TESTING THE RATIONALITY OF STATE REVENUE FORECASTS

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Abstract—Recent revenue shortfalls in several states focus attention on the question of whether states do a "good" job of forecasting revenues. In modern economics, forecasts are evaluated on the basis of whether or not they are "rational"—do the forecasts optimally incorporate all available information? This paper develops a method for testing the rationality of state revenue forecasts, and applies it to the analysis of data from New Jersey, Massachusetts, and Maryland. One of our main findings is that in all three states, the forecasts of own revenues are systematically biased *downward*.

I. Introduction

IN 1985, the 50 states raised $349 billion in revenues from their own sources, and received $84 billion in grants from the federal government. (U.S. Bureau of the Census (1987, p. 266).) State governments are clearly important players in the U.S. system of public finance, and the efficiency with which they conduct their financial affairs has an important impact on consumer welfare. One important determinant of a state's ability to conduct reasonable fiscal policies is the quality of its revenue forecasts. Sensible deliberations about expenditures cannot be made in the absence of "good" forecasts. Indeed, in the presence of constitutional or statutory provisions for balanced budgets, unanticipated changes in revenues can wreak havoc not only on proposals that are scheduled for funding, but on plans that have already been put into effect as well.

In recent months, two powerful governors, Michael Dukakis of Massachusetts and Mario Cuomo of New York, have suffered major political embarrassments because actual revenues fell substantially short of the predictions in their respective states. Such episodes focus attention on the question of whether states do a "good" job of forecasting revenues. In modern economics, forecasts are evaluated on the basis of whether or not they are "rational"—do the forecasts optimally incorporate all information that is available at the time they are made? Although there is a large literature on state revenue forecasting methods, that literature focuses mostly on state budgetary institutions. Forecasts themselves are evaluated only in an informal fashion.[1] Although the theory and econometric methods of rational expectations have been used to evaluate forecasts made by households and businesses,[2] these powerful tools have not been applied to state government forecasts. This paper applies these methods to the problem of state revenue forecasting, and as an example, uses them to analyze data from New Jersey, Massachusetts, and Maryland. The results cast light not only on the question of rationality *per se*, but on issues such as the impact of political factors on forecasts.

Section II presents the conceptual framework for testing rational expectations. The relevant institutional issues and data are described in section III. The results are discussed in section IV. We find that in all three states forecasts of own revenues are systematically biased *downward*. Section V concludes with a summary.

II. Basic Concepts

State revenue forecasters operate in an environment characterized by great uncertainty. Future revenues generated by a given revenue structure depend on future values of variables like employment, population, and nominal income, none of which is easy to predict. Additional uncertainty is

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[1] See, for example, Litterman and Supel (1983). Klay (1983) and Hyde and Jarocki (1983) discuss the various institutional arrangements for making revenue forecasts, summarize the techniques that have been used, and provide brief histories of state revenue forecasting.

[2] For some examples, see Bernheim (1987) on expected social security benefits, Zarnowitz (1985) on expected business conditions such as GNP and the inflation rate, Leonard (1982) on businesses' wage expectations, and Mankiw and Shapiro (1986) on the GNP predictions made by the Bureau of Economic Analysis. Lovell (1986) summarizes a number of other studies.

created since the state tax structure itself may be changed in the future. Such changes depend in part on the political climate in the state, another thing that is hard to predict.

Operating in such an environment, forecasters cannot be expected to obtain precisely correct answers. Rather, the most one can ask is that forecasters do as well as possible given the available information at the time of the forecast. To formalize this notion, let R_t be the actual percentage change in nominal revenues in period t, and R^e_{t-f} be the forecast of R_t made f periods ago.[3] I_{t-f} is the set of information available when the forecast is made. By definition, the conditional expectation of the forecast error, v_{t-f}, given this information set, is

$$v_{t-f} = E\left[\left(R_t - R^e_{t-f}\right)|I_{t-f}\right]. \quad (1)$$

Following Brown and Maital (1981), note that (1) implies the following regression equation:

$$\left(R_t - R^e_{t-f}\right) = v_{t-f}\left(I_{t-f}\right) + u_t, \quad (2)$$

where $E[u_t|I_{t-f}] = 0$.

