71 60		78
Retail trade	0 0		0 0		3,707	2,611	2,203	2,693
Rail transportation	0 0		0 0		17	11	8	11
Truck transportation	1 1		1 1		48	32	28	34
Real estate	1,763 2,	178	2,561 2,	710	37,275	86,958	76,799	96,655
Used and secondhand goods	-1,484 -	1,306	-1,282 -	1,625	-1,457 -	2,428	-2,589 -	2,701
Total	247,090 251,	450	273,972 312,	805	346,199 597,	869	571,927 664,	230

Table 2: Industry Employment, Major Sectors

	Nonresidential Construction			Residential Construction		
	1996 2006	2016	1996		2006 2016	
Total	3,999,287 3,	656,320 3,	684,711 5,	581,752	7,428,519 7,	613,064
Agriculture	22,917 12,	033	9,397	40,665	28,375 22,	724
Mining	168,064 256,	581 239,	736	28,475	32,604	30,814
Construction	2,097,787 2,	208,497 2,	287,739 2,	836,555	4,697,972 4,	852,542
Manufacturing	445,048 280,	967 223,	690 690,	958	580,470 471,	689
Utilities 17,142		11,653 10,485 25,667		26,165		23,761
Wholesale	97,403 65,	779 54,	308	133,884	126,764	105,745
Retail	300,865 100,	273 107,	381 486,	601	240,125 252,	672
Transportation	104,248 83,	954	86,096 143,	040	160,019	163,507
Information	42,299 26,	831 24,	128 58,	890	51,144 48,	121
Financial Activities	97,024	84,099 84,883		244,993	356,716	406,469
Professional and Business Services	407,942 374,	425 396,	101 593,	522	789,879 869,	088
Education Services	5,394	4,491 5,	004 7,	816	9,665	10,839
Health Care Services	5,390	4,051 4,	447 7,	637	8,581 9,	439
Leisure and Recreation Services	51,831	41,522	48,849	79,222	88,314	107,036
Other Services	44,517 28,	861 27,	757 62,	834	59,857 58,	365
Federal Government	15,642	8,061	6,915	24,847	18,693	16,302
State & Local Government	75,774	64,243	67,796	116,149	153,176	163,954

Table 3: Detailed Industries with the Biggest Gains/Losses in Residential Construction Related Employment from 1996 to 2006 and their Projected Change between 2006 and 2016

	Residential			Res. as % of Total			
	95-05	96-06	06-16	1995 2005	2006	2016	
Construction	1,943,233	1,861,417	154,570	38.8% 50.	8% 48.	9% 48.	7%
Real estate	127,258	89,002	50,538	7.6%	12.9% 11.	1% 11.	5%
Architectural, engineering, and related services	103,943	79,237	34,450	11.9% 16.	3% 14.	6% 13.	6%
Employment services	82,070	45,577	1,159	4.4% 5.	3% 4.	5% 3.	9%
Services to buildings and dwellings	59,090	34,451	16,507	4.1% 5.	7% 4.	9% 4.	4%
Wholesale trade	35,587	-7,120	-21,019	2.1% 2.	6% 2.	1% 1.	6%
Cement and concrete product manufacturing	30,911	25,997	-441	23.4% 31.	8% 29.	6% 27.	6%
Monetary authorities, credit intermediation, and related activities	30,330	15,313	-3,472	2.4% 3.	0% 2.	5% 2.	2%
Architectural and structural metals manufacturing	29,755	21,162	-8,756	18.9% 24.	7% 22.	5% 19.	4%
Truck transportation	29,429	9,292	9,706	4.1% 5.	4% 4.	5% 4.	0%
Retail trade	-173,691	-246,476	12,547	3.1% 1.	8% 1.	5% 1.	5%
Other wood product manufacturing	-35,557	-51,809	-6,961	33.6% 24.	0% 21.	1% 19.	9%
Household and institutional furniture and kitchen cabinet manufacturing	-5,122	-7,991	-5,865	5.5% 4.	7% 3.	9% 2.	7%
Commercial and service industry machinery manufacturing	-4,539	-3,720	-573	3.9% 1.	0% 1.	0% 0.	5%
Crop production	-4,384	-4,878	-1,889	1.2% 1.	1% 0.	9% 0.	8%
Logging	-3,998	-5,245	-3,366	13.2% 14.	9% 12.	1% 10.	7%
Other electrical equipment and component manufacturing	-3,560	-4,220	-5,209	7.0% 6.	6% 6.	1% 2.	6%
Clay product and refractory manufacturing	-2,756 -	4,382	-1,895	11.3%	10.4%	8.9%	6.6%
Semiconductor and other electronic component manufacturing	-2,543	-5,147	-1,431	1.3% 1.	0% 0.	7% 0.	5%
Communications equipment manufacturing	-2,540	-2,763	-401	1.6% 0.	9% 0.	7% 0.	4%

Table 4: Industries that Employed the Most Workers due to Demand for Residential Construction

Industry	2005
Construction 4,	660,182
Retail trade	292,187
Real estate	246,474
Architectural, engineering, and related services 232,	286
Employment services	190,063
Wholesale trade	158,243
Services to buildings and dwellings	132,301
Architectural and structural metals manufacturing 99,	173
Truck transportation	90,469
Monetary authorities, credit intermediation, and related activities	87,113

Table 5: Detailed Industries with the Biggest Gains/Losses in Nonresidential Construction Related Employment from 1996 to 2006 and their Projected Change between 2006 and 2016

	NonResidential			Nonres. as % of Total			
	95-05	96-06	06-16	1995	2005 2006	2016	
Support activities for mining	63,800	93,171	-15,910	88.2%	88.6% 88.	8% 88.	4%
Amusement, gambling, and recreation industries	3,002	2,142	294	0.1%	0.3% 0.	3% 0.	3%
Management, scientific, and technical consulting services	2,406	2,183	10,313	2.4%	1.7% 1.	7% 1.	5%
Architectural, engineering, and related services	1,696	2,457	16,050	8.9%	6.9% 7.	0% 6.	5%
Retail trade	-189,316	-200,592	7,107	2.0%	0.7% 0.	6% 0.	6%
Construction	-93,959	110,710	79,242	29.4%	21.4% 23.	0% 23.	0%
Wholesale trade	-20,274	-31,624	-11,471	1.6%	1.2% 1.	1% 0.	8%
Plastics product manufacturing	-11,611	-12,575	-1,893	4.1%	2.7% 2.	6% 2.	3%
Architectural and structural metals manufacturing	-9,487 -	7,578	-4,462	14.6%	11.0%	11.3%	9.8%
Household and institutional furniture and kitchen cabinet manufacturing	-9,335	-9,061	-2,703	3.9%	1.9% 1.	8% 1.	2%
Management of companies and enterprises	-8,162	-5,981	-8,413	2.7%	2.1% 2.	3% 1.	6%
Other wood product manufacturing	-7,161	-6,521	-4,881	9.0%	7.2% 7.	3% 6.	1%
Telecommunications	-7,083	-7,857	-183	2.0%	1.2% 1.	2% 1.	1%
Other fabricated metal product manufacturing	-6,610	-6,044	-3,205	5.3%	3.5% 3.	5% 2.	7%

Table 6: Industries that Employed the Most Workers due to Demand for Nonresidential Constr uction

	2005
Construction 1,	961,902
Support activities for mining	205,055
Retail trade	108,153
Architectural, engineering, and related services	97,829
Wholesale trade	71,346
Employment services	70,491
Architectural and structural metals manufacturing	44,072
Truck transportation	40,947
Management of companies and enterprises	37,728
Services to buildings and dwellings	36,499

