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Accuracy and rationality of state General Fund Revenue forecasts: Evidence from panel data

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Abstract

Using a new panel data set, this paper employs a random effects model to investigate the determinants of General Fund Revenue forecast errors of state Legislative Fiscal offices. Employing exclusively judgmental methods increases the forecast error. The use of cross-sectional data, in addition to time-series, increases the accuracy. The forecast error is not influenced by the existence of a dominant political party or the existence of another official forecast. If the forecasts are obtained less frequently than monthly or bi-monthly, forecast errors become smaller. Grants from federal government have a small worsening effect. If the predictions of the national (state) economic trends that are used in forecasting are obtained from the state government, forecasts become less (more) accurate. The forecasts are free of systematic under or over-prediction, but they can be improved by using available information more efficiently.

Keywords: Revenue forecasting; Random effects; Rationality

1. Introduction

State governments play an important role in the United States public finance system. In 1993, the total General Fund Revenue collected by the 50 states of the United States was $317.1 billion, with a median of $3.6 billion.[1] The magnitude of the state budgets, coupled with the balanced budget requirements that apply to a majority of state governments, underline the importance of obtaining accurate revenue forecasts. An over-prediction of the revenues can generate serious political difficulties because it may force the initiation of cuts in previously budgeted public services and generate undesirable tax increases. An underprediction of the revenues can also create problems because it causes underfunding of public services and suggests that tax rates are artificially high. Feenberg et al. (1989) reported that

...[The present and former state budget officials] stated that unexpected surpluses are just as bad as deficits from their point of view. When there is an unexpected surplus, much of the extra

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[1] The General Fund Revenue constitutes approximately 85% of revenues from all sources.

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revenue goes to localities. While the localities are happy to receive the new money, they are irked that they have to re-do their planning, and resent the fact that they were not given correct figure at the outset. Budget officials also emphasized the fact that the newspapers point out forecast errors very aggressively, whether they are negative or positive (Feenberg et al., 1989, p. 301).

Shkurti and Winefordner (1989) analyzed the revenue forecasting process and the political consequences of forecast errors in the state of Ohio. They underline the belief that the governor, John Gilligan's, handling of an unexpected budget surplus in 1974 contributed to his defeat by Republican James A. Rhodes. Eight years later, when Democrat Richard F. Celeste was elected governor, believing that rosy revenue forecasts had contributed to the debilitating budget crises that had plagued his predecessor, he instructed his budget planners to be conservative in their revenue and spending estimates for the remainder of the 1983 Fiscal Year (Shkurti and Winefordner, 1989, p.364). These arguments indicate that it is in the best interest of the policy makers to obtain the most accurate revenue forecast possible.

Some recent studies investigate the determinants of forecast errors in state government revenue forecasts. Bretschneider et al. (1989) analyzed three surveys of state governments and found that forecast accuracy increases when there are independent forecasts from competing agencies, and decreases when outside expert advisors are used and when there is a dominant political party or ideology in the state. Interestingly, they also found that the accuracy of forecasts increases when simple regression models and judgmental methods are used as opposed to univariate time-series methods or econometric models. Cassidy et al. (1989) examined the data from 23 states for the period 1978 to 1987. They found that the forecast errors in economic variables, such as the state's personal income, generate increases in the forecast error in the general fund budget, but that there is no link between political and institutional factors and the revenue forecast accuracy. Bretschneider and Gorr (1992) analyzed the determinants of the errors in predicting the sales tax revenues. They reported interactions between economic uncertainty, political environment and bias in forecasting.

In this paper, we use a new longitudinal data set compiled through the National Conference of State Legislatures. Using random effects models, we analyze the determinants of the accuracy of the general fund revenue forecast of 20 state legislative fiscal offices over seven years. We also investigate whether the forecasts are rational (efficient); that is to say, whether all the available information is utilized by the forecasters and whether the forecasters make systematic errors.

The next section describes the data used in the study. The section on Empirical Analysis presents the results of the analysis of the forecast accuracy. The following section describes the methodology of the rationality analysis and reports the corresponding results. The last section is the conclusion.

2. Data

Previous studies on the analysis and evaluation of the forecasting process and forecast accuracy used data obtained from the executive branch of the state governments. In this study we analyze data obtained from State Legislative Offices to investigate the accuracy and rationality of their General Fund forecasts. The General Fund is the largest source of appropriations in all states, financing most state-run or state-subsidized activities, such as education, welfare, environmental protection and general operations (Cassidy et al., 1989). The fiscal year for most states runs from July 1 through June 30. Generally, the Legislative Office prepares its forecast for submission to the General Assembly during December, and the budget deliberations begin in January, utilizing the forecast of the Legislative Office along with the executive branch's forecast.

