An Analysis of Estimates arising from The Tennessee Econometric Model as presented in *An Economic Report to the Governor, 1995*

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A Report to the State Funding Board

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Introduction

Each year, economists at the Center for Business and Economic Research (CBER) at the University of Tennessee (Knoxville) prepare an economic forecast for the state of Tennessee. Their forecast is formally presented in *An Economic Report to the Governor*. The Tennessee State Funding Board is required by statute to comment on the reasonableness of the estimated growth rate of the state's economy, as measured by Tennessee nominal personal income. If deemed reasonable, the estimated growth rate is used as a basis for determining the legally allowable increase in appropriations from state tax revenues for the next fiscal year. The purpose of this paper is to provide an assessment of the economy's performance and to assist the Tennessee State Funding Board in determining the reasonableness of CBER's forecast for 1995.[1]

Statutory Requirements

Article II, Section 24 of the *Constitution of Tennessee*, as amended, limits the rate of growth of appropriations from state tax revenues to the rate of growth in the state's economy, as determined by law. No appropriations in excess of this limitation can be made unless the General Assembly, in a separate appropriations bill that contains no other subject matter, establishes the dollar and percentage amounts by which the limitation is exceeded.

Tennessee Code Annotated §9–6–201 requires that the estimated rate of growth in the state's economy be based on the projected change in Tennessee nominal personal income, and that Tennessee personal income consist of the same sources of income that are included in the definition of U.S. personal income. A detailed definition of personal income is contained in Appendix 1.

T.C.A. §9–6–203(c) requires the Governor, in any year when the growth limit is exceeded in the budget document, to submit to both houses of the General Assembly a separate appropriations bill that contains dollar and percentage amounts by which the limit is exceeded, with no other subject matter. *T.C.A.* §9–6–203(d) requires the General Assembly to establish by law the percentage and dollar amounts of the excess of appropriations over the projected change in Tennessee nominal personal income.[2]

The Tennessee State Funding Board, under provisions set forth in *T.C.A.* §9–6–202, is given the responsibility for obtaining, evaluating, determining, and commenting upon the reasonableness of the forecast for Tennessee nominal personal income obtained from the Tennessee Econometric Model, as outlined below:

> (a) At least once each year...the state funding board shall secure from the Tennessee econometric model a report of the estimated rate of growth of the state's economy.

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[1] This paper is adapted in part from past economic reports and analyses, 1976-1994.

[2] Since fiscal year 1984-85, this limit has been exceeded seven times: fiscal year 1984-85 ($396.1 million or 14.6 percent); fiscal year 1985-86 ($58 million or 1.79 percent); fiscal year 1986-87 ($100 million or 2.76 percent); fiscal year 1988-89 ($101 million or 2.38 percent); fiscal year 1989-90 ($74 million or 1.59 percent); fiscal year 1991-92 ($703.1 million or 15.09 percent); fiscal year 1992-93 ($450 million or 8.69 percent).

(b) Upon receiving the report...the state funding board shall make comments relating to the reasonableness of the estimate, including any different estimate the board deems necessary. The Board shall also enclose a list identifying state tax revenue sources and nontax sources, approved by the attorney general. The department of finance and administration shall provide to the board revenue estimates for each source.

(c) In the event data from the Tennessee econometric model is unavailable, the funding board, after consulting with the finance, ways and means committees...shall obtain and/or prepare a report of the estimated rate of growth of the state's economy.

(d) The reports...shall be forwarded to the commissioner of finance and administration and to each member of the general assembly, after review and definitive comment by the finance, ways and means committees of the senate and house of representatives.

Assessing Reasonableness

Assessing the Performance of the Tennessee Econometric Model

Econometric models are one of the forecasting tools used to reduce uncertainty about future events. Forecasting is an imperfect science, but is necessary to minimize the economic and social costs caused by changes in the business cycle. Two measures of the accuracy of a forecasting model are its ability to predict future levels of economic activity and its ability to predict turning points in the business cycle. The economist interprets the forecasts that are generated by the model, assesses the model's forecast of particular variables (e.g., Gross Domestic Product (GDP), and the unemployment and inflation rates), and may change the forecasts based on factors that are not incorporated in the econometric model. Judgment is an integral component of the forecasting process, and forecasts are often a product of the economist's judgment in addition to the model's formal solutions.

Economic forecasting ultimately attempts to predict the behavior of economic units (i.e., individuals, businesses, and governments), using past behavior as a guide. Economic decisions depend upon perceptions of past events, and expectations of future events, which are often inaccurate. Consequently, economic behavior is difficult to predict, and forecasts are subject to large errors. Statistical techniques can be used to measure forecast errors.

The forecast error is the difference between the predicted and actual values for a specific indicator, or variable. There are two types of forecast error: magnitude errors and turning point errors. Magnitude errors occur when the forecaster incorrectly estimates a variable's degree of change, but correctly predicts the direction of change. For example, predicting growth in nominal personal income to be seven percent when it actually grows by eight percent is a magnitude error. Turning point errors occur when the forecaster fails to predict a change in the direction of the growth of an economic variable. Predicting an end to a recession when no increase in output occurs is an example of a turning point error. Turning points in economic time series are usually

very difficult to predict and are more significant than magnitude errors because they may result in higher economic and social costs. One indication of systematic turning point error is to determine whether a forecast systematically leads, lags, or is coincident with its targeted variable.[3] The most common approach to assessing the overall accuracy of a forecast is to calculate the fit between predicted and observed behavior using regression analysis.

Staff evaluated several criteria to determine the reasonableness of the CBER forecast of nominal Tennessee personal income growth. First, the Wharton Econometric Forecasting Associates'(WEFA) forecasts for the national economy were compared to forecasts from other prominent forecasters and its historical accuracy is assessed. Second, the historical accuracy of CBER forecasts was analyzed, particularly the performance of Tennessee nominal personal income forecasts. Third, staff considered the consistency of the U.S. and Tennessee forecasts with recent economic events.