Table 7: Occupations with the Most Construction Related Employment

Occupation	NRES		RES		NRES as % total		RES as % total	
	2006	2016	2006	2016	2006	2016	2006	2016
Carpenters	217,832	236,030	466,321	504,660	14.9%	14.6%	31.9%	31.3%
Construction laborers	207,437	225,088	435,019	472,275	16.8%	16.5%	35.3%	34.6%
First-line supervisors/managers of construction trades and extraction workers	128,869	137,675	251,917	271,776	16.7%	16.4%	32.6%	32.3%
Electricians	117,508	126,535	246,118	264,958	16.7%	16.7%	34.9%	35.0%
Plumbers, pipefitters, and steamfitters	87,733	97,510	184,772	205,273	17.5%	17.6%	36.8%	37.0%
Office clerks, general	73,542	75,999	157,710	168,167	2.3%	2.1%	4.9%	4.7%
Truck drivers, heavy and tractor trailer	83,452	83,169	153,255	154,591	4.5%	4.1%	8.2%	7.5%
Operating engineers and other construction equipment operators	68,501	73,433	137,035	147,812	16.2%	16.0%	32.3%	32.2%
Bookkeeping, accounting, and auditing clerks	66,193	67,726	136,736	142,832	3.1%	2.8%	6.5%	6.0%
Painters, construction and maintenance	59,983	63,594	128,680	136,569	13.0%	12.3%	27.8%	26.4%
Construction managers	55,082	60,252	116,899	128,245	11.3%	10.7%	24.0%	22.8%
Farmers and ranchers	52,243	37,237	114,666	83,275	4.9%	3.8%	10.8%	8.6%
Laborers and freight, stock, and material movers, hand	54,032	48,389	107,360	97,624	2.2%	2.0%	4.4%	4.0%
Secretaries, except legal, medical, and executive	50,942	47,943	106,203	102,458	2.6%	2.4%	5.5%	5.2%
General and operations managers	54,552	50,872	102,529	98,131	3.2%	2.9%	6.0%	5.6%
Cement masons and concrete finishers	48,114	53,397	102,261	113,203	21.7%	21.6%	46.2%	45.9%
Heating, air conditioning, and refrigeration mechanics and installers	42,372	46,837	90,508	99,882	14.5%	14.8%	31.0%	31.5%
Retail salespersons	38,231	40,720	88,288	93,885	0.9%	0.8%	2.0%	1.9%
Janitors and cleaners, except maids and housekeeping cleaners	31,944	32,199	86,456	90,750	1.3%	1.2%	3.6%	3.3%
First-line supervisors/managers of retail sales workers	35,789	30,495	79,626	68,920	2.1%	1.7%	4.8%	3.9%

The Business Cycle, the Long Wave, and the Limits to Growth

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1. The Future Is Now

The "Modern Era" (1492-date) is historically unique in creating a culture where scientific and technological advances have been accelerating rather than stagnating after a brief period. As a result, population and economic activity have reached unprecedented levels. The "Post-Modern Era" will have begun when technological progress reaches the point of diminishing returns.

Computing power is the archetype, since it has increased by far more orders of magnitude than any other technology. A mainframe computer in 1968 might cost \$10,000,000 and would fill a rather large room, air-conditioned to 68°F or cooler. Now one can buy a desktop personal computer that is far more powerful for less than \$1000 and it requires no special cooling other than a small fan on the CPU.

In 40 years the cost of computing hardware has dropped by a factor of *more* than 10,000 (don't forget inflation) and the energy and other operating costs have been reduced by like amounts. However, per-capita GDP has not increased much and by some measures the standard of living in the USA has gone down. Why?

Despite what some people say, IT (information technology) isn't everything. As digital computing has become cheaper, it has taken on many tasks more menial than scientific and engineering calculations. Professional typesetters are no longer employed; everybody has word processing software.

The "Post-Modern Era" will provide new challenges for policy makers in government and industry and a rapidly evolving environment for the data analysts and forecasters who serve them. The goal of this presentation is to raise awareness of what is happening during the transition period, which is the future that is now.

2. The Dynamics and Time Scale of Business Cycles

Short-term business cycles arise from the fact that economic systems are not static and do not reach equilibrium immediately; in fact, they never reach equilibrium at all. In the jargon of certain disciplines this is called a "pursuit problem." Producers are attempting to match supply to demand, while purchasers are reacting to fluctuations in supply and prices.

Various industries have differing production cycles, so that the composite for the national economy is a business cycle of variable duration that usually runs 4-10 years. The troughs of these cycles are called "recessions," during which the level of economic activity drops below its trend and suffers a contraction. An *ad hoc* definition is "two successive quarters of economic contraction" [as measured by GDP (gross domestic product)], but most forecasters and economists recognize the authority of the National Bureau of Economic Research. Unfortunately, these official pronouncements arrive months after the fact, sometimes long after the recession has come and gone.

There is no reason to believe that the business cycle will disappear. This could happen only if the accuracy of forecasts were to improve significantly. It is highly unlikely that the dynamics of the economy will become as predictable as the motions of the major planets. Were that to happen astrology would work.

3. Long Waves

Long waves are a topic that has generated considerable analysis and much controversy. The most unusual feature of some of the theories is a regular cycle with a period of 54 years. This corresponds to an astronomical cycle known since ancient times that is characterized by an approximate repeat of eclipses of the sun and moon. (During the *saros,* eclipses repeat approximately every 6585.32 days, about 18.03 years, but shifted 120° in longitude.) Anything that smacks of astrology is bound to attract the derision of scientists and economists, though even they have to admit seasonality abounds. However, seasonal variations have an obvious exogenous cause.

What has happened to this 54-year cycle? If the crash of 1929 marks one trough, there should have been another in 1983. There was a stock market crash in 1987, but it did not much affect the economy and share prices soon recovered. However, if one looks at a detailed analysis of long waves (Goldstein, 1988), it becomes obvious that circumstances have changed. The post-World War II era was characterized by the Cold War and global domination by two "superpowers," the USA and the USSR. The former European "great powers," along with their worldwide networks of colonies, collapsed and were reduced to nothing more than vassals. The disintegration of the Soviet Union marked the end of that era and now the world is in transition, though nobody is certain to what.

The true character of the long wave is not a regular period, but causes other than short-term imbalances in supply and demand. For example, the USA is now suffering from a financial crisis created by the securitization of subprime mortgages. This, in turn, is reacting with various long established trends in both the national economy and the global economy.

Trade deficits and the loss of high paying manufacturing jobs are obviously related. The home building industry has been largely immune to outsourcing, because houses are much too large and fragile to ship from Asia. What's more, population growth has caused housing and land prices to escalate faster than general inflation. There is only so much land and there are tolerable limits to commuting distances, which are shrinking due to increased traffic and rising gasoline prices. A major consequence of these factors is that home equity has become the primary vehicle for capital accumulation for the middle class.

Inflation and income taxes make fixed-income investments, such as bank accounts and life insurance, guaranteed losers. Historically high numbers of people have purchased common stocks, which may decline in value just when there is a need to dip into savings. Declining home prices are having a negative effect on both the psychological and financial aspects of the economy. To add to those woes there has been a decline in the exchange rates of the US dollar in terms of the euro and many other currencies. However, cheaper dollars can stimulate the economy by increasing exports.

There can be little doubt that long wave phenomena are affecting the US economy. Forecasting the results will be difficult because there is no regular cycle and the developments will play out quite differently from the Great Depression because technologies have changed and the global economic and political landscape is quite different.

In addition to the comprehensive, historical study of the long wave done by Goldstein (1988), popular expositions have been written by Shuman and Rosenau (1972), Stoken (1978), and Snyder (1982). Large numbers of cycles have been catalogued by Dewey (1970, 1971). Peschel and Mende (1986), Mesterton-Gibbons (1989), and Morrison (2008) discuss methodologies and criteria for modeling cycles. Yet these hardly constitute an exhaustive bibliography on cycles of fixed and variable periods. However, an authoritative analysis of these phenomena remains to be done. Probably not all cycles are due to the same mechanism and many may be phantoms.