To obtain data on the details of the Legislative Branch's forecasts, a questionnaire was mailed through the National Conference of State Legislatures (NCSL) to the Fiscal Analysis Offices of all 50 member states as well as Washington D.C. and Puerto Rico. After follow-up phone calls, 38 states replied. Almost half of the states' legislative branches do not perform general fund revenue forecasting. Instead, they monitor and review the forecasts provided by various sources, such as the Department of Finance and Taxation, Comptroller's Office, the Governor's Office, the Joint State-House Revenue Projection Commitee, or a Consensus Group. These states could not be included in the study.[2] The legislative offices of 20 states obtain General Fund Revenue forecasts. These states, which are included in the study, are Alabama, Arizona, Colorado, Connecticut, Florida, Illinois, Indiana, Iowa, Louisiana, Maryland, Michigan, Mississippi, Missouri, Nebraska, North Carolina, Pennsylvania, Rhode Island, South Dakota, Vermont and Wisconsin. The survey included questions regarding the way in which the forecasts of the General Fund revenue are obtained. More precisely, information about forecast frequency, agents that are involved in the process other than the legislative office, various data sources and types, and estimation techniques that are used by the legislative office for the fiscal years 1985–1992 are obtained. Also acquired is the magnitude of the final forecast and the actual realization of the general fund revenues for the same period. Some states failed to report their forecast values for earlier years. This was generally the case when the financial officer who filled out the questionnaire was hired after 1985, which was the first year covered by the survey. Thus he/she was not knowledgeable about the details of the process before his/her time. Therefore, we used the final general fund revenue forecasts obtained from NCSL, which were obtained from various issues of State Budget Action, National Conference of State Legislatures, Fiscal Affairs Program; Denver. The values reported by the states on the questionnaire and the ones obtained from NCSL were extremely close to each other (the zero order correlation between the two was 0.994). The actual general fund revenues are also obtained from the same source.

[2] These states are Alaska, Arkansas, Delaware, Georgia, Idaho, Kansas, Maine, Minnesota, New Mexico, North Dakota, Oklahoma, Oregon, South Carolina, Tennessee, Texas, Virginia, Washington and West Virginia.

3. Empirical analysis

3.1. Measurement of the variables

The dependent variable (*FRCSTERR*) is the absolute percent forecast error of the general fund revenue forecasts of state legislatures, which is calculated as $|100 \times (ACTUAL - FORECAST)/ACTUAL|$, where *ACTUAL* is the actual general fund revenue collected by the state for that fiscal year and *FORECAST* is the predicted value. The forecast error can be a function of the quality of the data employed in the analysis, the methodology used, and the political environment surrounding the process. To capture the impact of the data quality we employed eight variables (which are *NFRLEGISL*, *NFRGOV*, *NFRCONSULT*, *NFROTHERS*, *SFRLEGISL*, *SFRGOV*, *SFRCONSULT* and *SFROTHERS*), that demonstrate the group who was responsible for forecasting the national (prefix *N*) and the state level (prefix *S*) economic trends. For example, *NFRLEGISL* is a dichotomous variable which takes the value 1 if the legislative staff was responsible for forecasting the national economic trends, and 0 otherwise. *NFRGOV*, *NFRCONSULT* and *NFROTHERS* are also dichotomous variables which take the value of 1 if the state government, outside consultants (including DRI, CHASE and WEFA), and others (including economic advisory groups) were responsible for forecasting the national economic trends, respectively. Similarly, *SFRLEGISL*, *SFRGOV*, *SFRCONSULT* and *SFROTHERS* represent the groups that were responsible for predicting the state economic trends. Note that these categories are not mutually exclusive, and it is possible (in fact common) to have the economic trend forecasts obtained by more than more group in a given year for a given state.