Historical Accuracy of The Tennessee and WEFA Econometric Models

The Center for Business and Economic Research's Tennessee Econometric Model (TEM) and the WEFA econometric models have been examined in previous analyses and have been deemed to be reasonable forecasting tools. Descriptions of the econometric models, and the methodology used to generate forecasts are contained in Appendix 2. The TEM depends on WEFA forecasts of national economic performance. For this reason, the accuracy and reasonableness of CBER's forecasts depend upon the quality of WEFA forecasts.

Accuracy of the WEFA Econometric Model

The WEFA forecasts incorporated into the 1995 *Economic Report to the Governor* and TEM forecasts were released in November 1994. Comparisons of selected U.S. economic indicators released from WEFA and other major forecasting services in December are displayed in Exhibits 1 and 2. None of WEFA's quarterly forecasts for real gross domestic product, inflation, and the unemployment rate through the fourth quarter of 1996 deviate significantly from the averages of the other forecasts reported by the Conference Board.

The longitudinal accuracy of WEFA forecasts was evaluated using the following criteria: (1) evidence of persistent bias in forecast errors as indicated by mean error, (2) evidence of statistical fit and precision as measured by coefficients of determination and mean absolute error, and (3) evidence of systematic turning point error as indicated by systematic lags or leads of changes. Summary statistics concerning the longitudinal accuracy of WEFA's national economic forecasts are reported in Exhibit 3. The r^2, specifying the overall fit of the forecasts with the actual economic indicator, as well as mean error and mean absolute values of the forecasts are reported for each indicator.

Mean error is the average forecast error. Ideally, mean error statistics are zero. Statistical fit, as measured by the model's historical correlation with actual economic performance, is estimated using regression analysis. A regression coefficient (r^2) is reported for each variable,

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[3] Michael P. Niemira and Philip A. Klein, *Forecasting Financial and Economic Cycles*, (New York: Wiley), 1994, pp. 220-42.

Exhibit 1
Comparison of U.S. Forecasts
Real GDP Growth, Inflation and Unemployment Rates[4]
Date of Forecast: December 1994

	1994 Q4	1995 Q1	1995 Q2	1995 Q3	1995 Q4	1996 Q1	1996 Q2	1996 Q3	1996 Q4
Real GDP[5]									
WEFA	**3.6**	**2.8**	**2.4**	**2.7**	**2.4**	**2.6**	**2.5**	**2.3**	**2.6**
Conference Board	4.5	3.4	3.4	4.9	4.5	3.3	3.6	3.9	2.9
Data Resources Inc.	3.4	3.2	1.2	1.1	1.3	1.7	1.6	2.7	3.4
UCLA	4.0	3.9	2.2	2.0	1.9	1.3	1.5	1.7	2.2
Merrill Lynch	4.0	2.9	2.5	2.3	2.0	2.5	-	-	-
Dupont	3.5	2.7	2.0	1.9	1.8	-	-	-	-
Georgia State	4.5	2.8	3.9	2.6	1.8	1.2	1.4	0.6	-0.3
Eaton	3.9	2.4	2.7	2.2	3.3	-	-	-	-
L.H. Meyer	4.3	2.4	2.6	2.4	2.3	2.1	2.1	2.0	2.1
Michigan-RSQE	3.5	2.4	1.7	1.5	1.6	1.7	2.0	2.3	2.6
Northern Trust	3.5	3.0	2.8	2.5	0.9	-	-	-	-
Reg. Fin. Assoc.	3.8	2.9	3.0	2.5	2.3	2.9	2.9	2.6	0.9
Forecast Average	**3.9**	**2.9**	**2.5**	**2.4**	**2.2**	**2.1**	**2.2**	**2.3**	**2.1**
Forecast Range									
Lowest	**3.4**	**2.4**	**1.2**	**1.1**	**0.9**	**1.3**	**1.4**	**0.6**	**-0.3**
Highest	**4.5**	**3.9**	**3.9**	**2.5**	**3.3**	**2.9**	**2.9**	**3.9**	**3.4**

	Unemployment Rate			Inflation (Deflator)	
	CY1994	CY1995	CY1996	1994Q4	1995Q4
WEFA	**5.7**	**5.8**	**5.7**	**2.7**	**2.9**
Conference Board	5.7	5.6	5.6	2.8	3.0
Data Resources Inc.	5.7	5.6	6.1	2.4	2.3
UCLA	5.9	5.5	5.9	2.9	3.1
Merrill Lynch	5.6	5.8	-	2.6	3.1
Dupont	5.9	5.9	-	2.6	3.4
Georgia State	5.7	5.1	5.8	2.7	2.8
Eaton	5.6	5.6	-	2.6	3.1
L.H. Meyer	5.7	5.4	5.6	2.3	2.8
Michigan-RSQE	5.6	5.8	6.0	2.5	2.7
Northern Trust	5.7	5.6	-	2.7	3.4
Reg. Fin. Assoc.	5.7	5.8	6.0	2.8	3.4
Forecast Average	**5.7**	**5.6**	**5.8**	**2.6**	**3.0**
Forecast Range					
Lowest	**5.6**	**5.1**	**5.6**	**2.4**	**2.3**
Highest	**5.9**	**5.9**	**6.1**	**2.9**	**3.4**

[4] As measured by quarter-to-quarter percent change, in seasonally adjusted annual rates (SAAR).

[5] All forecasts are from the Conference Board, *Economic Times,* January 1995.

indicating on a zero (0) to one (1) scale, how well the forecast predicts actual economic performance. Mean absolute error measures the average magnitude of errors. Systematic turning point error is reported in terms of whether the forecast generally lags, leads, or coincides with its targeted economic variable.