The forecast R^e_{t-f} is said to be *strongly rational* if $R^e_{t-f} = E[R_t|I_{t-f}]$. From equation (2), this implies that $v_{t-f}(I_{t-f})$ is zero. Hence, suppose we estimate a regression of $(R_t - R^e_{t-f})$ on I_{t-f}. If the variables included in I_{t-f} are statistically significant, then we can reject the hypothesis of strong rationality. Intuitively, if predictions are strongly rational, then R^e_{t-f} should incorporate all relevant information available at the time the forecast is made. Therefore, the forecast error $(R_t - R^e_{t-f})$ should be uncorrelated with any of this information.

Suppose now that only a subset of I_{t-f} is utilized in making the prediction. If this subset is used efficiently, then the forecast is said to be *weakly rational*. That is, even if all information is not fully utilized, the forecaster gets the correct answer on average. Like strong rationality, weak rationality has a simple interpretation in a regression framework. Suppose we estimate

$$R_t = \alpha_0 + \alpha_1 R^e_{t-f} + u_t. \quad (3)$$

If R^e_{t-f} is weakly rational, then $\alpha_0 = 0$ and $\alpha_1 = 1$. Hence, a test of weak rationality requires only that we estimate (3) and use appropriate statistical methods to test that joint hypothesis.

There are conflicting views as to whether revenue predictions are unbiased, and if not, whether revenues are over- or underpredicted. Klay (1983, p. 308) argues that the forecasts are systematically too low: "Intentional underestimates are a means of coping with uncertainty by reducing the likelihood that program reductions will become necessary during the budget year..." Indeed, if a surplus "unexpectedly" surfaces during the budget year, this might enhance the popularity of the administration. Another possible motivation for underpredicting revenues is to conceal from legislators and special interest groups the resources that are available to them. Giovinazzo (1971, p. 103) quotes former New Jersey Governor Driscoll as saying, "What the Legislature can't find, it can't spend."

On the other hand, there are also arguments that forecasters have incentives to overestimate revenues. High revenue forecasts might help support efforts to borrow money to pay for operating expenses. One revenue estimator interviewed by Giovinazzo (1971, p. 19) indicated that he sometimes faced political pressures to overestimate revenues: "... occasionally friendly persuasion and reasoned discussion [were] brought to bear on him with the aim of convincing him to increase some of his estimates."

It is reasonable to ask whether over- *or* underpredicting revenues year after year is a viable strategy for fooling people. One would expect that eventually the forecasts would lose credibility. Indeed, it could also be argued that like their counterparts in the private sector, public sector officials have incentives to forecast rationally. The present and former state budget officials with whom we spoke claimed that they did their best to be on target. Interestingly, they stated that unexpected surpluses are just about as bad as deficits from their point of view. When there is an unexpected surplus, much of the extra 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 figures at the outset. Budget officials also emphasized the fact that the newspapers point out forecast errors very aggressively, whether they are negative or positive. This observation is consistent with press reports that in 1988,

[3] The analysis can just as well be conducted in terms of levels as percentage changes; we follow Zarnowitz (1985) and others in using percentage changes.

Governor Cuomo was "... annoyed that his budget aids had embarrassed him by underestimating revenue... in each of the three previous years, [and] ordered them this year not to be so conservative."[4] Taken together, these considerations suggest that forecasters have incentives to be rational in the technical sense defined above.

In short, there appears to be substantial disagreement regarding the likely outcome of estimating equation (3). Resolution of this disagreement requires analysis of the data.

III. Institutional Background and Data

A. The Budgetary Process

New Jersey: The last week of every January the Governor of New Jersey submits to the legislature a budget statement that includes forecasts of revenues and expenditures.[5] The forecast for each item is made over two time horizons. The first, which we call the *short forecast*, is for the fiscal year that began the previous July 1. The second, which we call the *long forecast*, is for the fiscal year beginning the subsequent July 1. Hence, the short forecast presented in January 1988 covers the period July 1, 1987 to June 30, 1988; the long forecast contained in that message is for July 1, 1988 to June 30, 1989.