An objective and rigorous analysis of the data using statistical methods should increase forecasting accuracy. However, it may be argued that econometric and time-series models may not produce precise predictions in the event of structural changes, unless the predictions are modified by those who have insights into the dynamics of the state economy. Because of this, some states rely heavily on the advice of "old hands" who have a good sense of what is really going on in the state (Feenberg et al., 1989, p.302). There is also evidence in the literature indicating the forecast error reducing effect of the judgmental methods (e.g. Armstrong, 1983; Bretschneider et al., 1989). Our data set enables us to investigate the relationship between the judgmental forecasts and forecast accuracy directly. The legislative financial officer is asked whether qualitative (judgmental), quantitative, or combination of qualitative and quantitative forecasting methods were used. We employ the variable *JUDGMENTAL*, which takes the value of 1 if judgmental methods were used exclusively, and 0 otherwise. To analyze the impact of using quantitative techniques further, we included another variable, *CROSSDATA*, which is 1 if the forecasting process employed cross-section data and 0 otherwise. All of the respondents indicated that they used time-series data in all years. Thus, the use of cross-section data in forecasting the General Fund Revenue is an indication of the additional emphasis put on the use on quantitative techniques.

Bretschneider and Gorr (1987) and Bretschneider et al. (1989) found that if both the executive and legislative branches participate in the forecasting process, this reduces the forecast error. To capture the impact of this institutional structure, a dummy variable, *LEGISPLUS*, is included which is equal to 1 if the executive branch and/or a consensus group also produces a forecast in addition to the Legislative Branch's forecast, and 0 if the legislative branch's forecast is the only one supplied to the General Assembly for budget deliberations.

Shkurti and Winefordner (1989) emphasized the need for the investigation of the relationship between the frequency of the forecast revisions and the accuracy. They mentioned the case where frequent revision of the forecasts produced a forecast error because of the misinterpretation of few additional monthly observations as a trend. Three dummy variables are included to capture the impact of forecast frequency on accuracy. *ANNUAL*, *BIANNUAL*, and *QUARTERLY* are variables that take the value of 1 if the General Fund revenue forecast is performed once a year, twice a year, and four times a year, respectively. The omitted category is the group with more frequent forecast, such as monthly and bi-monthly.

The structure surrounding the forecasting process may be a function of the difficulty of predicting the General Fund revenue. More precisely, certain characteristics of the state which may influence the precision of the forecasts can also determine the attributes of the forecasting environment, such as the choice of judgmental versus quantitative methods, the frequency of the forecasts, the existence of a consensus group, and others. Failure to control for these characteristics may generate biased parameter estimates because the disturbance term, which will embody the state characteristics, would be correlated with the explanatory variables. To minimize the risk of this type of a bias we gathered seven additional variables representing state characteristics. For example, some states are allowed to carry their deficit to the next fiscal year, while some others are required to finish the year with a balanced budget. The possible impact of this difference is captured by a dummy variable *NODEFCARRY*, which takes the value of 1 if the state is not allowed to carry its deficit to the next fiscal year, and 0 otherwise. Partisan politics may also influence the forecasts. Cassidy et al. (1989) could not find evidence that partisanship affects federal economic forecasts. Bretschneider et al. (1989), on the other hand, found evidence which indicates that states with a dominant political party or ideology will create less accurate forecasts. We include a dummy variable *MAJORITY*, which takes the value of 1 if the majority of the house, the majority of the Senate and the governor belong to the same political party, and 0 otherwise. *GRANTPERPOP* is the ratio of federal grants received by the state divided by state population. *URATE* is the unemployment rate of the state. *EMPLOYMENT* stands for the non-agricultural employment of the state, and *INCOME* is state per capita income. These last three variables aim to gauge the composition and the activity of the state economy. *STAFFPERPOP* is the number of professional staff members employed at the state Legislative Offices per 1,000 people. This variable should be positively related to level of complexity of state economy and to the difficulty of forecasting the General Fund revenue. These data are obtained from various issues of The Book of the States, National Conference of State Legislatures; Denver, and the Statistical Abstract of the United States.

3.2. Descriptive statistics

Table 1 presents the variables, their definitions and the sample means and standard deviations. The mean percent error (not reported in Table 1) is −0.58 with a standard deviation of 7.58. The mean value of the absolute percent error, which is the dependent variable, is 4.49, with a standard deviation of 6.12. Note that 16% of the sample use strictly judgmental (qualitative) forecasts.[3] The majority of the sample obtains forecasts on a quarterly basis, followed by bi-annual and annual forecasts. In 55% of the sample, the executive branch and/or a consensus group is responsible to generate an official General Fund revenue forecast in addition to the Legislative Branch ($LEGISPLUS = 0.55$). In 36% of the sample, the majority of the House and the Senate belong to the same party as the governor of the state and in 65% of the sample, the states are not able to carry their deficits into the next fiscal year.