Exhibit 2
Analysis of Annual National Forecast Accuracy
Selected Economic Indicators As Reported in
An Economic Report to the Governor,
1976–1995

Forecasted Indicator	Years	Adjusted r^2	Mean Error	Mean Absolute Error
Change in the Implicit GNP/GDP Deflator/Inflator (%)*	1976–93	0.75	-0.15	0.84
Growth in Real GNP/GDP (%)*	1976–93	0.79	-0.12	0.78
Growth in U.S. Nominal Personal Income (%)	1977–93	0.69	-0.06	0.72
U.S. Unemployment (% Rate)	1977–93	0.74	-0.10	0.45

* Reported statistics changed from Gross National Product (GNP) to Gross Domestic Product (GDP) in 1991.

Exhibit 3 provides an analysis of the lags and leads in forecasts of selected economic indicators for the United States. Historically, the national economic forecasts reported in *An Economic Report to the Governor* have been very good. On average, WEFA's national forecasts have erred less than one percent from the actual value of each indicator, with a slight tendency to overestimate these indicators as measured by the mean error.

The r^2s are in respectable ranges, and are statistically significant at a probability of less than .05. As Exhibit 3 shows, only one of the selected forecasts, inflation, shows signs of systematically lagging or leading the actual figure.

Economist Stephen McNees of The Federal Reserve Bank of Boston analyzed the accuracy of forecasts from nine prominent forecasting services over the period from 1986 to the third quarter of 1991. McNees concluded that no single forecasting service outperformed competing forecasts for all, or even most of the economic series evaluated. Even the differences in accuracy between the best and second best forecaster were small. On average, the errors of the best forecasts were less than 10 percent smaller than the errors of the second best forecasts. McNees argues that such small differences are not economically or statistically significant.[6]

[6] Stephen K. McNees, "How Large are Economic Forecast Errors?," *New England Economic Review,* (July/August, 1992), p. 33.

Exhibit 3
Analysis of Annual National Forecast Timing
Selected Economic Indicators As Reported in
An Economic Report to the Governor,
1976–1995

Forecast	Leads			Regression Coefficients		Lags	
	3 yrs.	2 yrs.	1 yr.	0 yrs.	1 yr.	2 yrs.	3 yrs.
Percent Change in the Implicit GNP/GDP Deflator/Inflator*	0.06	0.04	0.32	0.75	**0.91**	0.71	0.42
Growth in GNP/GDP (%)*	0.05	0.06	0.16	**0.79**	0.06	0.01	0.09
Growth in U.S. Personal Income (%)	0.01	0.07	0.06	**0.69**	0.12	0.07	0.11
Percent U.S. Unemployment (% Rate)	0.08	0.03	0.20	**0.74**	0.68	0.05	0.07

* Reported statistics changed from Gross National Product (GNP) to Gross Domestic Product (GDP) in 1991, All regression coefficients are adjusted r^2s.

McNees also addressed the accusation that forecasters often produce biased estimates. He concluded, however, that none of the forecasting services included in this study (which included WEFA) showed tendencies to systematically overestimate or underestimate forecasted variables. The mean errors of the forecasts analyzed are close to zero for both preliminary and revised actual data for all forecast horizons.[7]

Other studies evaluating the quality of macroeconomic models and forecasts have failed to provide evidence of the supremacy of a single forecasting group or methodology. Also, the large number of competitive forecasting services suggests that no single forecasting service has achieved a dominant position within the forecasting industry.[8] A comparison of WEFA's to other forecasts, and a survey of literature on macroeconomic modeling and forecasting, leads staff to conclude that WEFA forecasts are reasonable. Furthermore, staff cannot assert that TEM forecasts could be improved if CBER used U.S. economic forecasts produced by another forecasting service.

Accuracy of the Tennessee Econometric Model

The historical accuracy of TEM forecasts indicates that forecasts of income and output are generally more accurate than the model's taxable sales and employment forecasts. To provide an assessment of the historical accuracy of TEM forecasts, several of the major Tennessee economic indicators were analyzed for the period 1976 to 1993. The accuracy of the forecasts was evaluated using the following criteria: (1) evidence of persistent bias in forecast errors as indicated by mean error, (2) evidence of statistical fit and precision as measured by coefficients of determination and mean absolute error, and (3) evidence of systematic turning point error as indicated by systematic lags, leads, or coincidence of forecasts.

[7] Ibid, p. 26.

[8] Paul Newbold and Theodore Bos, *Introductory Business Forecasting*, (Cincinnati, Ohio), 1990, p.341.

Table 1 provides forecasts and summary statistics for the State Funding Board's primary variable of interest, nominal Tennessee Personal Income growth.

Table 1
Tennessee Nominal Personal Income Growth Forecasts

Year	Actual	Forecast	Error
1976	11.67	13.77	-2.10
1977	10.82	12.16	-1.34
1978	14.05	10.79	3.26
1979	12.22	10.40	1.82
1980	10.30	10.38	-0.08
1981	10.59	10.68	-0.09
1982	5.13	9.96	-4.83
1983	6.52	8.02	-1.50
1984	11.06	10.48	0.58
1985	7.11	8.67	-1.56
1986	8.42	7.02	1.40
1987	7.58	6.31	1.27
1988	7.36	6.63	0.73
1989	7.02	7.05	-0.03
1990	6.29	5.81	0.48
1991	4.98	4.87	0.11
1992	8.44	5.03	3.41
1993	6.03	5.75	0.28
Adjusted r^2		**0.50**	
Lag/Lead		**(Coincident)**	
Mean Error		**0.10 Percentage Points**	
Mean Absolute Error		**1.38 Percentage Points**	

Forecasts of Tennessee Personal Income appear quite good. As illustrated in Table 1, the mean absolute value of the error is 1.38 percent during the 1976–1993 time frame. There is little indication of systematic turning point error (both coincident and one–year lags produce equally high r^2s) and the model accounts for approximately 50 percent of the variance in nominal income growth in Tennessee. In 1992, a turning point error pulled the average error toward underestimating growth in nominal personal income, resulting in an average tendency to underestimate by a small margin the actual growth rate of Tennessee personal income. Over the entire history of TEM forecasts, it has underestimated growth, by an average of one–tenth of one percent. Normally, systematic bias in a forecasting mechanism is undesirable. However, because one of the purposes of the TEM forecast for personal income growth is determining the legally allowable increase in appropriations from state tax revenues for the next fiscal year, the tendency to underestimate this variable may be desirable.