In most states, forecasts are made by a budget division within the executive branch (Hyde and Jarocki (1983, p. 266)). The final responsibility lies with the governor, who reviews the forecasts, and can modify them before presentation. New Jersey is typical in these respects. The forecasting process begins in the October preceding the budget address, and a set of figures is produced by November. However, these figures are usually revised once or twice before the budget message goes to press in January.

Revenue forecasting methods differ widely across the states. Some states rely on econometric models, others on much more informal methods. In New Jersey, rather than use econometric models, forecasters employ a "judgmental approach" —they informally analyze past trends in different revenue sources, and rely heavily on the expertise of members of the various tax bureaus. Our conversations with budget officials indicated that attempts at econometric modeling generally led to disappointing results, and that it was better to rely on the advice of "old hands" who had a good sense of what was really going on in the state.

Massachusetts: The Massachusetts institutions are very similar to those of New Jersey. Revenue estimates are prepared each November, and forwarded to the Governor, who presents them during the last week of the following January. Formal econometric modeling plays a somewhat greater role than it does in New Jersey. Specifically, the bureau that prepares the forecasts receives econometric forecasts for Massachusetts generated by a consulting firm (Data Resources, Inc.), and then plugs these forecasts into a micro simulation model based on Massachusetts tax returns. However, all forecasts are subject to the judgment of "old hands," and some revenue sources are forecast without any formal modeling at all.

Maryland: Estimates of state revenues in Maryland are developed through a process that is similar to the processes of New Jersey and Massachusetts. However, the use of econometric forecasting techniques appears to be more prevalent in Maryland than in either New Jersey or Massachusetts. Regression models have been utilized in forecasting state revenues in Maryland since the early 1970s. The models tend to be quite simple—generally there are fewer than three explanatory variables for each revenue source, and estimation is by ordinary least squares. While revenue forecasting models are developed entirely in-house, budget officials depend significantly on outside econometric forecasting services for the information on which the models are based. Such services provide forecasts of various explanatory variables such as state personal income. As of 1987, econometric methods were applied to revenue sources that comprised 87.5% of Maryland tax revenues.

Of course, the unvarnished regression output is not included in the governor's message—quite a few modifications are made. Nevertheless, it will be of some interest to see whether the heavier reliance on econometrics leads to more accurate forecasts.

B. Data

New Jersey: The budgetary data are from the budget messages of February 1948 through Jan-

[4] *New York Times*, May 26, 1988, p. B1.
[5] Before 1973, the message was presented in mid-February.

uary 1987. For each revenue source, the budget contains the actual value for the fiscal year that ended the previous June 30, as well as the short and long forecasts for each revenue source. The actual percentage changes correspond to the R_t's of the previous section, and the forecasts are the R_t^e's.

State revenues are disaggregated very finely. In 1985 there were over 170 revenue sources, which included items such as hunters' license fees and shell fisheries leases. For many of these individual items, the time series are not very long—particular taxes and license fees come and go.[6] For this reason and for purposes of simplicity, we aggregated all revenues into two categories, revenues from own sources and revenues in the form of grants from the federal government. The distinction between own source revenues and grants has played an important role in both theoretical and econometric analysis of state and local government fiscal decisions (see Inman (1979)); it seems worthwhile to investigate whether the expectational mechanisms for the two revenue sources differ.