4. Limits to Growth

The underlying simplicity of "limits to growth" contrasts vividly with the complexities of the business cycle and the long wave. And by "growth" we mean constant rate (exponential). [Constant amount (linear) growth would not be sustainable either, though the time scale would be longer.] Exponential growth produces a doubling in a fixed time interval, which is somewhat variable in the real world, due to cyclical effects.

The formula for exponential growth

$$x = x_0 \exp [a(t - t_0)] \qquad (1)$$

is the solution of the trivial, linear initial value problem

$$\begin{aligned} dx/dt &= ax \\ x_0 &= x(t_0) \end{aligned} \qquad (2)$$

with x being a variable, $a > 0$, a parameter, and t, time. To find the doubling time $T(2)$, solve

$$(1 + r/100)T = 2 \qquad (3)$$

where

$$r = 100(e^a - 1) \qquad (4)$$

is the percent growth per unit time (usually one year). The result is

$$\begin{aligned} T(2) &= \ln 2/\ln(1 + r/100) && (5)\\ &= 0.693147\ldots / \ln(1 + r/100) && (6)\\ &=: 70/r =: 72/r && (7) \end{aligned}$$

The formulas (7) are known as the "rule of 70 (or 72)" and are handy for quick mental estimates when a scientific calculator is not at hand. (The symbol =: is used for "approximately equal.")

For how many intervals can growth continue? Well, $2^{10} = 1024$, so $10^{20} > 1{,}000{,}000$. What can grow by a factor of 1000, let alone 1,000,000? Not much, other than the quantity of currency units. The most recent victim of runaway inflation has been Zimbabwe.

A graph of the exponential function (1) has limited visual impact. Figure 1 shows a series of concentric circles doubling in area. Note that the perimeter accelerates, also at an exponential rate. So even though a growing population might be housed in ever taller high rises, its needs for resources would expand to encompass ever more of the earth's surface.

Limits to growth may be applied to population or economic activity or some metric that is a mix of the two. What is critically important is what happens after a period of growth ends. More people enjoying a sustainable higher level of consumption is the good outcome. Total collapse and human extinction is the bad outcome. More people with a lower level of consumption is not so great; fewer people consuming more per capita is maybe better.

Supposedly rational economic decisions discount the future. But is that the wisest thing to do? Those who discount the future too much may find that they don't have one. This is the predicament of the 21st century.

5. Major Feedbacks Competing to End Growth

Politicians and economists have prescribed economic growth as a cure for everything that afflicts humanity. More people consuming more goods and services equals universal peace and prosperity. Unfortunately, this utopian vision is mathematically absurd and physically impossible.

5.1 Peak Global Oil Production

Population and the global economy have expanded enormously since the start of the Industrial Revolution. The strongest driving force has been the availability of inexpensive and relatively clean energy from petroleum. And not only does this gooey mixture of hydrocarbons provide fuel, it also serves as the feedstock for plastics and myriad other things. It is the most versatile and useful of natural resources, but there was only so much and now about half of it is gone. (Expert estimates of peak oil production run from 2006 out to an optimistic 2030.) Some of the plastic is recycled, but the oil burned as fuel is gone for good.
The ingenuity of chemists permits coal and tar to serve as petroleum substitutes. The trouble with this approach is that a lot of energy is needed to convert these substances to liquid fuels. Natural gas can be used to do the job, but that also is limited in supply. Hydrogen to be used in fuel cells poses the same problem. It is abundant, but not a *source* of energy. Electricity, from wind power or nuclear reactors, for example, is needed to produce hydrogen by the electrolysis of water.

Alternative energy sources include solar power, wind, geothermal, nuclear, and biofuels. Rising petroleum prices have made these economical, if they were not already. The problem is that they are not available in sufficient quantities to replace declining petroleum production. Even when the coal and tar products are added in, the sum will not support current levels of energy consumption, let alone growth.

5.2 Nonsustainability

Peak oil is a special case of nonsustainability. It has received a lot of attention because retail gasoline prices have risen well above \$3/gallon and crude oil has been trading at over \$100 per barrel. But there are many other commodities required by industrial society and a number of these are farther toward depletion than petroleum.

The capacity for generating renewable resources may be reduced by poor management and excessive harvesting. That the world is consuming more than it can keep producing was determined by Wackernagel *et al.* (2002) several years ago.

5.3 Global Warming

Global warming was not anticipated in the "limits to growth" debate of 40 years ago (Meadows *et al.*, 2004). Now it is generally recognized as a major threat (Lovelock, 2006, American Geophysical Union, 2008), though a vocal minority argues that it is at least partly the product of natural phenomena, not human industrial activity (Scafetta and West, 2008). The alleged cause is the rise of the amount of CO_2 and certain other "greenhouse" gases in the atmosphere. With higher concentrations of these gases, more of the sun's radiant energy is retained, thereby creating a warmer average global climate.

Among the many problems that will be created by global warming are disturbances to ecosystems, the spread of tropical diseases, loss of water resources, and rising sea levels. And though it is true that global warming cannot be attributed to human activities with absolute certainty, the level of risk has to be multiplied by the possible damages.

A major challenge posed by global warming is the need for unprecedented international coöperation. The UN is too weak and no national government can make every other country do what is necessary. However, this is equally true of all the other forces that are arising to end growth. Hence, the best thing to do is provide a good example and perform and share the research needed for the transition to a sustainable, steady-state global economy.

5.4 Water Shortages

From a strategic viewpoint, global warming is one of several feedbacks that individually or collectively will end economic and population growth, possibly with a collapse. Another that may have a shorter time scale is water shortages. Clean water is essential in huge quantities for many things besides direct human consumption. Agriculture in many regions depends on irrigation and some of the sources are "fossil" water, *i.e.*, underground reservoirs that are not being replenished.

Most industrial processes consume a lot of water. Nuclear fission reactors, which have the virtue of not emitting greenhouse gases, need a lot of water for cooling.

Global warming is a threat to water resources. Many regions depend on melting glaciers to provide year round water. The retreat of glaciers, as well as rising sea levels, was observed long before global warming emerged as a scientific topic and political issue. This effect may emerge as a threat to economic activity and the environment long before higher temperatures and rising sea levels.

Actions that will potentially reduce or end global warming will also reduce the threat of other processes that could end growth with disastrous results.

5.5 The Critical Feedback

For some people, global warming has become an ideological issue rather than a scientific one. Denial of the reality of peak global oil production is another example of such behavior. However, the ultimate reality is that growth is not sustainable and one or more feedbacks will end it, probably leading to a decline and possibly to a collapse.

The most likely candidate is water shortages, not global warming or peak oil. However, something as yet unforeseen might arise and end growth even sooner. One possibility that has been suggested is a pandemic disease, like the Spanish flu outbreak of 1918. Other threats include antibiotic resistant infections, which already exist because pathogenic microörganisms are evolving faster than medical researchers can discover new drugs.

6. The Domino Economy

The logic of the domino economy is simple enough. A recession (a short period phenomenon) triggers a depression due to a financial collapse (a long wave phenomenon). This depression never goes away because the limit to growth has been surpassed (a secular phenomenon, a trend reversal). Over a period of decades, population and economic activity decline until a sustainable level is reached.

A financial crisis has been brewing for decades. The USA has been running current account deficits since the end of World War II. These created a run on the dollar in the 1970s that ended the currency's convertibility to gold. The consequences have included the first global inflation in history, as foreign central banks accumulated dollar credits and then created their own currencies to redeem them for exporters. The current situation is that the USA is financing its federal deficits by borrowing back its trade deficits. This is destabilizing the dollar, which has lost about 50% of its value against the euro.