The summary statistics for nominal Tennessee gross state product (nominal GSP) growth forecasts are shown in Table 2.

Table 2
Tennessee Nominal Gross State Product Growth Forecasts

Year	Actual	Forecast	Error
1976	13.28	12.90	0.38
1977	13.82	12.75	1.07
1978	15.34	10.98	4.36
1979	10.30	9.50	0.80
1980	6.59	8.12	-1.53
1981	10.69	10.37	0.32
1982	4.08	8.78	-4.70
1983	8.07	8.23	-0.16
1984	12.49	12.56	-0.07
1985	7.23	7.12	0.11
1986	8.07	6.21	1.86
1987	10.10	6.43	3.67
1988	7.08	6.89	0.19
1989	5.89	6.57	-0.68
1990	3.97	4.50	-0.53
1991	5.85	6.02	-0.17
1992	7.43	6.82	0.61
1993	7.74	6.21	1.53
Adjusted r^2		**0.64**	
Lag/Lead		**(Coincident)**	
Mean Error		**0.39 Percentage Points**	
Mean Absolute Error		**1.26 Percentage Points**	

Forecasts of Tennessee nominal GSP over the period of 1976 to 1993 were good, considering the volatility of growth in GSP. The mean error of percentage points and the mean absolute error of 1.26 percentage points appear reasonably favorable, given the wide variations in the series. The mean error indicates that the TEM tends to underestimate growth in nominal GSP, as it also does with growth in personal income. Overall, the fit of TEM forecasts with actual growth rates during the 1976-1993 period has been good, and there is no evidence that there is a systematic turning point bias toward lagging or leading actual GSP forecast targets.

Table 3 provides accuracy statistics for predictions of real Tennessee gross state product (real GSP) growth.

Table 3
Tennessee Real Gross State Product Growth Forecasts

Year	Actual	Forecast	Error
1976	7.18	5.70	1.48
1977	7.12	7.17	-0.05
1978	7.69	4.45	3.24
1979	1.96	2.58	-0.62
1980	-3.29	-0.01	-3.28
1981	1.39	1.94	-0.55
1982	-1.42	0.40	-1.82
1983	3.94	2.78	1.16
1984	7.44	7.05	0.39
1985	3.67	2.99	0.68
1986	4.76	2.28	2.48
1987	6.35	2.92	3.43
1988	2.88	2.83	0.05
1989	1.72	2.19	-0.47
1990	0.13	0.18	-0.05
1991	2.50	0.68	1.82
1992	3.68	3.19	0.49
1993	4.27	3.46	0.81
Adjusted r^2		**0.68**	
Lag/Lead		**(Coincident)**	
Mean Error		**0.51 Percentage Points**	
Mean Absolute Error		**1.27 Percentage Points**	

Historically, TEM forecasts of real GSP have been almost as accurate as the forecasts of nominal GSP. The mean absolute error of 1.27 is almost the same as that for nominal GSP forecasts. The TEM tends to underestimate growth in real GSP by half a percentage point. The large mean error and the frequency of underestimates may indicate that real GSP forecasts were systematically biased downward over the period of 1987 to 1992.

Forecast accuracy statistics for the growth rate of nominal taxable sales appear in Table 4. No regression coefficient (r^2) is reported, nor are the results of any lag or lead analysis reported because this series is too young to provide a reasonable number of observations ($\approx$15) for a regression analysis.

The growth rate of nominal Tennessee taxable sales is a very difficult variable to forecast, particularly over a forecast horizon as long as one year. For short periods, consumers often increase expenditures at a faster rate than income growth. A period of reduced expenditures follows, during which household debt decreases or savings are replenished. The result of this behavior is booming taxable sales growth that rapidly dissipates. It is very difficult to accurately

Table 4
Tennessee Nominal Taxable Sales Growth Forecasts

Year	Actual	Forecast	Error
1987	5.96	5.77	0.19
1988	5.92	7.12	-1.20
1989	3.95	4.52	-0.57
1990	3.84	5.20	-1.36
1991	1.57	3.20	-1.63
1992	6.62	3.60	3.02
1993	8.00	4.66	3.34
Mean Error			**0.26 Percentage Points**
Mean Absolute Error			**1.62 Percentage Points**

forecast the timing of these events because a complete boom–and–subsequent–bust cycle could occur within a single year.

Growth in taxable sales was erratic, and difficult for CBER to forecast over the 1987 to 1993 period. The range of the actual observations of the series varied from a low of 1.57 percent in 1991 to a high of 8.00 in 1993. The mean error of 0.26 percentage points is quite good considering the erratic behavior of actual taxable sales statistics. With the addition of one more year of data, the mean absolute error of the forecasts increased from 1.35 in last year's report to 1.62 this year.

The interpretation of the mean error and mean absolute error statistics is that the forecasts' errors were frequently large, but because the forecasts erred on both sides of the actual observations, the average size of the forecast errors was relatively small. Thus, there is little evidence of systematic bias, but a comparatively high degree of error.