Both the Legislative Office and the Executive Branch are involved more heavily in the prediction of the state economic trends as opposed to national trends. For example, in 48% of the sample the Legislative Office is involved in forecasting the national economic trends ($NFRLEGISL = 0.48$), whereas its involvement in forecasting the state economic trends is 63%. Similarly, the Executive Branch provides projections for national trends in 15% of the sample ($NFRGOV = 0.15$), whereas in 19% of the sample it provides projections for state economic trends. About half of the sample use outside consultants (which includes DRI, CHASE and WEFA) to predict the national economic trends, but only 38% employ outside consultants to predict state economic trends. Others, such as the economic advisory groups, are being employed three times more frequently to provide predictions about the state economic trends than national trends (the mean of *SFROTHER* is 0.38, whereas the mean of *NFROTHER* is 0.12).

[3] Note that "sample" refers to the 140 observations which are obtained from 20 states over seven years. Thus, 16% of the sample, for example, does not imply 16% of the states since a variable's value may change in a given state over the span of the analysis.

3.3. Estimation methodology and the results

The empirical analysis is carried out using the following model.

$$Y_{it} = \alpha + \Sigma\beta_j X_{jit} + u_i + \epsilon_{it}\,, \qquad (1)$$

where Y_{it} represents the absolute percent forecast error for state i in year t, X_{jit} is the value of the jth explanatory variable for state i in year t, and α and β_j are the coefficients. ϵ_{it} is an iid error term with usual properties and u_i captures state-specific unobservables. u_i is also assumed iid with mean 0 and variance σ_u^2.

Recent studies which employed panel data to investigate the determinants of the biases in state governments' revenue forecasts used ordinary least squares (OLS) to estimate the models (e.g. Bretschneider et al., 1989; Cassidy et al., 1989). Strictly speaking, OLS is not an appropriate method in the presence of across-state variations. More precisely, pooling all the observations and estimating the model using OLS may yield biased and inconsistent estimates if there are differing structures across states represented by u_i in Eq. (1) above.

The heterogeneity due to state specific unobservables can be controlled for by using standard longitudinal methods. An easy way is to use

Table 1
Descriptive statistics

Variable	Obs.	Definition	Mean	Std. Dev.
FRCSTERR	138	Absolute percent forecast error.	4.490	6.117
NFRLEGISL	121	Dichotomous variable (=1) if the legislative staff is responsible for forecasting national economic trends, (=0) otherwise.	0.479	0.502
NFRGOV	121	Dichotomous variable (=1) if the state government is responsible for forecasting national economic trends, (=0) otherwise.	0.149	0.357
NFRCONSULT	121	Dichotomous variable (=1) if outside consultants (including DRI, CHASE and WEFA) are responsible for forecasting national economic trends, (=0) otherwise.	0.521	0.502
NFROTHER	121	Dichotomous variable (=1) if other groups are responsible for forecasting national economic trends, (=0) otherwise.	0.124	0.331
SFRLEGISL	128	Dichotomous variable (=1) if the legislative staff is responsible for forecasting state economic trends, (=0) otherwise.	0.633	0.484
SFRGOV	128	Dichotomous variable (=1) if the state government is responsible for forecasting state economic trends, (=0) otherwise.	0.195	0.398
SFRCONSULT	128	Dichotomous variable (=1) if outside consultants (including DRI, CHASE and WEFA) are responsible for forecasting state economic trends, (=0) otherwise.	0.383	0.488
SFROTHER	128	Dichotomous variable (=1) if other groups are responsible for forecasting state economic trends, (=0) otherwise.	0.281	0.451
CROSSDATA	127	Dichotomous variable (=1) if cross-sectional data are used in General Fund revenue forecasting in addition to time-series data, (=0) otherwise.	0.126	0.333
JUDGMENTAL	127	Dichotomous variable (=1) if only judgmental (qualitative) methods are used in General Fund revenue forecasting, (=0) otherwise.	0.165	0.373
QUARTERLY	140	Dichotomous variable (=1) if the General Fund revenue is obtained quarterly, (=0) otherwise.	0.464	0.501
ANNUAL	140	Dichotomous variable (=1) if the General Fund revenue is obtained annually, (=0) otherwise.	0.150	0.358
BIANNUAL	140	Dichotomous variable (=1) if the General Fund revenue is obtained bi-annually, (=0) otherwise.	0.329	0.471
LEGISPLUS	140	Dichotomous variable (=) if n addition to the Legislative Office, The Executive Branch and/or a consensus group is also responsible for obtaining General Fund revenue forecasts, (=0) otherwise.	0.550	0.499
MAJORITY	131	Dichotomous variable (=1) if the Majority of the House, the majority of the Senate and the Governor belong to the same political party, (=0) otherwise.	0.359	0.482
NODEFCARRY	140	Dichotomous variable (=1) if the state can not carry the deficit over to the next fiscal year, (=0) otherwise.	0.650	0.479
URATE	140	State unemployment rate.	5.901	1.920
STAFFPERPOP	140	Legislative Staff per 1,000 population.	0.096	0.041
INCOME	140	State per capita nominal income.	16490.886	3028.180
EMPLOYMENT	140	State nonagricultural employment.	2114.874	1516.296
GRANTPERPOP	140	Per capita grants the state receives from the Federal Government.	466.904	136.140