In addition to budgetary data, execution of the strong tests requires the variables in the information set. As usual in studies of this kind, it is not quite clear how to answer the question, "What did they know and when did they know it?" For the "what" part of the question, we assume that information on the percent changes in the following economic and demographic variables is relevant for predicting future revenues: nominal personal income, population, consumer price index, nonagricultural employment, and the lagged value of revenue itself. Except for lagged revenue, each variable is available on a calendar year basis.[7] This leads to a complication in answering the "when" part of the question. Given that the forecasts are made before the calendar year is entirely over, it is not clear whether variables dated that year should be included in the information set. On one hand, it could be argued that even though the official estimates for the year are not out by December, officials can monitor things closely enough to have a pretty good idea of what the values are. However, one could just as well argue that the actual values for these variables may be quite different from the officials' perceptions. Our conversations with budget officials indicated that except for income, it is reasonable to treat the variables as "known" by the time the forecasts are made. On the other hand, income data are available only with a lag; hence, only the lagged percentage change in income is assumed to be in the information set.

As noted in section II, revenue forecasts must take into account possible changes in tax structure that will be enacted. Hence, revenue forecasters must make political as well as economic forecasts. Variables that might help predict the political climate should therefore be included in the information set. For these purposes, we defined a series of dichotomous variables to indicate whether the party of the governor was the same as the majority in the legislature, whether the governor was a Republican, whether the budget message was presented in an election year, and whether the message was presented in the first year of a governor's administration.

Some summary statistics regarding forecast accuracy for New Jersey are presented in table 1a. The first row shows the average percentage change in each revenue source during the sample period. Own revenues grew at an annual rate of about 10% during our period, and grants from the federal government at about 14%. The relatively large standard deviations suggest that this growth was not smooth, however. The next three rows show several ways of summarizing the forecast errors for the various revenue sources. Row 2 has the mean forecast error. These figures suggest that there was a conservative bias in the forecasts. For example, on average, the actual year to year percentage increase in own revenues exceeded the forecast increase by 2.92 percentage points; for grants the forecast averaged 2.19 percentage points below actual growth. Of course, these figures are only suggestive; correct testing for the presence of bias requires the methods outlined in the previous section. The third row of table 1a shows the mean of the absolute value of the difference between the

[6] An important example is the state income tax, which has only been in existence since 1977.

[7] Data sources for New Jersey are as follows: Employment: Bureau of Labor Statistics, *Statistical Abstract of the United States*, various issues; Political Affiliations (for both governor and state legislators): Council of State Governments, *Book of the States*, various issues; CPI: *Economic Report of the President 1987*, table B-57; Population and Personal Income: Bureau of Economic Analysis, *State Personal Income: 1929–1982*, U.S. Government Printing Office, Washington, D.C., 1984, pp. 79–82, and updated with various issues of the *Statistical Abstract of the United States*.

TABLE 1A.—SUMMARY STATISTICS: NEW JERSEY

	Short Horizon		Long Horizon	
	(1) Own Revenues	(2) Grants	(3) Own Revenues	(4) Grants
1) R_t	0.103	0.141	0.227	0.287
	(0.0934)	(0.237)	(0.141)	(0.317)
2) $(R_t - R^e_{t-f})$	0.0292	0.0219	0.0697	0.0836
	(0.0342)	(0.109)	(0.0805)	(0.188)
3) $\|R_t - R^e_{t-f}\|$	0.0316	0.0863	0.0776	0.147
	(0.0318)	(0.0696)	(0.0728)	(0.142)
4) R.M.S.E.	0.0445	0.110	0.106	0.203
Trend in $\|R_t - R^e_{t-f}\|$:				
γ_0	0.0647[a]	0.0932	0.126	0.211
	(0.0208)	(0.0303)	(0.0311)	(0.0620)
γ_1	−0.00121[a]	−0.000248	−0.00176	−0.00230
	(0.000665)	(0.00100)	(0.00105)	(0.00210)

Notation: R_t = actual percentage change in nominal revenues
R^e_{t-f} = forecast of R_t made f periods ago
$(R_t - R^e_{t-f})$ = forecast error
$|R_t - R^e_{t-f}|$ = absolute value of forecast error
R.M.S.E. = root mean squared error of forecast.
For the "long horizon," R_t and R^e_{t-f} are calculated over a two-year period; the numbers are not annualized.
Numbers in parentheses are standard deviations (for means), or standard errors (for regression coefficients).
[a] Estimates obtained after quasi-differencing to correct for autocorrelation. (According to the Durbin-Watson statistic, this was not required for the other equations.)

actual percentage change and the predicted percentage change, and row 4 shows the root mean squared error. The general impression conveyed by the table is that own revenues are predicted better than grants.