Instability in domestic financial markets has been created by subprime mortgages. Banks have packaged these as securities and sold them as high-grade investments when they were anything but that. Defaults on these mortgages have cost investors in these securities dearly and punctured the long enduring housing bubble, in which prices rose faster than general inflation.

7. Forecasting the Next Recession

Forecasting the next recession is never trivial or routine. But unlike a certain few problems in the physical sciences, the predictions cannot be improved by making the model bigger and more complex. Many factors are stochastic and some may be chaotic.

On the other hand, forecasts often may be improved by aggregation and smoothing (Morrison, 2008). Mathematically these are the same process, one being weighted averaging over state variables (economic time series) and the other, averaging over time (moving averages or other low pass filters). And of course, nonlinear transformations may be useful too, notably phase plane models [in essence, the conversion from Cartesian-like to polar coördinates (see Figure 2)].
For the US national economy the production of aggregate series has been carried out for decades. Indices of

leading, lagging and coincident indicators have been generated, initially by the USDoC and now by The Conference Board. This effort was begun long before the insights provided by recent research into nonlinear dynamic systems.

More than a decade of experience with phase plane models of the business cycle have shown them to be useful, but not infallible (Morrison and Morrison, 1997, 2001). They do provide a phase angle, a sort of economic time scale that tells one where things are and which way they are headed. The model may stall for a while, but it rarely runs backward. Time series forecasts in either polar or Cartesian coördinates may be used (Morrison and Morrison, 2002).

In our previous presentation to the Federal Forecasters Conference (Morrison and Morrison, 2006) the start of the next recession was tentatively predicted for July 2007. But it had not yet begun in the fourth quarter of 2007. The phase angle for the model has moved more slowly than expected by the forecast, so the anticipated "official" start has been delayed to June or July 2008 (see Figure 3).

A financial crisis has begun to unfold, but it has been slowed or halted by swift action by the Federal Reserve. Loans have been made available to major investment institutions, in addition to the customary commercial banks. Expanding the scope of regulation in the investment industry is now a topic of current proposals.

The short-term quandary is whether a recession triggered a financial crisis or the financial crisis pushed the recession over the brink. Of greater economic importance is how rapidly the housing industry recovers from the bursting of the "bubble," which was a rise in prices more rapid than general inflation. Such developments may require econometric analysis, since the relevant time series can become nonstationary and unsuitable for the usual forecasting methods.

The longer term question is whether the interactions of these short-term and long-term cycles will create the trend reversal long known as "limits to growth." Peak oil and other declines in nonrenewable resources will most likely prevent another doubling of either the global population or the world economy. Lack of water capacity, a renewable resource, provides a virtual guarantee that growth will effectively cease within the next decade.

This historic trend reversal will bring political and cultural factors into play in the forecasting profession. International trade, hardly a new phenomenon, has expanded due to cheap, long distance water transportation for commodities and fast air transport for expensive finished goods. Rising fuel costs will tend to reduce trade or cause price increases, because not everything can be obtained or produced locally.

The end of growth will ameliorate global warming, but not necessarily eliminate it. Alternative energy sources, such as solar and wind power, can help both the environment and the global economy. The future of technology is not "bigger is better," but doing more with less. The IT industry has shown that this is not only desirable, but feasible. This ethos is already spreading to other industries, especially in the mature, industrialized countries. This is the key to a tolerable, if not painless transition, rather than a collapse.

8. The Steady-state Economy of the Future

Just as growth overshot its limits, it is to be expected that the subsequent decline will drop below the level of sustainability. The danger of collapse is not negligible and is likely to happen in certain regions.

Political and economic systems designed to maintain stability rather than promote growth will have to evolve. The overall framework will certainly be a regulated market economy, just as it is now. One essential cultural change will be from regulations designed to treat symptoms, such as toxic pollutants, so that more growth can occur, to ones that promote a steady-state economy.

Land speculation and development will cease to be business opportunities. Producing better and more efficient products will be the way to increase profits or gain market share. The philosophical quandary will be whether science really is an "endless frontier," or just the academic make-work project that so much of it is already.

The 20th century was a fascinating time to live. Some people grew up with steam locomotives, Automats (coin-operated, self-service restaurants), Technicolor movies, AM radio broadcasting, and other such artifacts of the mature Industrial Revolution. Today we live in a science fiction world of HDTV, laptop computers, cell phones, robotics, and molecular biology. Is life better? Longer, yes, for most people around the world, but also more hectic. A lot of this gadgetry seems to be more bother than it's worth.

The steady-state economy of the future may offer less in the way of novelties that soon become routine and even tedious. But the quality of life could be better, as the frenzy of meaningless "progress" subsides, and there is time to reflect upon what really matters.

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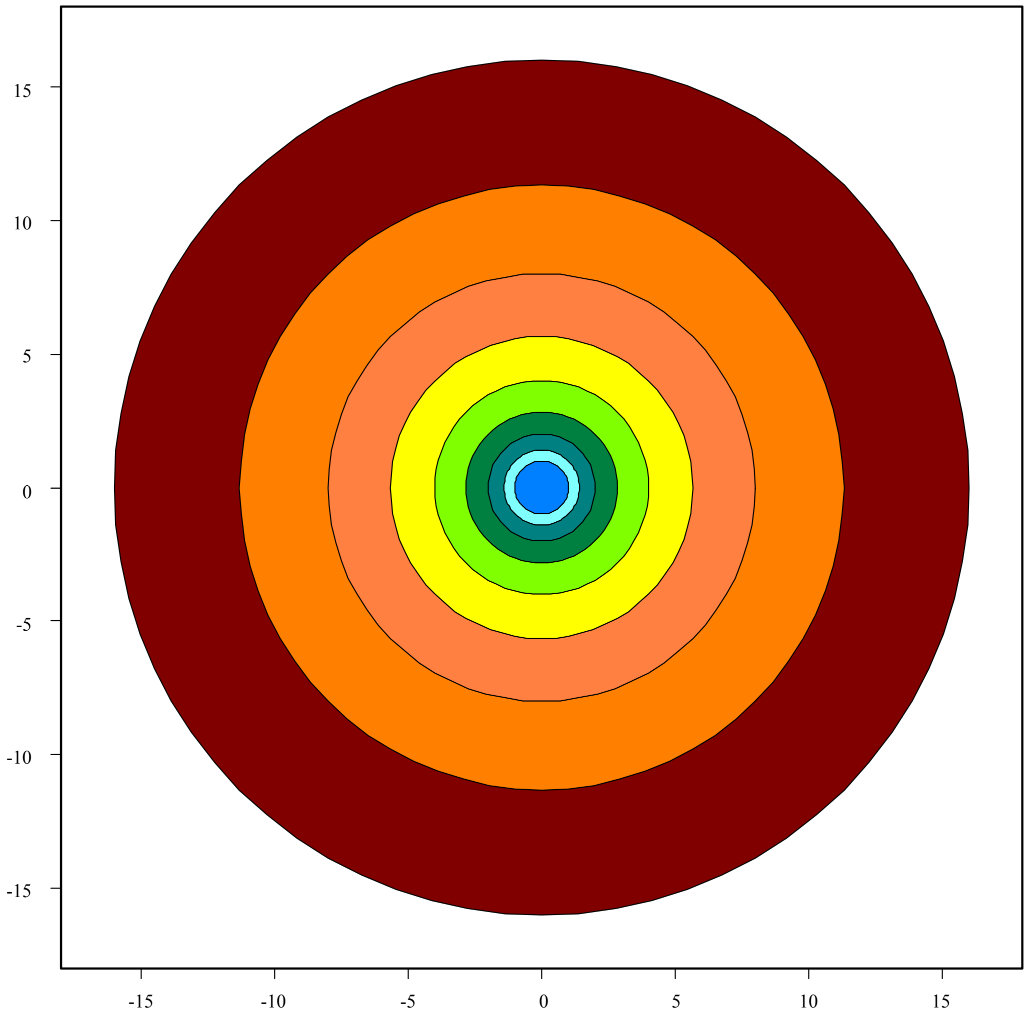