a fixed effects model, which can be implemented by including state dummies in the regression equation. If this is impractical (due to a large number of states but relatively small number of time periods), an equivalent way of controlling the fixed effects is to apply the transformation in which the time-means of the variables are subtracted out from the original ones for every state. In our case, this procedure is not feasible either because many variables do not exhibit time variation, although they differ across states. Therefore, we employ a random effects model to investigate the determinants of forecast accuracy. The random effects model views the individual specific intercepts ($\alpha + u_i$) as randomly distributed across the states (see Greene, 1990, pp.480–495; Hsiao, 1992).

The results are reported in Table 2. The dependent variable is the absolute percent forecast error. Thus, a negative coefficient indicates an increase in forecast accuracy. The coefficients of *ANNUAL, BIANNUAL* and *QUARTERLY* are negative and significant, demonstrating that if forecasts are obtained less frequently (once, twice or four times a year, instead of monthly or bi-monthly) this helps to decrease the forecast error. If the random effects model and the exogeneous variables do not adequately capture the unobservable state characteristics, which may include the difficulty of the forecasting process, and if the difficulty of forecasting is positively correlated with forecast frequency, the estimated coefficients of forecast frequency dummies may be biased downwards. On the other hand, given that we have three dummy variables for forecast frequency, (*ANNUAL, BIANNUAL,* and *QUARTERLY*) it is reasonable to expect a positive covariance between *QUARTERLY* and the unobserved forecast difficulty, especially if unobserved difficulty is linearly related to forecast frequency. This would generate a positive bias in the estimated coefficient of *QUARTERLY*. However, the estimated coefficient of *QUARTERLY* is negative, indicating that the omitted variable bias should not be a big concern.

Table 2
General fund forecast error regression

Explanatory variable	Coefficient	t-statistic	p-value
CONSTANT	16.600	1.606	0.112
ANNUAL	−20.751	−4.345	0.000
BIANNUAL	−7.659	−2.309	0.023
QUARTERLY	−8.485	−3.315	0.001
LEGISPLUS	−0.970	−1.107	0.271
MAJORITY	0.043	0.019	0.984
NODEFCARRY	−1.406	−0.842	0.402
NFRSTGOV	7.447	2.052	0.043
NFRLEGISL	−6.071	−0.911	0.365
NFRCONSULT	1.302	0.364	0.717
NFROTHERS	−2.696	−0.626	0.533
SFRSTGOV	−4.621	−2.015	0.047
SFRLEGISL	5.621	1.017	0.312
SFRCONSULT	−2.266	−0.625	0.534
SFROTHERS	0.449	0.212	0.833
JUDGMENTAL	3.808	2.747	0.007
CROSSDATA	−7.605	−1.730	0.087
GRANTPERPOP	0.026	2.518	0.014
URATE	−0.331	−0.576	0.566
EMPLOYMENT	0.0003	0.745	0.458
INCOME	−0.001	−1.279	0.214
STAFFPERPOP	−30.796	−1.251	0.214
F	320.587		
Adjusted R^2	0.984		
N	107		

Note: The dependent variable is the absolute percent forecast error,

$$|100 \times (ACTUAL - FORECAST)/ACTUAL|$$

The forecast error is not influenced by the relationship between House majority, Senate majority and the governor's party affiliation.[4] Similarly, the coefficient of *LEGISPLUS* is negative but not statistically significant, which indicates that the existence of at least one other official forecast, either from the executive branch or from a consensus group, has no appreciable influence on the forecast error. The ability of the state to carry the deficit over to the next fiscal year has no statistically significant impact on the forecast accuracy, but an increase in federal grants coming in to the state is associated with a reduction in forecast accuracy.