A regression analysis was performed using previously reported growth in retail and total sales from earlier CBER reports as proxies for taxable sales figures prior to 1987. This procedure produced an r^2 of 0.21. Although this would be the lowest level of explained variance of any of the forecasts presented, the comparison is somewhat tenuous because directly comparable data prior to 1987 are not available.

The accuracy statistics for Tennessee unemployment rate forecasts appear in Table 5.

The mean error and mean absolute error of Tennessee unemployment rate forecasts are comparatively small, at -0.03 percentage points and 0.73 percentage points, respectively. An analysis of the timing of TEM unemployment forecasts indicates that the forecasts tend to lag behind changes in the unemployment rate by one year. TEM forecasts are more closely associated ($r^2 = 0.83$) with the unemployment rate in the previous year than with the forecast year. However, there is little indication of bias in the forecast error. In fact, TEM forecasts of Tennessee unemployment have the smallest mean errors of any of the forecasts analyzed.

Table 5
Tennessee Unemployment Rate Forecasts

Year	Actual	Forecast	Error
1976	6.00	7.00	-1.00
1977	6.30	6.30	0.00
1978	5.80	4.90	0.90
1979	5.80	5.90	-0.10
1980	7.30	7.10	0.20
1981	9.10	7.10	2.00
1982	11.80	8.90	2.90
1983	11.50	11.40	0.10
1984	8.60	9.60	-1.00
1985	8.00	7.90	0.10
1986	8.00	8.00	0.00
1987	6.60	7.90	-1.30
1988	5.80	7.20	-1.40
1989	5.10	6.20	-1.10
1990	5.20	5.60	-0.40
1991	6.60	6.50	0.10
1992	6.40	6.90	-0.50
1993	5.70	5.80	-0.10
Adjusted r^2		**0.67**	
Lag/Lead		**(One–year Lag)**	
Mean Error		**-0.03 Percentage Points**	
Mean Absolute Error		**0.73 Percentage Points**	

These findings are consistent with McNees' findings regarding the accuracy of econometric forecasting services. McNees found that only one–third of the forecasters he studied were able to outperform a "straw man" forecast. A "straw man" forecast is one that predicts no change from the present year. It is considered one of the most naïve predictions that one could make, but one that frequently "works" better than the majority of forecasters in predicting unemployment. Despite lagging the unemployment rate, TEM forecasts still outperform "straw man" forecasts, which produce an r^2 of only 0.59.

Forecasts of Tennessee nonagricultural employment growth rates, and the corresponding errors and accuracy statistics appear in Table 6.

An r^2 of 0.48 for forecasts of nonagricultural job growth fits the actual figures less than any of the series selected, with the possible exception of taxable sales. The mean error of 0.58 percentage points indicates that the TEM tends to underestimate nonagricultural job growth a little more than one–half percentage points on average. The mean absolute error of 1.52 percentage points, almost as high as the absolute error for taxable sales forecasts, underscores the relatively poor fit between forecasted and actual nonagricultural job growth.

Table 6
Tennessee Nonagricultural Employment Growth Forecasts

Year	Actual	Forecast	Error
1977	4.49	5.19	-0.70
1978	5.40	3.01	2.39
1979	2.32	2.18	0.14
1980	-1.71	0.36	-2.07
1981	0.49	2.07	-1.58
1982	-2.96	-0.13	-2.83
1983	0.91	0.92	-0.01
1984	5.41	4.22	1.19
1985	3.08	1.51	1.57
1986	3.32	1.92	1.40
1987	4.24	1.67	2.57
1988	4.00	2.02	1.98
1989	3.59	1.11	2.48
1990	1.20	0.89	0.31
1991	-0.44	0.41	-0.85
1992	2.81	1.01	1.80
1993	3.67	1.66	2.01
Adjusted r^2		**0.48**	
Lag/Lead		**(Coincident)**	
Mean Error		**0.58 Percentage Points**	
Mean Absolute Error		**1.52 Percentage Points**	

As mentioned, this series is quite volatile, with annual growth rates ranging from -2.69 percent to 4.24 percent, making it much more difficult to forecast. Likewise, unemployment rates and employment growth rates have been difficult to forecast because of structural changes in the state's economy as well as large changes in revised estimates of actual figures.[9]

Conclusion: The Historical Accuracy of TEM Forecasts

The quality of TEM forecasts for the period examined varied across economic indicators. The TEM tended to slightly underestimate nominal personal income growth, which is a desirable property of forecasts used in the budgeting process. TEM forecasts of nominal and real Tennessee gross state product were good, although the reader should note that real GSP tended to be underestimated during the period analyzed. Forecasts of taxable sales, the Tennessee unemployment rate, and Tennessee nonagricultural employment growth rate forecasts appear to be less accurate than those of the other economic variables. Overall, the historical accuracy of TEM forecasts supports the conclusion that previous TEM forecasts were reasonable.

[9] CBER, *An Economic Report to the Governor*, 1994, pp. 29-30.

National Short Term Forecast Summary

Overview of the U.S. Economy: 1994

As the year began, advance estimates of fourth quarter growth in GDP indicated an even stronger rate of growth than predicted during the last quarter of 1993, foreshadowing strong patterns that continued throughout 1994.

Expectations of rising economic growth spurred increases in long–term interest rates during the first quarter. Long–term rates increased from 6.25 percent at the beginning of the quarter to 7.0 percent. The Federal Reserve Board raised the target for federal funds from 3.0 percent to 3.25 percent in February. In March, the Federal Reserve raised the target again, this time to 3.5 percent. Commercial banks, meanwhile, raised the prime lending rate from 6.0 percent to 6.25 percent.