EXPONENTIALLY GROWING CIRCLES

Figure 1

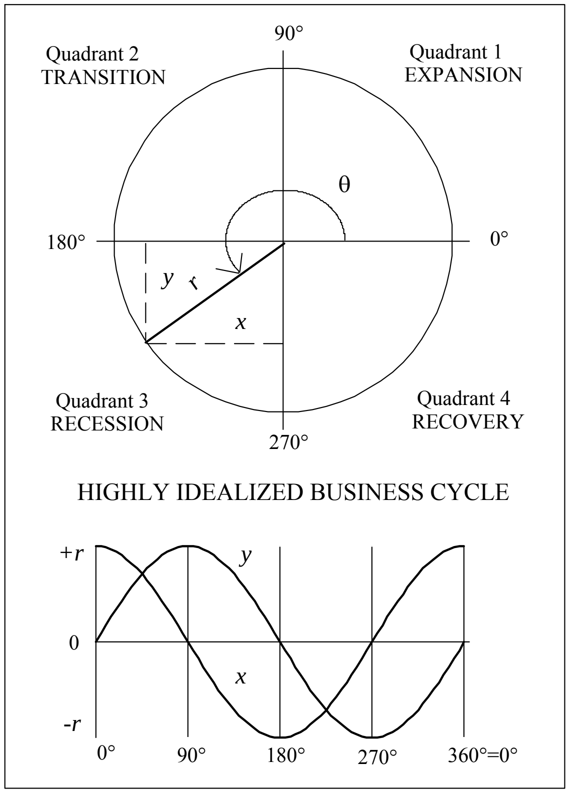

Figure 2. Idealized Business Cycle

In the idealized business cycle, the leading indicator (*x*) "leads" the coincident indicator (*y*) by 90°. Plotting each data series against the other, instead of against a horizontal time scale, yields a cycle in "economic" time.

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.

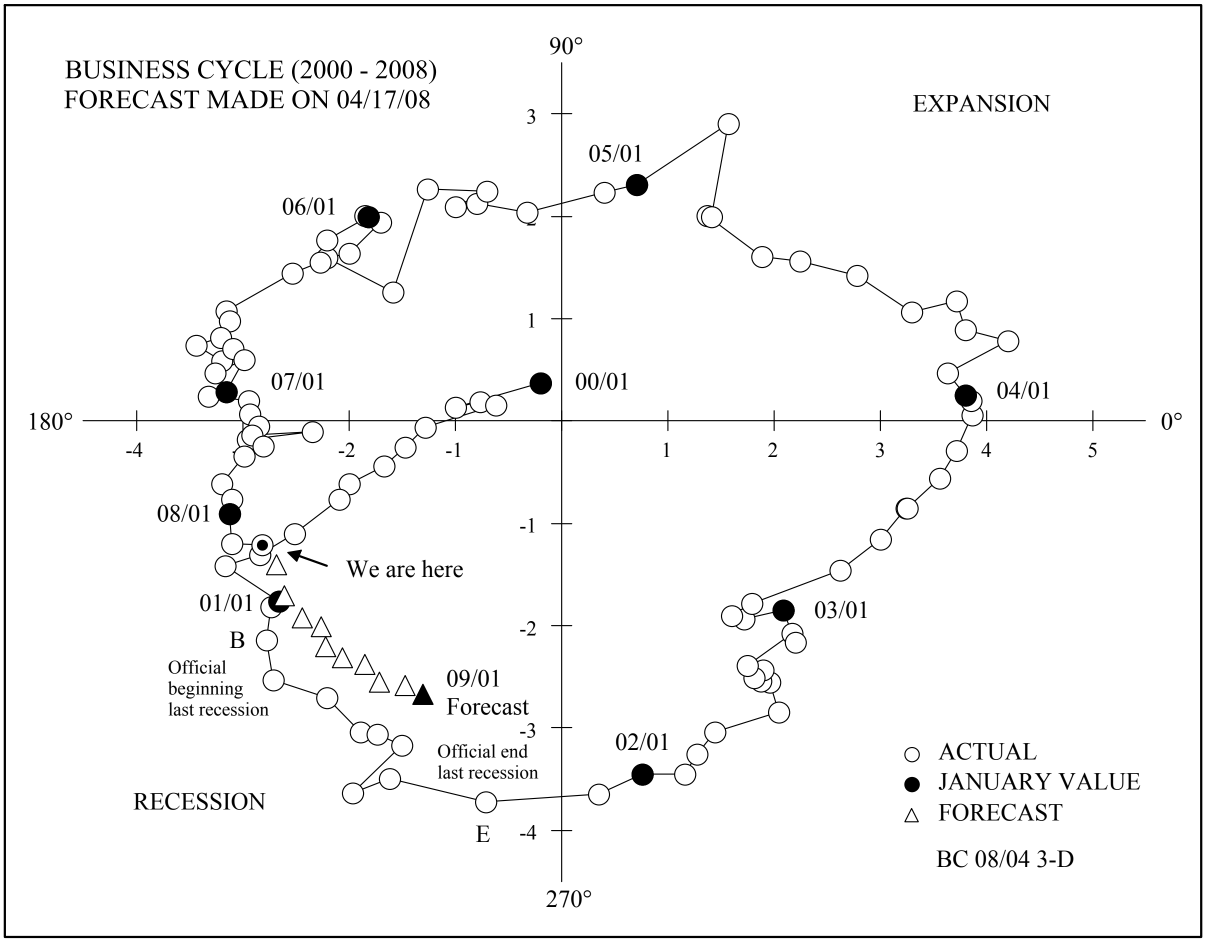

Figure 3. The Current Business Cycle and Forecast for 2008

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 1-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".

International Aspects of Forecasting

Session Chair: Vidya Kori, International Trade Administration

Energy in 2020: Assessing the Economic Affects of Commercialization of Cellulosic Ethanol

Stefan Osborne, International Trade Administration, U.S. Department of Commerce

U.S. dependence on imports of crude oil has steadily increased for three decades. One way to reduce this dependence is to increase domestic production of renewable fuels such as ethanol. This report examines the effect on the U.S. economy in 2020 if advances in technology allow cellulosic ethanol to become commercially viable and if cellulosic ethanol production becomes adequate to allow total ethanol production to reach 30 billion gallons (including 10.5 billion gallons of corn-based ethanol). We find reaching these targets lowers crude oil imports by 460,000 gallons per day and increases U.S. consumption by $12.6 billion in 2020.

Modeling Tourism Demand for Indonesia

Cynthia Haliemun, Quincy University and Brian W. Sloboda, U.S. Postal Service

Indonesia serves as a major tourism attraction in the south Pacific primarily for its exotic locale and the existence of many islands which offer an array of activities. In fact, tourism is a dominant industry in Indonesia which comprises approximately 70 percent of its GDP. Given the preeminence of tourism in Indonesia, their tourism sector is vulnerable to terrorist attacks by extremist groups such as the effects of the Bali bombings in October 2002 and other terrorist attacks throughout Indonesia since these bombings. Additionally, Indonesia experiences earthquakes and other natural disasters since Indonesia is part of the Pacific Rim as shown with the tsunami in December 2004. Given the consequences of these terrorist attacks and natural disasters, these events potentially have consequences on the Indonesian tourism sector.

The goals in this paper are to contribute an empirical study of tourism demand dynamics for the Indonesian tourism sector using time series methods of seasonal integration and cointegration. These methods will allow us to examine the effects of terrorism and natural disasters on the Indonesian tourism sector.

Domestic Jobs Attributable to U.S. Exports

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

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 domestic jobs attributable to U.S. exports. Using the available historical data and the most recent U.S. economic and employment projections developed by the Bureau of Labor Statistics, the export-related jobs by industry are compared for the 1996-2006 and 2006-2016 periods, and conclusions are drawn regarding the job impacts of accelerating globalization on the U.S. economy.