Another interesting result pertains to the use of national and state economic trend forecasts. *NFRLEGISL, SFRLEGISL, NFRCONSULT, SFRCONSULT, NFROTHERS* and *SFROTHERS* are not statistically different from 0. The insignificance of these variables may be due to possible collinearity among them. Further tests, however, revealed that they were not jointly significant either.[5] This means that the use

[4] The state of Nebraska is not included in this model because in Nebraska the members of the Senate and the House consist of independents.

[5] We tried various combinations, as well as using them as a group. In no combination was significance found.

of projections of the national and state economic trends, supplied by the legislative office, outside consultants or economic advisory groups, has no impact on the accuracy of the General Fund revenue forecasts. However, the coefficient of *NFRGOV* is positive and significant, and the coefficient of *SFRGOV* is negative and significant. This implies that if the predictions of the national economic trends that are used in General Fund revenue forecasting are obtained from the state government, the General Fund revenue forecast becomes less accurate, but if the governor's office supplies the predictions of state economic trends, the forecast error will be smaller. The indication is that the executive branch has a significant handicap (with respect to other data sources) in predicting the national economic indicators, but it has a comparative advantage in predicting the future of the state's economy.

Table 2 also reveals that the estimated coefficient of *JUDGMENTAL* is 3.81 with a t-ratio of 2.75, indicating that using exclusively judgmental methods increases the forecast error by 3.8 percentage points. On the other hand, the use of cross-section data reduces the absolute forecast error by almost eight percentage points. All states in all years indicated their use of time-series data, while only 16% of the sample declared the use of cross-section data in addition to time-series. While time-series data can be used for relatively simple procedures such as extrapolation and trend forecasting, cross-sectional data necessitates the use of econometric methods. Thus, the use of cross-section data is an indication of additional emphasis put on quantitative methods. These results underscore the importance of using quantitative methods in increasing the forecast accuracy, and stand in contrast to those reported by Bretschneider et al. (1989). Lastly, changes in unemployment rate, per capita income and per capita staff members have no impact on prediction error.[6]

[6] We also estimated the model running OLS on pooled data. The signs of the coefficients were identical to the ones reported in Table 2, and the magnitudes were also similar. However, in OLS only *QUARTERLY, ANNUAL* and *GRANTPERPOP* were statistically significant.

4. Tests of rationality

The previous section demonstrated the ways in which the errors in state General Fund forecasts can be reduced. In this section we analyze the rationality of the forecasts. Let R_t stand for the actual revenue at time t and ${}_tR^*_{t-1}$ be the forecast of R_t formed at time $t-1$, based on the information set I_{t-1} that is available to the forecaster at time $t-1$. A test for *weak rationality* can be performed by estimating the regression

$$R_t = \alpha + \beta_t R^*_{t-1} + \epsilon_t\,, \tag{2}$$

and testing the null hypothesis H_0:$(\alpha, \beta) = (0, 1)$, where ϵ_t is the white noise error term with usual properties. If H_0 cannot be rejected, this implies that $E[R_t - {}_tR^*_{t-1}] = E[\epsilon_t] = 0$. In other words, the failure to reject the null hypothesis of weak rationality implies that the expected value of the forecast error is 0; i.e. the forecaster does not make systematic errors, and predicts the correct revenue on the average. Thus the test for weak rationality is also a test for unbiasedness.

Consider Eqs. (3) and (4) below.

$$R_t = \gamma_0 + \gamma_1 X_{1,t-1} + \gamma_2 X_{2,t-1} + \ldots + \gamma_k X_{k,t-1} + u_t\,, \tag{3}$$

$${}_tR^*_{t-1} = \lambda_0 + \lambda_1 X_{1,t-1} + \lambda_2 X_{2,t-1} + \ldots + \lambda_k X_{k,t-1} + v_t\,. \tag{4}$$

Eqs. (3) and (4) relate the actual revenue and its forecast to $X_{1,t-1},\ldots,X_{k,t-1}$, which are the variables in the information set I_{t-1}. A test for rationality can be performed by investigating whether the forecast and the actual realization of the revenue are governed by the same regression relationship; i.e. whether $\gamma_i = \lambda_i$ for all i. Note that subtracting (4) from (3) yields

$$R_t - {}_tR^*_{t-1} = \delta_0 + \delta_1 X_{1,t-1} + \delta_2 X_{2,t-1} + \ldots + \delta_k X_{k,t-1} + e_t\,, \tag{5}$$

where $\delta_i = \gamma_i - \lambda_i$, and $e_t = u_t - v_t$.