Employment growth slowed relative to the rapid pace of the last quarter of 1993, partly due to the weather and to a lesser degree, the earthquake in southern California. Nevertheless, the average monthly increase was close to the previous quarter at roughly 220,000 new jobs. In January, the Bureau of Labor Statistics (BLS) began using a new methodology for calculating unemployment. Using this new method, estimates of unemployment increased to 6.7 percent in January, and declined to 6.5 percent for both February and March. In March, the BLS reported that this new methodology had probably increased the estimate of unemployment by about 0.2 percent from the previous methodology.

Second quarter activity in the housing sector bounced back from the slow start in the first quarter, but final tax payments in the second quarter slowed consumer spending. The pace of automobile purchases slowed somewhat, but shortages of popular models appeared to be a factor in this development. Also, the Federal Reserve continued to raise the target for federal funds to 3.7 percent in mid–April. Long–term interest rates continued to climb, increasing another quarter point to 7.5 percent by quarter's end.

Employment growth accelerated in the second quarter, with a monthly average of 320,000 new jobs. Unemployment, meanwhile, declined during the quarter to 6.0 percent, which most analysts consider close to full employment.

Third quarter consumer spending strengthened as automobile manufacturers adjusted to demand for certain models. Capacity utilization rates increased to nearly 85 percent, while unemployment continued to decline, reaching 5.9 percent in September.

In response to inflationary concerns, the Federal Reserve again raised the federal funds target, to 4.0 percent and the discount rate increased to 4.75 percent. Commercial banks quickly followed suit with an increase of one–half percentage points to 7.75 percent. Long–term interest rates also continued to climb, reaching the two–year high of 8.0 percent in early October.

Fourth quarter performance showed continued strength despite increased interest rates. A large jump in average hourly earnings fueled concerns about inflation, pushing long–term interest rates to an annual peak of 8.17 percent in early November. Meanwhile, the Federal Reserve again increased the target for federal funds to 5.5 percent and pushed the discount rate to 4.75 percent.

Two particularly significant events occurred in the last quarter of 1994. First, Republicans won a majority of seats in both chambers of Congress, many vowing to support "The Contract

with America," which includes increased defense spending, a balanced budget amendment, and reductions in most non–defense programs. This is the first time since 1954 that both the House and the Senate have been controlled by the Republican Party. Finally, Orange County, California, announced heavy losses as a result of risky investments. News of this event sent bond prices lower as 1994 came to a close.

Short Term U.S. Economic Forecasts

The WEFA group predicts strong growth in 1995, though slightly slower than growth in 1994. These forecasts, which are incorporated in the Tennessee econometric forecasts, appear in Exhibit 4. According to WEFA, the economy's output as measured by gross domestic product is predicted to grow at a seasonally adjusted rate (SAAR) of 2.66 percent during 1995, somewhat slower than the revised estimate of 3.82 percent for 1994. Inflation, as measured by the personal consumption deflator, is expected to be 3.5 percent, while real personal income is expected to increase by 2.7 percent. WEFA predicts that nonagricultural jobs will increase by 2.5 percent and unemployment will remain low at a rate of 5.9 percent.

Exhibit 4
WEFA Econometric Model
1995 Annual Forecasts
Selected U.S. Indicators[10]
Forecast Date: November 1994

	1995 Forecasted Level	1995 Forecasted Rate of Growth
US GDP (Billions $)	$7,102.1	5.59%
US GDP (Billions 87$)	$5,472.3	2.66%
Implicit Deflator, GDP (1987=100)	129.8	2.86%
US Personal Consumption Deflator (1987 = 100)	134.0	3.50%
US Personal Income (Bil $)	$6,054.7	6.31%
US Personal Income (Bil 87$)	$4,519.2	2.72%
US Unemployment Rate	5.9%	-
US Nonagricultural Jobs (Millions)	116.2	2.53%

[10] All forecasts are from *An Economic Report to the Governor, 1995.*

Tennessee Short Term Forecast Summary

Overview of the Tennessee Economy

As expected, the Tennessee economy grew strongly in 1994 creating concern among some economists that the economy might overheat. In response, the Federal Reserve raised interest rates six times during 1994 and once more in the first quarter of 1995. According to the CBER, economic growth is expected to progress at a more sustainable pace than experienced in 1994. In general, the CBER projects that the Tennessee economy will fare well during 1995.[11]

Personal income and employment statistics for 1994 indicated strong growth. The CBER estimates that personal income grew at (SAAR) 6.68 percent during 1994, while overall employment growth stood at 4.0 percent.[12]

Non–agricultural employment grew at 2.68 percent between October 1993 and October 1994, with the largest gains occurring in the trade sector which grew at 3.7 percent. Unemployment, statewide, fell to a seasonally adjusted rate (SAAR) of 4.6 percent in October 1994. For the 1994 calendar year, CBER estimates an unemployment rate of 4.9 percent, which was lower than last year's prediction of 5.1 percent. In 1994, CBER correctly suggested that unemployment might be less than 5.0 percent in 1994, and suggested that it may remain below that level in 1995.[13] Unemployment, however, was unevenly distributed in Tennessee, with nonmetropolitan areas of the state averaging 7.4 percent. While seven Tennessee counties reported unemployment rates of 3.0 percent or lower, 17 counties experienced rates that ranged from 7.1 to 10.5 percent. CBER expects Tennessee's economic performance to continue to surpass U.S. economic performance.[14]

Short Term Tennessee Economic Forecasts

CBER's 1995 forecasts for selected Tennessee indicators are found in Exhibit 5, which contains quarterly forecasts through the end of the 1995 calendar year. As illustrated in Exhibit 4, CBER economists are predicting that nominal and real Tennessee personal income will grow by 7.22 percent and 3.59 percent, respectively, in 1995. In 1996, CBER expects growth in nominal and real personal income to begin leveling off at 6.77 percent and 2.97 percent. Tennessee per capita income in real dollars is expected to grow 0.6 percentage points faster in both 1995 and 1996 than U.S. per capita personal income. This indicates that Tennessee will continue to close the historical gap in personal income with the rest of the country. The employment forecasts for Tennessee continue to indicate strong growth. Tennessee nonagricultural employment is expected to grow at a seasonally adjusted annual rate (SAAR) of 2.75 percent in 1995. Unemployment is predicted to remain low at 4.9 percent for 1995 and 4.8 percent for 1996. Taxable sales are expected to increase by 8.12 percent in nominal terms and 4.53 percent in

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[11] CBER, p. 35.

