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ABSTRACT

In recent months, the governors of several states have suffered major political embarrassments because actual revenues fell substantially short of the predictions in their respective budgets. 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? 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.

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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 brings these methods to bear on the problem of state revenue forecasting, and as an example, applies them to the analysis of 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. Estimation problems and 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 and suggestions for future research.

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 created by the fact that 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. To make matters even more complicated, state revenues may depend upon difficult to forecast actions taken by the federal government. For example, in 1986, the federal government announced that after that year, state sales taxes would no longer be deductible on federal tax returns. As a consequence, many taxpayers moved up their purchases of durables to 1986, creating an unanticipated increase in sales tax revenues that year.

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 the forecast is made. To formalize this notion, let R_t be the actual percent 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

$$(2.1) \quad v_{t-f} = E[(R_t - R^e_{t-f}) \mid I_{t-f}]$$

Following Brown and Maital [1981], note that (2.1) implies the following regression equation:

$$(2.2) \quad (R_t - R^e_{t-f}) = v_{t-f}(I_{t-f}) + u_t \ ,$$

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

The forecast R^e_{t-f} is said to be strongly rational if $R^e_{t-f} = E[R_t \mid I_{t-f}]$. From equation (2.2), 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

$$(2.3) \quad R_t = \alpha_0 + \alpha_1 R^e_{t-f} + u_t .$$

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 (2.3) and use appropriate statistical methods to test that joint hypothesis.

There are conflicting views with respect 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:

> [It] is common for revenue forecasts to be made conservatively in a wide range of settings . . . 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- <u>or</u> underpredicting revenues year after year is a viable strategy for fooling people. One would expect that eventually the forecasts would lose credibility. This point is especially telling in states whose legislatures have their own revenue forecasting organizations. (The legislatures of New Jersey and Maryland have such organizations; Massachusetts does not.) 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, 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 (2.3). 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. Legal responsibility for revenue estimation resides with the Governor and the Director of Budget and Accounting. However, the forecasts are developed in consultation with a number of offices in the executive branch, particularly the various tax bureaus.

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 the early 1970s Giovinazzo [1971, p. 27] noted that in New Jersey "formalized, systematic techniques are seldom, if ever, used." Rather than using econometric models, forecasters used a "judgmental approach"--they informally analyzed past trends in different revenue sources, and relied heavily on the expertise of members of the various tax bureaus. Our conversations with current and recent budget officials indicated that this is still pretty much the case. These officials indicated that attempts at econometric modelling 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. Revenue forecasts are made entirely in-house; there is no contracting to outside consultants.

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. These estimates are prepared by the Bureau of Administration and Finance (BA&F). Formal econometric modelling plays a somewhat greater role than it does in New Jersey. Specifically, BA&F 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 modelling at all. Corporate income taxes were offered as an example where familiarity with individual cases was sufficiently important that "judgment forecasts" were used to the exclusion of statistical forecasts.

Maryland. Estimates of state revenues in Maryland are developed through a process that is similar to the processes of New Jersey and Massachusetts. Revenue forecasting is carried out by the Bureau of Revenue Estimates (BRE) under the supervision of the State Comptroller, Treasurer, and Secretary of Budget and Fiscal Planning. The Governor receives the estimates in mid-December and incorporates them into his budget message which is presented to the state legislature in mid-January.

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, BRE 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 January 1987. Although budget documents were available back to the 1930s, there appears to have been a change in accounting conventions after World War II that made it difficult to construct a coherent time series.

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 percent 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. As in most states, federal grants have played a very important role in the New Jersey budget. In 1986, grants were 25 percent of own source revenues; the ratio has been as high as 40 percent.

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 (INC), population (POP), consumer price index (CPI), non-agricultural employment (EMP), and the lagged value of revenue itself (R_{t-f-1}). 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 by the legislature and signed by the governor. 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 define the following dichotomous variables:

GOVAGR = 1 if the party of the governor is the same as the majority in the legislature, and zero otherwise. (If the two houses are split, GOVAGR = 0.5.)