Thus, a rationality test can also be performed by testing the null hypothesis H_0:$(\delta_0, \delta_1, \delta_2, \ldots, \delta_k) = (0, 0, 0, \ldots, 0)$ in Eq. (5). This procedure, which was employed by

Mullineax (1978), Friedman (1980), Brown and Maital (1981), Feenberg et al. (1989) and Gentry (1989), is called a strong rationality test. Failure to reject the null hypothesis gives support to strong rationality and implies that all information is being utilized efficiently to create forecasts.

We estimated Eq. (2) using the actual General Fund revenue as the dependent variable, and the forecast of the General Fund revenue (*FORECAST*) as the independent variable. The result is reported in Table 3. The estimated constant is 74.016 and statistically not different from 0. The coefficient of *FORECAST* is 0.987 and we cannot reject the hypothesis that it is equal to 1. The joint hypothesis of the constant being 0 and the coefficient of *FORECAST* being 1 could not be rejected either. Thus, we could not reject the hypothesis that the Legislative forecasts of the State General Fund Revenues were weakly rational. This implies the absence of systematic errors and indicates that the forecasts hit the actual values on the average.

The execution of the strong rationality test requires the knowledge about the variables in the information set I_{t-1}. As Feenberg et al. (1989) pointed out, it is not clear how to answer the question "What did the forecasters know at the time of the forecast?" We assume that the explanatory variables of Table 2 are known to the forecaster; i.e. they are in the information set I_{t-1}. In addition, following Feenberg et al. (1989) and Gentry (1989) we include state population, the national inflation rate (obtained from the Statistical Abstract of the United States), and the previous year's General Fund revenue. As was the case in previous studies cited above, we entered the variables with one lag, based on the presumption that the forecasters have reliable information on the variables at the time of the forecasts. Reliable personal income data are generally not available until after the completion of the budget process. Therefore, income is entered with two lags. We also used income with one lag. The results did not change in any meaningful way. To be comparable to earlier studies, we report the results with two-lag specification.

The results are reported in Table 4. The

Table 4
Strong rationality test

Explanatory variable	Coefficient	t-statistic	p-value
$CONSTANT$	−1419.622	−1.074	0.286
$ANNUAL_{-1}$	−516.104	−0.923	0.359
$BIANNUAL_{-1}$	347.889	0.761	0.450
$QUARTERLY_{-1}$	836.717	2.409	0.019
$LEGISPLUS_{-1}$	−483.467	−2.299	0.025
$MAJORITY_{-1}$	−240.367	−1.046	0.299
$NODEFCARRY_{-1}$	−930.368	−4.216	0.000
$NFRSTGOV_{-1}$	3022.033	3.864	0.000
$NFRLEGISL_{-1}$	65.584	0.073	0.942
$NFRCONSULT_{-1}$	1074.162	1.239	0.220
$NFROTHERS_{-1}$	2360.266	3.071	0.003
$SFRSTGOV_{-1}$	−1348.966	−3.128	0.003
$SFRLEGISL_{-1}$	803.178	1.172	0.245
$SFRCONSULT_{-1}$	−637.807	−0.861	0.392
$SFROTHERS_{-1}$	−1213.821	−3.119	0.003
$JUDGMENTAL_{-1}$	618.815	2.361	0.021
$CROSSDATA_{-1}$	−1585.976	−2.933	0.005
$GRANTPERPOP_{-1}$	3.114	2.335	0.023
$URATE_{-1}$	−63.927	−0.875	0.385
$EMPLOYMENT_{-1}$	2.211	1.647	0.104
$STAFFPERPOP_{-1}$	5227.353	1.439	0.155
$POPULATION_{-1}$	−0.225	−0.440	0.661
$INCOME_{-2}$	−0.031	−0.603	9.548
$INFLATION_{-1}$	−10.049	−0.119	0.906
$ACTUAL_{-1}$	−0.788	−4.921	0.000
F	24.455		
Adjusted R^2	0.862		
N	91		

Note: The dependent variable is the forecast error (*ACTUAL* − *FORECAST*).