[12] In March ,1995, the revised benchmark estimates of 1994 non-agricultural job growth stood at 3.96 percent, according to the Department of Employment Security, higher than the preliminary estimate of 2.2 percent.

[13] CBER, 1994, p. 30

[14] CBER, p. 29-36.

inflation–adjusted dollars in 1995. In 1996, CBER expects growth taxable sales to grow by 6.84 percent in nominal terms and 3.03 percent in inflation adjusted dollars.

According to CBER, recent statistics on the Tennessee economy indicate that it is quite strong, but growth may slow relative to the 1994 calendar year. CBER reports:

> *When the economy is functioning at full capacity, there is very little room for large monthly expansions and the decline in the leading index suggests that the Tennessee economy may experience slower growth as 1995 progresses.*[15]

This assessment is echoed in other reports on the Tennessee economy.[16] Many economists feel that the much discussed "soft landing" may occur, without the dangers of inflation or economic contraction during 1995.

Conclusion

Several aspects of CBER's forecasts have been examined with respect to their accuracy and reasonableness. As of November 1994, CBER economists predict that the growth in the state's economy, as measured by nominal Tennessee personal income growth, will be 7.2 percent for 1995. This estimate appears reasonable, given the analysis of previous forecasts and the optimistic economic data available since the publication of the 1994 *Economic Report to the Governor.*

CBER reported in February that the Tennessee economy shows no sign of impending weakness. An examination of coincident indicators suggests that recent setbacks in Tennessee's leading index are symptoms of a "state economy that is running at full steam."[17]

Staff concludes that the nominal Tennessee Personal Income growth forecast is reasonable after analyzing several issues. Analysis of the WEFA group's forecasts for the U.S. economy, which are included in the assumptions of the Tennessee Econometric Model, determined that the U.S. economic forecasts used by CBER appear reasonable. CBER's Nominal Tennessee Personal Income forecasts have been well within professionally accepted standards of accuracy and exceeded those standards in certain cases. For example, the CBER is one of a minority of forecasting services that surpasses the performance of "straw man" predictions of unemployment. Confidence in the reasonableness of the personal income forecasts is also boosted by the optimistic economic data made available through the end of 1994 and into the new year. The most recently available data indicates that both the U.S. economy and Tennessee labor markets continue to exhibit strength.

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[15] CBER, Tennessee Economic Overview (October Index as of January 31), p.1.

[16] John Gnuschke, "The Expansion Keeps Rolling Along," *Business Perspectives*, Vol. 8, no. 1 (December 1994), pp. 1-8; Juan Gonzales, "More Boom Times for the TVA Region," *Business Perspectives*, Vol. 8, no. 1 (December 1994), pp.14-19.

[17] Ibid.

Exhibit 5
Tennessee Econometric Model
1995 Annual Forecasts
Selected Tennessee Indicators

	1995 Forecasted Level	1995 Forecasted Rate of Growth
TN Personal Income (Millions $)	$107,395	7.22%
TN Personal Income (Millions 87$)	$80,164	3.59%
TN GSP (Millions $)	$133,073	6.76%
TN GSP (Millions 87$)	$100,715	3.42%
US Personal Consumption Deflator (1987 = 100)	134.0	3.5%
TN Unemployment Rate	4.9%	N/A
TN Nonagricultural Jobs (Thousands)	2,456.5	2.75%
TN Manufacturing Jobs (Thousands)	543.7	0.87%
TN Taxable Sales (Millions $)	$57,893	8.17%
TN Taxable Sales (Millions 87$)	$43,211	4.53%

Exhibit 6
Tennessee Econometric Model
Forecasted Growth Rates
Selected Tennessee Indicators

	1995 Q1	1995 Q2	1995 Q3	1995 Q4	1995 Annual	1996 Q1	1996 Q2	1996 Q3	1996 Q4	1996 Annual
TN Personal Income (Millions $)	9.45	5.96	6.95	7.35	7.22	7.77	5.87	5.38	6.19	6.77
TN Personal Income (Millions 87$)	5.71	3.36	3.12	3.60	3.59	4.11	2.00	1.26	2.28	2.97
TN GSP (Millions $)					6.76					6.79
TN GSP (Millions 87$)					3.42					3.18
US Personal Consumption Deflator (1987 = 100)	3.53	3.48	3.71	3.61	3.50	3.51	3.79	4.07	3.83	3.70
TN Unemployment Rate[1]	5.0	5.0	4.9	4.8	4.9	4.9	4.8	4.8	4.7	4.8
TN Nonagricultural Jobs (Thousands)	2.92	2.70	3.09	3.03	2.75	1.50	2.83	2.29	2.62	2.48
TN Manufacturing Jobs (Thousands)	1.12	0.75	0.69	1.37	0.87	0.73	0.91	0.32	1.19	0.86
TN Taxable Sales (Millions $)	9.63	4.99	7.62	5.09	8.17	9.38	5.78	6.99	5.24	6.84
TN Taxable Sales (Millions 87$)	5.89	1.45	3.77	1.43	4.53	5.67	1.92	2.81	1.36	3.03

APPENDIX 1
Personal Income Definition[18]

Personal income is a measure of income received by individuals, unincorporated businesses, and non–profit organizations. While it is an important measure of economic activity, personal income is not a complete measure of the money income of individuals. The Bureau of Economic Analysis (BEA), U.S. Department of Commerce, defines persons as "...individuals, nonprofit institutions, private noninsured welfare funds, and private trust funds...." In addition, the BEA includes other types of income as personal income:

> Proprietors' income is treated in its entirety as received by individuals. Life insurance carriers and private noninsured pension funds are not counted as persons, but their saving is credited to persons.