REPUB = 1 if the governor is a Republican, and zero otherwise

ELECTYR = 1 if the message is presented in an election year, and zero otherwise

FIRSTYR = 1 if the message is presented in the first year of a governor's administration, and zero otherwise.

Some summary statistics regarding forecast accuracy for New Jersey are presented in Table 1a. The first row shows the average percent change in each revenue source during the sample period. Own revenues grew at an annual rate of about 10 percent during our period, and grants from the federal government at about 14 percent. 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 percent 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 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. Like its New Jersey counterpart, the Massachusetts budget document includes actual revenue for the recently completed fiscal year as well as forecasts for the current and next fiscal year. As is also 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 percent 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 (.103 against .097 per year) and have been forecast with about the same accuracy. New Jersey is a bit better at the short forecast and Massachusetts at the long forecast. 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. Federal grants have grown more slowly and been forecast more accurately in Massachusetts than New Jersey. (Recall, however, that the Massachusetts time series on grants does not include the early 1950s.) The root mean squared error of the long grants forecast is 0.093 in Massachusetts as compared to 0.203 in New Jersey.

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

As is also the case in New Jersey and Massachusetts, grants play an important role to state public finance. In 1987, the ratio of grant to non-grant revenues was about 24 percent; it has been as high as 31 percent. However, Table 1c indicates that unlike New 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. Econometric Issues and Results

A. Econometric Issues

As noted in section III, execution of the weak tests involves estimating $R_t = \alpha_0 + \alpha_1 R^e_{t-f} + u_t$, and testing the joint hypothesis $\alpha_0 = 0$ and $\alpha_1 = 1$. Suppose that ordinary least squares estimation of this equation leads to errors that are serially correlated. This suggests that strong rationality will be rejected, because information that was available when the prediction was made (the previous forecast error) was not being taken into account. Nevertheless, weak rationality can still obtain. However, in the presence of autocorrelated errors, inferences based on the least squares errors may be incorrect. Moreover, standard "fix-ups" such as quasi-differencing will not work in this situation because there is no guarantee that the error term in period t will be orthogonal to the lagged value of the right hand side variable. Newey and West [1987] have proposed a procedure for correcting the standard errors without quasi-differencing, and it is used whenever autocorrelation is diagnosed in the ordinary least squares results.[9]

B. Results: 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.

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 percent level, but accept it at a 1 percent 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 one percent 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 one percent 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.

C. Results: Strong Tests of Rationality

New Jersey. In light of the fact that the New Jersey data already rejected weak rationality for own revenues, we expect that strong rationality will also be rejected. Nevertheless, it is still of some interest to examine the coefficients on the various variables in the information set. This should indicate which information is not being properly assimilated into the forecasts. In contrast, on the basis of the weak tests, the grants equations are still in the game. For them, a test of the joint hypothesis that all the coefficients are zero is of considerable interest.

Table 3a shows the results for the strong tests. As noted above, the information set includes economic variables from the calendar year preceding the budget message, except for income, which is lagged by a year. In interpreting the coefficients, note that a negative coefficient means that an increase in the associated variable makes the forecast more optimistic, ceteris paribus. Consider, for example, the column (1) results for the short forecasts of own revenues. On the basis of t-tests conducted at conventional significance levels, the variables that stand out as significant are R_{t-f-1}, REPUB, FIRSTYR, and ELECTYR. Except for REPUB, they all have negative coefficients. Thus, larger percent increases in lagged own revenues are associated with more optimistic revenue forecasts. Forecasts made during election years tend to be more optimistic than average, as are those made during the first year of an administration. Republican administrations tend to be pessimistic about revenue growth. The qualitative story with respect to these coefficients is about the same for the long own revenue forecasts in column (3). Here, however, none of them is statistically significant.