Another interesting question about the forecasts is whether they have been improving over time. To investigate this issue, we estimated a series of regressions of the form $|R_t - R^e_{t-f}| = \gamma_0 + \gamma_1 t$. An estimate of $\gamma_1 < 0$ would suggest that the absolute value of the forecast error has been falling, *mutatis mutandis*. The results, reported in the bottom of table 1a, suggest that the absolute value of the error in the short own revenue forecasts has been falling by about 0.12 percentage points a year, and for long own revenue forecasts, by about 0.18 percentage points. These coefficients are marginally significantly different from zero at conventional levels. The values of γ_1 for grants are also negative, but they are imprecisely estimated. One cannot reject the hypothesis of no improvement in the forecasts of federal grants.

Massachusetts: Budgetary data for Massachusetts are taken from the annual budget messages of January 1950 through January 1987. As is the case for New Jersey, there are many different sources of revenue, and we aggregated them into "own source" and "grants" categories. However, changes in accounting procedures over time made it very difficult to construct a coherent time series for the sum of *all* own source revenues. Therefore, we focus instead on total tax revenues, which appear to have been consistently defined over the decades, and which accounted for over 90% of own source revenue in 1986.

Moreover, it was only in 1958 that the Massachusetts document began including federal grants. Hence, our regressions for grants are estimated using a shorter sample period than those for own revenues. For purposes of doing the strong tests of rationality, the same variables are assumed to be in the information set as for New Jersey.[8]

Summary statistics relating to the accuracy of the Massachusetts forecasts are presented in table 1b. Comparing the summary statistics in tables 1a and 1b, we can see that own revenues have increased slightly faster in New Jersey than tax revenues in Massachusetts (0.103 against 0.097 per year) and have been forecast with about the same accuracy. Like New Jersey, the estimates of γ_1 suggest that there has been no dramatic trend in the quality of the revenue forecasts, as measured by the absolute value of the forecast error.

Maryland: Forecasted and actual values of state revenues in Maryland are taken from the annual

[8] *INC*, *POP*, *CPI* and *EMP* are from the same sources as New Jersey. *REPUB*, *FIRSTYR*, *GOVAGR* and *ELECTYR* are from Dalton and Wirkkala (1984).

TABLE 1B.—SUMMARY STATISTICS: MASSACHUSETTS

	Short Horizon		Long Horizon	
	(1) Own Revenues	(2) Grants	(3) Own Revenues	(4) Grants
1) R_t	0.0975	0.0884	0.186	0.172
	(0.0772)	(0.107)	(0.100)	(0.122)
2) $(R_t - R^e_{t-f})$	0.0216	0.0191	0.0366	0.0369
	(0.0485)	(0.0696)	(0.0873)	(0.0867)
3) $\|R_t - R^e_{t-f}\|$	0.0302	0.0494	0.0666	0.0746
	(0.0435)	(0.0518)	(0.0665)	(0.0560)
4) R.M.S.E.	0.0525	0.0709	0.0935	0.0926
Trend in $\|R_t - R^e_{t-f}\|$				
γ_0	0.0357	0.0139	0.102	0.0979
	(0.0152)	(0.345)	(0.0222)	(0.0379)
γ_1	−0.000304	0.00154	−0.00200	−0.00101
	(0.000738)	(0.00143)	(0.00107)	(0.00157)

Note: See notes to table 1a.

budget messages of the governor and reports of the state comptroller for fiscal years 1946 through 1987. While short estimates of grants are available back to 1954, a coherent time series of long estimates of grants can only be constructed for fiscal years 1972 through 1987. As "own source" revenues, we aggregated all revenue sources which are categorized in Maryland as "General Fund" revenues. This category makes up about 75% of non-grant revenues, and includes all non-dedicated state funds such as receipts from the individual income tax, corporate income tax, and the retail sales and use tax. Time series for both short and long forecasts of own source revenues are available starting in fiscal year 1946. The variables relating to the political environment are from Boyd (1987).