Table 3
Weak rationality test

Variable	Coefficient	t-statistic	p-value
$CONSTANT$	74.016	1.430	0.155
$FORECAST$	0.987	107.983	0.000
Mean (standard error) of dependent variable = 6012.48 (4411.77)			
$R^2 = 0.99$	$n = 138$	$p(\alpha = 0, \beta = 1) = 0.312$	

Note: The dependent variable is the General Fund Revenue.

hypothesis of $H_0:(\delta_0, \delta_1, \delta_2, \ldots, \delta_k) = (0, 0, 0, \ldots, 0)$ is strongly rejected with a p-value 0.00.[7] This implies that there is information in the explanatory variables which can be extracted to alter the forecast error. Table 4 reveals that the coefficient of *ACTUAL* is negative and significant, which implies that an increase in actual General Fund revenue collected by the states brings about an optimistic forecast for the following year. Similarly, the involvement of other agencies in the forecasting process (*LEGISPLUS* = 1) generates an increase in the forecast. An increase in the federal grants coming in to the state motivates the forecast to be more conservative, signified by the positive and significant coefficient of *GRANTPERPOP*. The use of cross-sectional data and the inability of covering the deficit with the budget of the succeeding fiscal year yield optimistic forecasts. We also note that the data sources contain information that is not being incorporated into the forecasts. More precisely, if the legislative office is using national economic trends that are being predicted by either the governor's office or economic advisory groups, General Fund forecasts tend to be conservative. On the other hand, if the same groups provide projections for state economic trends (*SFRGOV*, *SFROTHERS*), the legislative office's General Fund forecast has an overprediction tendency.

Feenberg et al. (1989) employed the framework described above to test the rationality of revenue and grant forecasts for New Jersey, Massachusetts and Maryland using time-series data from late 1940s to 1987. They provided strong evidence rejecting the rationality of both short- and long-term forecasts. Gentry (1989) investigated the rationality of the forecasts for individual taxes for the state of New Jersey using time-series data. With few exceptions, he also rejected the rationality of the forecasts and reported a downward bias in forecasts. Instead of using the levels, these studies employed the percent changes of the variables to test the rationality hypotheses. We also performed the test using percent changes. In this specification the dependent variable is the difference between actual percent change in General Fund revenue and the predicted percent change from one year to the next; i.e. $[(R_t - R_{t-1})/R_{t-1}] - [(tR^*_{t-1} - R_{t-1})/R_{t-1}]$. All explanatory variables are entered in percent change form, except for dichotomous variables. Again, the results did not support the strong rationality assumption. The hypothesis that the coefficients are jointly 0 is rejected easily.

[7] Exclusion of the intercept did not have any impact on the results.

5. Conclusion

Using a new panel data set that covers the years 1986–1992, this paper investigates the determinants of forecast errors in state General Fund Revenue forecasts of 20 state Legislative Fiscal offices. To control for unobservable state characteristics, we estimate a random effects model. Clear-cut results emerge. If the states exclusively employ qualitative (judgmental) methods for forecasting, this increases the absolute forecast error by 3.8 percentage points. In 1993 the median General Fund revenue was \$3.6 billion. Therefore, in 1993 the benefit of using quantitative methods was to avoid a forecast error of \$137 million for the median state. The use of cross-sectional data reduces the forecast error by 7.6 percentage points. The indication is that using econometric models along with time-series techniques brings about a \$289 million reduction in forecast error for the median state in 1993. These results underscore the importance of employing quantitative techniques in forecasting the General Fund revenue.

If the forecasts are obtained once, twice, or four times a year, as opposed to monthly or bi-monthly, forecast accuracy increases. The accuracy of the forecasts also depends on the source which provides projections of the state and national economic trends. If the predictions of the national economic trends that are used in General Fund revenue forecasting are obtained from state government, the forecasts become less accurate. On the other hand, if the projections of state economy are obtained from the state government, General Fund revenue forecasts become more accurate. These results indicate that the state government has a comparative disadvantage in predicting national economic trends with respect to other data providers, but it provides better forecasts regarding the state's economy.

The existence of another official forecast, either from the executive branch or from a consensus group, and the dominance of a political party have no significant impact of forecast accuracy. An increase in federal grants coming in to the state generates a decrease in forecast precision.

We also investigate the rationality of the General Fund Revenue forecasts. The forecasts are called strongly rational if all available information is used efficiently to obtain the forecasts, and if the forecast error cannot be influenced by the information that was available at the time of the forecast. The forecasts are weakly rational if a subset of the information set is used efficiently, which implies that the projected value is equal to the actual value on the average. We find that the forecasts are weakly rational; i.e. they are free of systematic under- or over-prediction. However, they are not strongly rational, which implies that the forecasts can be improved by using the available information more efficiently.

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