We turn now to the grants forecasts. Given that both the short and long forecasts passed the test for weak rationality (at a 1 percent significance level), the key question is whether they pass the strong tests as well. For the short forecasts (column (2)), the p-value for a joint test of the hypothesis that all the coefficients are zero is 0.0620; for the long forecasts (column (4)), the p-value is 0.0821. Thus, in neither case can we reject the hypothesis that all the regression coefficients are zero. All the information is assimilated into New Jersey's grants forecasts, i.e., they are strongly rational.

Massachusetts. The strong tests of rationality for Massachusetts are reported in Table 3b. Consider first the short forecasts of own revenues. Except for the POP and CPI variables, the signs and magnitudes are quite similar to those for New Jersey. Thus, for example, increases in past revenues lead to more optimistic forecasts, as do being in the first year of an administration and being in an election year. Like their New Jersey counterparts, the Republican governors of Massachusetts tend to be more pessimistic about revenues than the Democrats (compare the coefficient on REPUB of 0.0183 to 0.0205 from column (1) of Table 3a). Of course, one should not make too much of these similarities, given that on a one-by-one basis, the coefficients in column (1) are insignificantly different from zero. Similarly, the column (3) results for the long forecasts of own revenues do not contain any significant variables.

With respect to the results for grants in columns (2) and (4), the key result is that one cannot reject the hypothesis that all the coefficients are zero; the p-value for the short forecasts is 0.427 and for the long forecasts, 0.229. It appears, then, that even more decisively than in the case of New Jersey, forecasters incorporate all of the relevant information into their forecasts of grants.

Maryland. The strong tests of rationality for Maryland are reported in Table 3c. As was the case for New Jersey and Massachusetts, strong rationality is rejected for forecasts of own source revenues. However, on a coefficient by coefficient basis, many of the results are different. In particular, the signs of the "political" variables are reversed. While one should not make too much of this result due to the fact that the individual coefficients are imprecisely estimated, it is perhaps worth noting that unlike New Jersey and Massachusetts, during our sample period Maryland was pretty much a one-party state. The Democrats controlled the governorship for all but two years. (The one Republican was Spiro T. Agnew.) This political environment differs considerably from that in New Jersey and Maryland; we conjecture that this difference might affect political incentives to over- or underestimate revenues.

Columns (2) and (4) of Table 3c indicate that forecasts of grants in Maryland are not strongly rational. Given the results in Tables 1c and panel (c) of Table 2, it is no surprise to find that 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.

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 (0.0934)	0.141 (0.237)	0.227 (0.141)	0.287 (0.317)
2) $(R_t-R^e_{t-f})$	0.0292 (0.0342)	0.0219 (0.109)	0.0697 (0.0805)	0.0836 (0.188)
3) $\lvert R_t-R^e_{t-f}\rvert$	0.0316 (0.0318)	0.0863 (0.0696)	0.0776 (0.0728)	0.147 (0.142)
4) R.M.S.E.	0.0445	0.110	0.106	0.203
Trend in $\lvert R_t-R^e_{t-f}\rvert$:				
$\gamma 0$	0.0647** (0.0208)	0.0932 (0.0303)	0.126 (0.0311)	0.211 (0.0620)
$\gamma 1$	-0.00121** (0.000665)	-0.000248 (0.00100)	-0.00176 (0.00105)	-0.00230 (0.00210)

*Notation: R_t = actual percent change in nominal revenues

R^e_{t-f} = forecast of R_t made f periods ago

$(R_t-R^e_{t-f})$ = forecast error

$\lvert R_t-R^e_{t-f}\rvert$ = 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).

**Estimates obtained after quasi-differencing to correct for autocorrelation. (According to the Durbin-Watson statistic, this was not required for the other equations.)