The Maryland summary statistics are presented in table 1c. All sources of revenue grew at faster rates in Maryland than their counterparts in New Jersey and Massachusetts. (Recall, however, that the time periods over which the averages are taken differ somewhat across the states, as do the definitions of "own revenues.") With respect to forecasts of own source revenues, the qualitative picture is much the same as that for New Jersey and Massachusetts—on average, revenues are underforecast, and there has been some tendency for the absolute value of the forecast errors to fall over time. However, table 1c indicates that unlike New

TABLE 1C.—SUMMARY STATISTICS: MARYLAND

	Short Horizon		Long Horizon	
	(1) Own Revenues	(2) Grants	(3) Own Revenues	(4) Grants
1) R_t	0.132	0.153	0.281	0.330
	(0.110)	(0.133)	(0.175)	(0.210)
2) $(R_t - R^e_{t-f})$	0.0286	−0.116	0.112	−0.293
	(0.0507)	(0.251)	(0.137)	(0.310)
3) $\|R_t - R^e_{t-f}\|$	0.0318	0.176	0.113	0.308
	(0.0487)	(0.213)	(0.135)	(0.294)
4) R.M.S.E.	0.0580	0.273	0.175	0.421
Trend in $\|R_t - R^e_{t-f}\|$:				
γ_0	0.0735	0.0266[a]	0.254	1.888[a]
	(0.0174)	(0.135)	(0.0492)	(0.557)
γ_1	−0.00151	0.00465[a]	−0.00502	−0.0390[a]
	(0.000580)	(0.00533)	(0.00162)	(0.0128)

Note: See notes to table 1a.
[a] Estimates obtained after quasi-differencing to correct for autocorrelation. (According to the Durbin-Watson statistic, this was not required for the other equations.)

Jersey and Massachusetts, in Maryland predictions of grants are too optimistic, on average. Moreover, using any method for measuring the errors, the grants forecasts are much worse than in New Jersey and Massachusetts. Closer investigation of the data indicated that these results are dominated by several years in the mid-1970s, when the forecast rate of growth of grants exceeded the actual by as much as 86 percentage points. According to the budget officials we consulted, those errors were largely due to unanticipated increases in the prices of petroleum products.

IV. Results[9]

A. Weak Tests of Rationality

New Jersey: The tests of weak rationality are presented in panel (a) of table 2. Consider column (1), which shows the results for the short forecasts of own revenues. The ordinary least squares estimate of α_0 is 0.0386; the standard error is 0.00833. One can reject the hypothesis that α_0 is zero. The estimate of α_1 is 0.873, with a standard error of 0.0625. At conventional significance levels, the hypothesis that $\alpha_1 = 1$ is also rejected. Of course, whether the data are consistent with weak rationality depends on the outcome of the *joint* hypothesis that $\alpha_0 = 0$ and $\alpha_1 = 1$. The p-value for the appropriate chi-square test is 0.00. Thus, the data reject by a wide margin that the short forecasts of own revenue are weakly rational.

It was already clear from table 1a that New Jersey's short own revenue forecasts tend to be biased downward. The estimates of α_0 and α_1 in table 2 indicate that there is no simple way to characterize the nature of the bias. That is, forecasters do not always underforecast by the same number of percentage points (because α_1 is not zero); neither do they underforecast by a constant proportion of the correct forecast (because α_0 is not zero). Hence, there does not appear to be a simple rule of thumb producing the discrepancy between actual and predicted forecasts of own revenues.

[9] For all of our regressions, whenever autocorrelation is detected, the standard errors are computed using the method suggested by Newey and West (1987). Brown and Maital (1981) stress that for multi-period ahead forecasts, the error terms may be moving averages. The Newey-West procedure produces consistent standard errors in the presence of such an error structure.