Domestic Jobs Attributable to U.S. Exports

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

This study focuses on domestic jobs attributable to U.S. exports. We examine what portion of employment is necessary to satisfy only the exports category of final demand. There are two reasons why we concentrate on export related employment only (and not on imports). Firstly, we are concerned with the direct link between the growth in exports and the growth in GDP. With given exports, a final demand category has a direct impact on changes in employment. Secondly, if we study industry exports and imports simultaneously, we tend to be overwhelmed by the net trade (exports – imports) effects.

Using the available historical data and the most recent U.S. economic and employment projections developed by the Bureau of Labor Statistics (BLS),[1] the export-related jobs by industry and by occupation are compared for the 1996-2006 and 2006-2016 periods, and conclusions are drawn regarding the job impacts of accelerating globalization on the U.S. economy.

Introduction

Over the past two decades, the growing economic interdependence of countries worldwide 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. Clearly, globalization creates opportunities because of the emergence of greater U.S. competitiveness in a growing world economy.

Although a weak dollar is now making U.S. exports more competitive overseas, exports are being hindered by slower growth in the foreign markets, especially in Europe. At the same time, strong U.S. demand for goods and services abroad continues to bring in more imports. Coupled with a steep rise in the price of imported oil, the slower foreign growth of exports, and the robust demand for imports, the U.S. trade gap reached a record high of 625 billion in real terms (in chained 2000 dollars) in 2006.

On a biennial basis, the Bureau of Labor Statistics prepares a set of 10-year projections of industry and occupational employment. Based on the current set of 2006-16 projections, the U.S. trade is projected to increase its global accessibility and international competitiveness, as the world becomes more open to trade and as the U.S. maintains its ability to compete in the world markets. Over the next decade, the BLS expects that U.S.-exports will benefit from strong overseas demand, with China, in particular, becoming an increasingly important exports destination for U.S.-made goods and services. Total exports of goods and services are expected to grow at a 5.5 percent annual rate between 2006 and 2016, compared with a 4.5 percent rate of growth exhibited over the 1996-2006 period.

In terms of employment, the 2006-16 results project total employment in the United States to increase by 15.6 million over the 2006-16 period, rising from 150.6 million to 166.2 million, while export related employment is expected to increase by 3.2 million over the same period, rising from 8.6 million to 11.8 million. As a share of total employment, export related employment is projected to increase from 5.8 percent in 2006 to 7.2 percent in 2016.

Methods

Estimates of employment related to exports are developed within an input-output framework, which traces the flows of goods and services through the entire chain of production in the U.S. economy. These estimates then, make it possible to measure the particular industry employment required to produce that good or service.

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, in this case, exports. The total requirements table shows both the direct and indirect input requirements necessary for production. For example, while automobiles to be exported are being produced in the automobile industry, they incorporate other products as inputs from the production chain, such as steel and plastics, which are produced in the

[1] A series of five articles discussing the employment outlook, 2006-2016, were published in the *Monthly Labor Review*, November 2007.

steel and plastics industries, respectively. 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 the employment requirements table—the heart of this analysis, demonstrates how industry interrelationships in the economy affect employment.

As mentioned earlier, the analysis in this article focuses specifically on measuring exports during the selected years—1996, 2006, and 2016. The employment resulting from industry exports has been calculated by multiplying the annual employment requirements table by the export trade column of the appropriate year.[2] In addition, an industry-occupation matrix is used to determine the effect of exports on occupational employment in 2006 and 2016.

Data

This analysis is based on industry-level data for both exports of goods and services, labor productivity, and employment. Historical data were developed for the years 1996 to 2006 and projections were carried out to 2016. Annual export merchandise data were obtained from the Commerce Department's Trade Policy Information System (TPIS) and the Census. The trade data are classified by using the North American Industry Classification System (NAICS) codes and 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 201 industries based on the historical input-output table prepared by BEA.

As stated earlier, the technique used to calculate occupational employment is based on a 2006 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.

U.S. foreign trade at aggregate level and by industry details

The historical and projected exports are represented in chart 1. From 2006 to 2016, exports of goods and services are expected to rise by 5.5 percent on an annual basis, while imports of goods and services are expected to grow at a somewhat slower pace than exports— 4.2 percent on an annual basis. The main factors causing a higher rise in the growth of exports than imports appear to be linked to the assumption that the dollar will continue to depreciate against foreign currencies, amid a continuing rise in productivity occurring in many industries.

In table 1, we observe the export changes occurring in selected industries. Among those selected, we distinguish industries based on their average annual rate of export growth. The pharmaceutical and medicine industry exhibited a high average annual rate of growth of exports of 12.6 percent during the period 1996-2006. Over the same period, the semiconductor and other electronic components industry grew at a rate of 8.4 percent, the fabric mills industry grew at a rate of 8.2 percent, the computers and peripheral equipment industry grew at the rate of 5.6 percent, and the communications equipment industry grew at the rate of 5.0 percent. However, the export growth rates for two industries, as diverse as the crop production industry and the air transportation industry remained as low as 2.6 and 2.4 percent, respectively, during the 1996-2006 span.

Over the next decade, it is interesting to note that the fabric mills industry's export growth is expected to drop sharply, with a 0.6 percent growth rate during the period 2006-2016, compared with the rate of growth of 8.2 percent from 1996 to 2006. By contrast, growth of exports for the air transportation industry is projected to rise to 7.6 percent on an annual basis between 2006 and 2016, compared with 2.4 percent over the period from 1996 to 2006. Ultimately, the theory of comparative advantage applies to most industries but we still need to explore deeper in many cases so as to see why a particular industry may be growing largely at a different pace than expected.

[2] See Eric B. Figueroa, "Estimating Defense-Related Output and Employment," the "Analysis Methods" section, the 15th Federal Forecasters Conference 2006 Paper and Proceedings on the Internet at *http://www1.va.gov/vhareorg/ffc/PandP/FFC2006.pdf*, p. 112; and "BLS projections methodology," on the Internet at *http://www.bls.gov/emp/empmth01.htm*.

Growth of productivity by industry

Growth of productivity is a must for both modern industries oriented towards exports almost by definition and for those traditional ones, not favored by the comparative advantage principle but which need to survive. In principle, productivity increases allow firms to be more competitive, by keeping the growth of prices in check. Table 2 considers labor productivity growth in several industries. As expected, in the United States, the ‘modern’ industries have generally higher rates of productivity growth than those prevailing in all other industries. Thus, from 1996 to 2006, both the computers and peripheral equipment industry and the semiconductor industry demonstrated a strong growth in labor productivity, 15.5 percent and 7.2 percent, respectively, while the fabric mills industry and the crop production industry showed a much lower rate of productivity growth, 3.4 percent and 3.1 percent, respectively, over the same period.

Over the next decade, the high productivity prevailing in both the computers and peripheral equipment industry and the semiconductor industry is projected to continue its rapid growth, while the fabric mills industry's annual productivity growth rate is expected to be negative over the 2006-2016 period. For the high-margin and low-productivity pharmaceutical and medicine industry, the labor productivity is expected to grow at a relatively low rate of 2.3 percent between 2006 and 2016, but much faster than the negative rate of growth posted in a decade ago.

Exports related employment by major sector and by industry

Data for export related employment by major sectors of the U.S. economy is displayed in table 3. Exports continue to be important to employment in the manufacturing industries. The 2006 percent ratio of export related employment to total employment in the manufacturing sector increased to 21.9 percent from the ratio of 18.8 percent in 1996. The ratio is expected to reach 26.0 percent in 2016. Exports are also important to the agriculture sector, but the levels of employment are small when compared to the level of export related employment prevailing in manufacturing. For example, in 2006, the export related employment in the agriculture sector was 377,400 while in manufacturing the level of export related employment numbered 3,181,700 or roughly 8.5 times the number of export related jobs in the agriculture sector.