The published components of personal income are derived from the U.S. National Income Accounting System. It includes the following measures:

1. Wage and salary disbursements (broken down into a broad classification of industries and by government);
2. Other labor income, including employer contributions for private insurance and retirement programs;
3. Proprietors' income, which consists of net income of sole proprietorships and non–incorporated businesses;
4. Net rental income, personal interest income, dividends, and royalties; and
5. Transfer payments by businesses and government (Social Security and other benefits), corporate gifts to non–profit institutions, and other payments not resulting from current services or production.

Some types of nonmonetary income are included in these categories, such as the rental value of owner–occupied homes and the value of food produced and consumed on farms. In addition, personal interest income includes the imputed value of interest earned on accounts to which no interest actually accrues, i.e., checking accounts.

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[18] Definition and component explanation adapted from National Income and Product Accounts (NIPA) of the United States, 1929-1974, U.S. Department of Commerce, Bureau of Economic Analysis, Washington, D.C.: Government Printing Office. Adapted from "An Analysis of the Forecast from *An Economic Report to the Governor*, 1990."

APPENDIX 2

The WEFA and Tennessee Econometric Models[19]

The WEFA Econometric Model is a complex mathematical simulation of the national economy, and is designed to produce both short–term and long–term forecasts for the U.S. economy. It contains over 10,000 variables. The WEFA mode is actually two models: the U.S. Quarterly Industrial Production Model, and the Mark 10, a core macroeconomic model. The industrial model covers industrial activity for 125 manufacturing, mining, and utilities sectors. The industry model's results are dependent on, but do not affect the outcome of the Mark 10 model. The Mark 10 model is a Keynesian model, and is designed to reflect short–run behavior as well as relatively stable long–term characteristics of the U.S. economy. The Mark 10 model is divided into six categories: final demand, which is employment and population; income; finance and government; wages and prices; and production. CBER economists utilize the Mark 10 model for their forecasts.

The Tennessee Econometric Model (TEM) is a mathematical simulation of the Tennessee economy. It is an extremely complex model and contains over two hundred equations. The TEM produces both quarterly short–term and annual long–term forecasts. The annual forecast attempts to predict long–term trends in seven broad categories: Gross State Product (GSP); employment; wages; personal income; retail sales; energy; and agriculture. The quarterly forecasts are more detailed in nature and attempt to predict short–term changes over the business cycle.

CBER economists first generate a quarterly forecast for the state over a 10–year period, using historic and forecast data generated by the WEFA model. Then, they generate the annual forecast for the state, and use as input the Tennessee quarterly forecast and national data from the WEFA model. Because WEFA's forecast data is used as input into the TEM, the forecast for the state of Tennessee depends on the reasonableness of the forecasts generated by the WEFA Econometric Model. Both models tend to lose accuracy during business cycle turning points.

Both models incorporate personal (or user) judgement when generating their respective forecasts. Personal judgement is often necessary because not every facet or aspect of the U.S. and Tennessee economies can be quantified and incorporated into a mathematical model. The practice of using user judgement is quite common and most economists believe that personal judgement can increase the accuracy of a forecast

[19] Information about both econometric models was obtained from The Center for Business and Economic Research, U.T. Knoxville, and from the WEFA Group, *Mark 10 Model Reference*, July 1992.

APPENDIX 3

Regression Analysis[20]

Regression analysis is a widely used statistical method that provides an estimate of how closely two or more variables are related. The results of a regression analysis include a summary statistic known as an r^2 (pronounced R–squared), commonly referred to as the "coefficient of determination." In multivariate analysis, the capitalized R^2 denotes the "coefficient of multiple determination," indicating the degree of concurrent association between several variables and a dependent variable. Mathematically, an r^2 represents the square of the correlation coefficient. The r^2 statistic ranges between zero (0) and one (1), with one (1) indicating a perfect fit and zero (0) indicating no correlation. The r^2 statistic is generally interpreted as the amount of variance or change in a variable that can be accounted for by changes in the explanatory variable or variables. In this report, regression analysis is used to identify how much of the variance in the indicators of actual economic performance can be accounted for by the corresponding forecasts of those same indicators. Adjusted r^2s are reported to compensate for the relatively small number of observations upon which these analyses are based. In short, regression analysis provides an overall estimate of how well a particular forecast fits with actual economic performance.

Based on the laws of probability, one can also calculate how likely the observed relationship, as measured by the r^2, could have occurred by chance. In most professional studies dealing with social, political or economic phenomena, the minimum confidence interval for accepting a coefficient is 95 percent. Put differently, a statistic of association (r^2) is deemed acceptable if the probability that it could have occurred by chance is less than 0.05. Physical sciences often employ stricter standards for accepting a finding, requiring a level of significance with a probability of less than 0.01, 0.001 or lower. The 0.05 standard is employed in this report according to the professional conventions in the social sciences. All reported r^2s have met the conventional standard of 0.05. Most of these regression coefficients also meet the stricter 0.01 or 0.001 standards (right–tailed test of significance for t).

Reported estimates of actual economic performance are continually revised for ten years or more. For these reasons, the regression statistics reported this year will differ from future reports which will include additional years as well as revised estimates of economic performance for the many of the same observations examined in this year's report.

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[20] This description draws heavily from Larry D. Schroeder, David L. Sjoquist and Paula E. Stephan. *Understanding Regression Analysis: An Introductory Guide.* (Beverly Hills: Sage Publications), 1986.