TABLE 2.—WEAK TESTS OF RATIONALITY

	Short Forecasts		Long Forecasts	
	(1) Own Revenues	(2) Grants	(3) Own Revenues	(4) Grants
	(a) New Jersey			
α_0	0.0386	0.0272	0.105	0.111
	(0.00833)	(0.0202)	(0.0169)	(0.0367)
α_1	0.873	0.956	0.772	0.867
	(0.0625)	(0.0813)	(0.0764)	(0.103)
D − W	1.40	1.73	1.81	1.88
R^2	0.89	0.79	0.74	0.66
$p(\alpha_0 = 0, \alpha_1 = 1)$	0.00	0.408	0.00	0.0156
	(b) Massachusetts			
α_0	0.0305	−0.0106	0.0916	0.0626
	(0.0123)	(0.0225)	(0.0214)	(0.0398)
α_1	0.883	0.921	0.633	0.810
	(0.121)	(0.162)	(0.124)	(0.136)
D − W	2.45	2.45	1.33	1.28
R^2	0.62	0.58	0.36	0.53
$p(\alpha_0 = 0, \alpha_1 = 1)$	0.0291	0.373	0.0009	0.232
	(c) Maryland			
α_0	0.0259	0.0890	0.129	0.0723
	(0.0116)	(0.0273)	(0.0324)	(0.0820)
α_1	1.026	0.239	0.900	0.415
	(0.112)	(0.0690)	(0.109)	(0.109)
D − W	1.50	2.26	1.47	1.87
R^2	0.79	0.28	0.39	0.51
$p(a_0 = 0, a_1 = 1)$	0.0101	0.00	0.00	0.00

Note: Numbers in parentheses are standard errors. In cases where the Durbin-Watson statistic rejects the null hypothesis of no autocorrelation, standard errors are computed using Newey and West's (1987) correlation for autocorrelation.

Column (2) shows the results for the short forecasts of grants. An examination of the coefficients one at a time seems promising for the null hypothesis of weak rationality—α_0 is only 1.3 times its standard error, and α_1 is within one standard error of unity. This impression is confirmed by the joint test, which has a p-value of 0.408. Thus, unlike own revenues, the short forecasts for grants are weakly rational. Although the grants forecasts are "worse" in the sense of having a lower R^2, they are unbiased.

The results for the long forecasts of own revenues are shown in column (3). Like the short forecasts of own revenues, the data clearly reject the hypothesis of weak rationality. The situation for the long forecasts of grants in column (4) is somewhat more murky. The p-value for the joint hypothesis is 0.0156, so one would reject the null hypothesis at a 5% level, but accept it at a 1% level.

Just as was true with the short forecasts, the R^2 of the long forecasts of grants is less than the R^2

for own revenues. Both long forecasts have lower R^2's than either of the short forecasts. Not surprisingly, the farther into the future one predicts, the more noise there is in the forecast.

Massachusetts: The weak tests of rationality for Massachusetts are presented in panel (b) of table 2. In several important respects, the results are similar to those for New Jersey. Weak rationality cannot be rejected for the short forecasts of grants; it is rejected decisively for long forecasts of revenues. Moreover, the R^2's for the long forecasts in each category are smaller than those of the associated short forecasts. But there are several differences as well. For short forecasts of own revenues, weak rationality is not decisively rejected; the p-value is 0.0291, indicating that at a 1% significance level one would accept the hypothesis. On the other hand, for long forecasts of grants, the Massachusetts data are clearly consistent with weak rationality, while for New Jersey, the outcome was more ambiguous.

Maryland: The weak tests of rationality are in panel (c) of table 2. As was the case for Massachusetts, weak rationality for the short forecasts of own revenues is not decisively rejected; the p-value is 0.0101, indicating that at a 1% significance level one would (barely) accept the hypothesis. For the long forecasts of own revenues, the results are identical to those of both New Jersey and Massachusetts—weak rationality is rejected. It appears, then, that the greater reliance on econometric forecasting methods in Maryland does not make much of a difference. One could argue that this inference is unfair, given that Maryland only began using econometrics for forecasting own revenues after 1973. We therefore estimated the equations separately for the before and after 1973 periods. Using standard F-tests, one cannot reject the joint hypothesis that α_0 and α_1 were the same during the two periods. Specifically, for the short forecasts, the significance level of the test was 0.790; for the long forecasts, it was 0.248.