Export related employment, which is part of the industry’s total generated employment, is examined in table 4. For the aerospace product and parts industry, the share of export related employment to total employment has been second highest when comparing it to all other industries in both 1996 and 2006, as well as in the projected year of 2016. In addition, while the audio and video equipment industry’s share almost remains the same at about 38 percent for all three years, the share for the leather and hide tanning and finishing industry increased rapidly, from 27.9 percent in 1996 to 49.6 percent in 2006, and is projected to reach 81.9 percent in 2016.

The changing structure of foreign trade

In modern times, several issues may reflect changes in the foreign trade structure. The organizational and structural changes may pose a demand for a more careful measurement of foreign trade in general as well as an acknowledgement of measurement problems, which ultimately accentuate the less positive aspects of foreign trade. These concerns relate to the following issues which are listed below:

- Direct and indirect employment
- Off-shoring and outsourcing
- The role of U.S. and foreign multinationals
- Development of vertical and horizontal integration

Direct and indirect employment. BLS observes exports related industry jobs by calculating export related both direct employment and indirect employment. The distinction between direct and indirect export employment provides additional information regarding the effect of changes in the magnitude and composition of exports of goods and services. While an industry’s direct employment is related to the exports of the particular industry, the indirect export employment is defined as the number of jobs in a given industry necessary to produce the goods or services incorporated in the exports of other industries.

In general, jobs generated in the services industries are considered to be direct, except in cases where those services jobs are generated by the production of indirect export goods.

In manufacturing, fairly wide variations exist among different industries regarding their prevailing proportions of direct or indirect industry employment over total industry employment. For a particular industry, the proportion depends on the degree of fabrication of the item produced. Industries whose outputs consist mainly of raw or semi-finished commodities generally incorporated into other products are likely to have a larger proportion of indirect rather than direct export employment. Conversely, industries producing highly processed items will probably have a greater share of their export employment designated as direct. Table 5 shows direct employment as it relates to exports for selected industries. Direct export employment predominated in the aerospace product and parts industry, its ratio to total industry employment amounted to about 97 percent in both 1996 and 2006, while in 2016, the proportion is expected to increase slightly, to 98 percent. On the other hand, direct export employment in the motor vehicle parts industry exhibited a lower ratio of 74.7 percent in 2006, indicating that employment related to the overall exports of this industry is more diffused throughout the economy.

Issues of off-shoring and outsourcing. Outsourcing is a factor influencing US jobs in many industries. Many economists view that outsourcing abroad (off-shoring) will not affect all types of jobs but particularly those that are more "routinized and sharply defined".[3] Allan S. Blinder mentioned, "massive off-shoring will not lead to massive unemployment. In fact, the world gained enormously from the first two industrial revolutions, and it is likely to do so from the third".[4] It has been talked about for many years that the final result may be temporal unemployment, which the government could fight against by subsidizing workers while they attain new skills necessary for available kinds of jobs. Thus, even if overall unemployment does not emerge as a result of off-shoring, the changes that could emerge are related to growth or fall in the number or type(s) of available occupations. The idea behind the study of occupations is that many industries share particular occupations, which themselves surpass the number of existing/defined industries. Occupations are discussed in more detail later.

The role of U.S. and foreign multinationals. The role of multinationals is of importance in that export jobs may be lost if the company moves part of its operations overseas. Part of the reason for going overseas is to reduce the cost of production and to be closer to the general market utilizing the product that is produced. What is also not specified by statistics is the portion of possible new investment that the U.S. multinationals undertake in the USA—i.e., the new investment may partly originate due to the increase in multinationals' profits or savings earned while operating abroad. Data on domestic employment generated by the foreign multinationals operating in the USA are largely not considered, although presumably these multinationals employ largely the U.S. labor force.

Development of vertical and horizontal integration. The level of export employment is related to current trends of vertical and horizontal integration. Due to the ever growing requirement of efficiency in production, given the rising competition in foreign trade, multinational firms organize the process of production—where different stages are in several countries, they can minimize the cost of production, by increasing ultimately the efficiency of production. Thus, the nature of trade is seen by many to be changing, where "countries increasingly specialize in producing particular stages of a good, rather than making a complete good from start to finish".[5] It is also assessed today that "production arrangements in which final goods are made via multiple stages in multiple countries account for one third of recent growth in total trade".[6] On the other hand, the process of horizontal integration involves the union or integration of companies producing the same kinds of goods or operating at the same stage of the supply chain. Horizontal integration increases the market power of the dominant firms, enabling them to secure excessive profits, but it remains questionable whether horizontal integration can become as important as vertical integration on the international scale.

Analysis of Occupations relating to trade

The complexity in studying occupational changes arises from the fact that each industry employment consists of employment of workers possibly having different occupations. As mentioned earlier, an industry-occupation matrix is used by BLS to project employment by occupation. The matrix covering the 2006-16 period includes 201 industries and 753 occupations.

In large part, the growth of occupations is determined by varying rates of growth in industries in which they

[3] Ben S. Bernanke, "Embracing the challenge of free trade: competing and prospering in a global economy," speech at the Montana Economic Development Summit, May 1, 2007.
[4] Blinder S. Allan, "The Next Industrial Revolution?" Foreign Affairs, March/April 2006.

[5] David Hummels, Dana Rapoport, and Kei-Mu Yi, "Vertical Specialization and the Changing Nature of World Trade," the Federal Reserve Bank of New York (FRBNY) Economic Policy Review, June 1998.
[6] George H. Hanson, Raymond J. Maddaloni, Jr., and Matthews J. Slaughter, "Vertical Production Networks in Multinational Firms," NBER Working Paper 9723, May 2003 on the Internet at *http://www.nber.org/papers/w9723.pdf.*

are concentrated. For example, professional and related occupations are projected to grow the fastest, largely because they are concentrated in some fast growing industry sectors, such as health care and social assistance and professional, scientific, and technical services. By contrast, production occupations are projected to decline, largely because most of these jobs are in the declining manufacturing sector.[7] In a similar vein, estimates of the growth of different occupations related to exports will be a function of the growth of export related industries.

The overall employment change may thus be calculated for all the 753 occupations by calculating export related employment changes attributable to the following factors:

- Changes in final demand export levels
- The export demand commodity distribution
- The input-output coefficients
- The export related employment to output relationships
- The occupational staffing patterns
- Some interactive effects which need to be considered among these five employment change factors[8]

In table 6, we display the projected export related employment of the major occupational sectors for the 2006-2016 period. The projection is based on the assumption of average annual rates of change prevailing in the export related employment of the major occupational sectors. Thus, among the 10 major sectors, the export related service occupations sector is expected to grow rapidly at an average annual rate of 5.9 percent from 2006-16, compared with the low rate of growth of 0.9 percent expected to prevail in the case of production occupations.

In table 7, we examine possible future export related employment for computer specialists alone. While employment for computer programmers is expected to grow relatively slow, at 2.2 percent on an annual basis, for the period 2006-16, employment for network systems and data communications analysts is projected to grow at 7.5 percent annually for the same period.

Conclusion

The main purpose of this paper is to look more closely at export-induced growth of employment in the U.S. economy. The data on exports of goods and services that relate to particular industries together with observations regarding the falling exchange rate which appears to have contributed to a rise in overall U.S. exports, all support the general implications of the theory of comparative advantage. The analyses of international trade issues on individual industry bases have included studies of the actual and potential growth of productivity, issues of direct and indirect employment in the production of exporting goods, as well as of those factors concerning the further development of multinational trade—factors which include the functioning of U.S. companies abroad as well as foreign companies within the United States. Among these issues, we also discuss off-shoring as well as issues relating to vertical and horizontal integration.

This also implies that in certain industries the U.S. work force may need to adjust due to the rapid changes in the demand for export goods or services. As some authors have suggested, the government may also need to be ready to provide aid to those displaced from work. In this study, we look more closely at the occupational staffing pattern changes that are related to future exports. These changes in occupational staffing patterns over time offer a view of the expected future changes in exports of particular industries.

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7 See Arlene Dohm and Lynn Shniper, "Occupational employment projections to 2016," the "Major Occupational Groups" section, *Monthly Labor Review*, November 2007, p. 88.

8 Carl Chentrens, "Factors Affecting Occupational Demand Growth, 2006-2016," on the BLS website at *ftp://ftp.bls.gov/pub/special.requests/ep/factor.analysis/fa_description.pdf*.

Chart 1. Exports and imports of goods and services

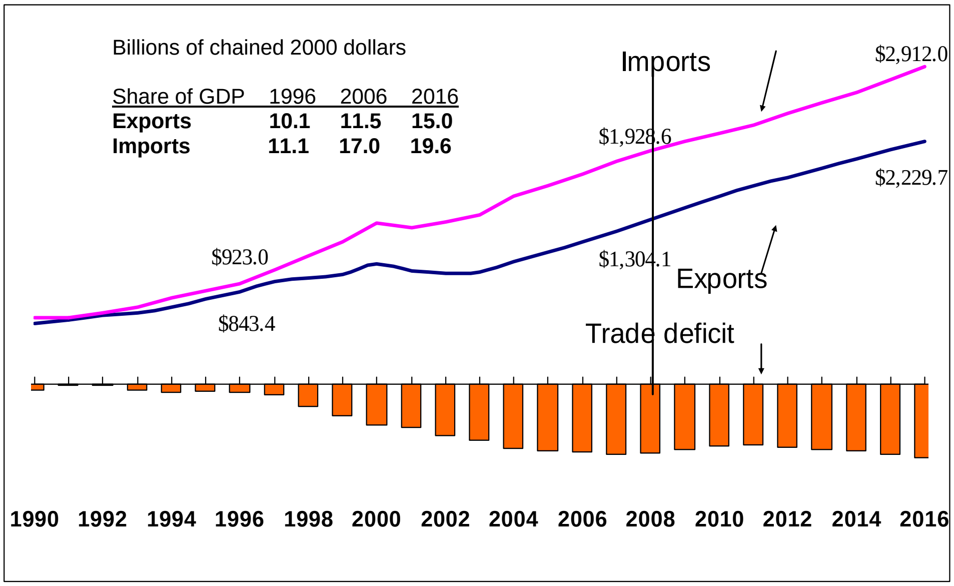

Table 1. Growth of exports in selected industries		
Industry	Average annual rate of growth (in percent)	
	1996-2006	2006-2016
Pharmaceutical and medicine	12.6	5.6
Semiconductor & other electronic components	8.4	4.9
Fabric mills	8.2	0.6
Computers and peripheral equipment	5.6	9.4
Communications equipment	5.0	5.2
Motor vehicle manufacturing	4.8	5.1
Basic chemicals	3.9	5.7
Crop production	2.6	5.9
Air transportation	2.4	7.6

Table 2. Labor productivity growth in selected industries		
Industry	Average annual rate of growth (in percent)	
	1996-2006	2006-2016
Pharmaceutical and medicine	-0.8	2.3
Semiconductor & other electronic components	7.2	14.9
Fabric mills	3.4	-0.1
Computers and peripheral equipment	15.5	25.8
Communications equipment	6.8	4.4
Motor vehicle manufacturing	6.3	3.8
Basic chemicals	6.2	2.8
Crop production	3.1	4.4
Air transportation	6.7	3.8

Table 3. Export related employment by major industry sector						
Major industry	Export related employment (Thousands)			Export related employment as percent of total employment		
	1996	2006	2016	1996	2006	2016
All sectors	8,213	8,592	11,755	6.2	5.8	7.2
Agriculture	474	377	461	17.4	17.6	23.5
Mining	99	93	123	8.2	7.9	10.8
Construction	46	50	64	0.6	0.5	0.6
Manufacturing	3,303	3,182	3,383	18.8	21.9	26.0
Wholesale. Retail, & transportation	1,559	1,619	2,177	6.4	6.2	7.9
Information	418	447	678	10.2	10.1	13.9
Finance, insurance, and real estate	400	495	850	5.2	5.4	8.1
Professional services and management	1,296	1,645	2,891	8.5	8.4	12.0
Education and health	68	87	152	0.4	0.4	0.6
Other services	258	272	504	1.6	1.4	2.4
Government and special industries	291	325	473	1.5	1.5	2.0

Table 4. Export related employment as a share of total employment, selected industries			
	in percent		
Industry	1996	2006	2016
Pharmaceutical and medicine	10.5	24.3	28.7
Semiconductor & other electronic components	47.2	59.0	36.0
Fabric mills	19.4	41.5	56.8
Motor vehicle manufacturing	10.8	11.9	14.1
Audio and video equipment	38.8	37.3	38.4
Aerospace product and parts	45.9	58.7	71.8
Metal ore mining	28.6	50.0	58.7
Leather & hide tanning & finishing	27.9	49.6	81.9

Table 5. Direct employment related to exports, selected industries			
	in percent		
Industry	1996	2006	2016
Aerospace product and parts	96.2	**97.6**	98.1
Pharmaceutical and medicine	89.4	**95.8**	95.4
Medical equipment and supplies	92.3	**94.3**	94.1
Computers and peripheral equipment	84.0	**92.3**	91.8
Communications equipment	86.3	**91.6**	91.6
Semiconductor & other electronic components	72.2	**83.1**	83.1
Crop production	73.3	**77.0**	79.1
Motor vehicle parts	70.3	**74.7**	69.6

Table 6. Export related employment by major occupational sector					
	Export related employment (numbers in thousands)		As a percent of total employment		Average annual rate of change
	2006	2016	2006	2016	2006-2016
All sectors	8,535	11,699	5.7	7.0	3.2
Management, business, and financial occupations	1,093	1,581	7.1	9.3	3.8
Professional and related occupations	1,191	1,747	4.0	5.0	3.9
Service occupations	580	1,031	2.0	3.1	5.9
Sales and related occupations	673	953	4.2	5.5	3.5
Office and administrative support occupations	1,460	2,061	6.0	7.9	3.5
Farming, fishing, and forestry occupations	158	195	15.2	19.3	2.1
Construction and extraction occupations	217	315	2.6	3.5	3.8
Installation, maintenance, and repair occupations	427	575	7.3	8.9	3.0
Production occupations	1,759	1,930	16.5	19.0	0.9
Transportation and material moving occupations	978	1,312	9.6	12.3	3.0

Table 7. Export related employment for computer specialists					
	Export related employment (numbers in unit)		As a percent of total employment		Average annual rate of change
	2006	2016	2006	2016	2006-2016
Computer specialists	283,559	441,906	8.9	11.0	4.5
Computer and information scientists, research	2,352	3,335	9.3	10.9	3.6
Computer programmers	34,374	42,562	7.9	10.2	2.2
Computer software engineers	96,060	149,699	11.2	12.7	4.5
Computer software engineers, applications	55,369	92,240	10.9	12.6	5.2
Computer software engineers, systems software	40,691	57,459	11.6	12.8	3.5
Computer support specialists	41,081	58,584	7.4	9.4	3.6
Computer systems analysts	42,637	70,986	8.5	10.9	5.2
Database administrators	9,776	16,182	8.2	10.5	5.2
Network and computer systems administrators	25,249	41,218	8.2	10.5	5.0
Network systems and data communications analysts	20,401	42,046	7.8	10.5	7.5
Computer specialists, all other	11,629	17,294	8.6	11.1	4.1