We do not regard these results as "proof" that econometric forecasting methods are useless—it could be that Maryland implements these methods poorly, and/or that the results are ignored by political decision-makers, and/or that for some reason revenues have become intrinsically more difficult to forecast since 1973, so that in the absence of econometric methods, the results would have been *worse*. Still, on the basis of these results, one would have to be cautious about urging states to fire their "old hands" and replace them with computers.

Turning now to the grants forecasts, we see that unlike New Jersey and Massachusetts, weak rationality is rejected. This finding is not altogether surprising given the discussion surrounding table 1c. The series of gigantic over-predictions of grants in the mid-1970s makes it impossible that the forecasts as a whole would exhibit weak rationality.

B. *Strong Tests of Rationality*

Table 3 shows the results for the strong tests. Each entry in the table shows the p-value for a joint test of the hypothesis that all the coefficients of the variables in the information set are zero. For both the short and long forecasts of own revenues, this hypothesis is rejected for all three states. Despite the fact that the data reject the joint hypothesis that all of the coefficients are zero, on a one-by-one basis, the coefficients are generally insignificant. Because of space constraints, these coefficients are not reported here. They are available upon request to the authors.

Turning now to the grants forecasts, for New Jersey and Massachusetts we cannot reject the hypothesis that all the regression coefficients are

TABLE 3.—STRONG TESTS OF RATIONALITY

	Short Forecasts		Long Forecasts	
	(1) Own Revenues	(2) Grants	(3) Own Revenues	(4) Grants
New Jersey	0.00	0.0620	0.00494	0.0821
Massachusetts	0.00	0.427	0.00	0.229
Maryland	0.00	0.00	0.0002	0.00

Note: Each entry in the table shows the significance level of a test of the hypothesis that all of the regressors have coefficients of zero.

zero—all the information is assimilated into the long and short grants forecasts. On the other hand, Maryland's forecasts of grants are not strongly rational. Given the results in Tables 1c and panel (c) of Table 2, it is no surprise to find that the forecasts of grants in Maryland do not incorporate all of the relevant information.

V. Conclusion

This paper has suggested a framework for examining whether state revenue forecasts are formed rationally, and used this framework to analyze budget data from New Jersey, Massachusetts, and Maryland. The states are remarkably similar in several ways: (a) on average, the forecasts of the growth of own revenues have fallen short of actual growth; (b) there has been some tendency for the forecasts of own revenues to improve over time, but the improvement is generally not statistically significant; and (c) forecasts of own revenues fail to incorporate all the information available to the forecasters.

On the other hand, we have also found some differences among the three states. The most important of these concern the forecasts for federal grant receipts. In New Jersey and Massachusetts, forecasts of grants are weakly and strongly rational; in Maryland they are neither. The results for New Jersey and Massachusetts seem more intuitive. Federal grants depend partially on expenditures from state funds. Their underestimation will neither restrain legislative spending in a way that might be desired by the executive, nor provide the executive with "unexpected" surpluses out of which to fund favored programs.[10] As we noted earlier, the time series on grants forecasts for Maryland is dominated by several large outliers in the mid-1970s. Of course, it is illegitimate to discard outliers from a time series, and we have not done so. Still, our guess is that if the grants forecasts of other states are analyzed, they will tend to be more like those of New Jersey and Massachusetts than those of Maryland.[11]

We also found that Maryland's more extensive use of econometric methods does not seem to have produced results much different than those of New Jersey and Massachusetts. However, data on more states are required to test carefully whether differences in state budgetary methods and institutions affect the quality of revenue forecasts.

[10] We are grateful to a referee for pointing out this fact to us.

[11] Another possible reason for the poor quality of Maryland's grants forecasts is that they are not integrated with the rest of the budget document. That is, the "bottom line" that indicates whether the budget is in balance is not affected by the forecast of grants.

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