Table 1b*

Summary Statistics: Massachusetts

	Short Horizon		Long Horizon	
	(1) Own Revenues	(2) Grants	(3) Own Revenues	(4) Grants
1) R_t	0.0975 (0.0772)	0.0884 (0.107)	0.186 (0.100)	0.172 (0.122)
2) $(R_t - R^e_{t-f})$	0.0216 (0.0485)	0.0191 (0.0696)	0.0366 (0.0873)	0.0369 (0.0867)
3) $\lvert R_t - R^e_{t-f} \rvert$	0.0302 (0.0435)	0.0494 (0.0518)	0.0666 (0.0665)	0.0746 (0.0560)
4) R.M.S.E.	0.0525	0.0709	0.0935	0.0926
Trend in $\lvert R_t - R^e_{t-f} \rvert$				
$\gamma 0$	0.0357 (0.0152)	0.0139 (0.345)	0.102 (0.0222)	0.0979 (0.0379)
$\gamma 1$	-0.000304 (0.000738)	0.00154 (0.00143)	-0.00200 (0.00107)	-0.00101 (0.00157)

*See notes to Table 1b.

Table 1c*

Summary Statistics: Maryland

	Short Horizon		Long Horizon	
	(1) Own Revenues	(2) Grants	(3) Own Revenues	(4) Grants
1) R_t	0.132 (0.110)	0.153 (0.133)	0.281 (0.175)	0.330 (0.210)
2) $(R_t - R^e_{t-f})$	0.0286 (0.0507)	-0.116 (0.251)	0.112 (0.137)	-0.293 (0.310)
3) $\lvert R_t - R^e_{t-f} \rvert$	0.0318 (0.0487)	0.176 (0.213)	0.113 (0.135)	0.308 (0.294)
4) R.M.S.E.	0.0580	0.273	0.175	0.421
Trend in $\lvert R_t - R^e_{t-f} \rvert$:				
$\gamma 0$	0.0735 (0.0174)	0.0266** (0.135)	0.254 (0.0492)	1.888** (0.557)
$\gamma 1$	-0.00151 (0.000580)	0.00465** (0.00533)	-0.00502 (0.00162)	-0.0390** (0.0128)

*See notes to Table 1a.

**Estimates obtained after quasi-differencing to correct for autocorrelation. (According to the Durbin-Watson statistic, this was not required for the other equations.)

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 (0.00833)	0.0272 (0.0202)	0.105 (0.0169)	0.111 (0.0367)
α_1	0.873 (0.0625)	0.956 (0.0813)	0.772 (0.0764)	0.867 (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 (0.0123)	-0.0106 (0.0225)	0.0916 (0.0214)	0.0626 (0.0398)
α_1	0.883 (0.121)	0.921 (0.162)	0.633 (0.124)	0.810 (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

Table 2 (continued)

(c) Maryland

α_0	0.0259 (0.0116)	0.0890 (0.0273)	0.129 (0.0324)	0.0723 (0.0820)
α_1	1.026 (0.112)	0.239 (0.0690)	0.900 (0.109)	0.415 (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

*Numbers in parentheses are standard errors. In cases where the Durbin-Watson statistic rejects the null hypotehsis of no autocorrelation, standard errors are computed using Newey and West's [1987] correction for autocorrelation.

Table 3a

Strong Tests of Rationality: New Jersey*

	Short Forecasts		Long Forecasts	
	(1) Own Revenues	(2) Grants	(3) Own Revenues	(4) Grants
Constant	0.0701 (0.0174)	-0.0969 (0.0696)	0.169 (0.0572)	0.0633 (0.133)
INC_{t-2}	-0.416 (0.226)	1.34 (0.782)	0.316 (0.708)	-1.52 (1.70)
POP_{t-1}	0.0113 (0.467)	3.79 (1.98)	-3.42 (1.89)	6.69 (4.56)
CPI_{t-1}	0.0320 (0.116)	-1.44 (0.694)	-1.15 (0.656)	0.00143 (1.56)
EMP_{t-1}	0.199 (0.163)	-0.398 (0.561)	-0.379 (0.512)	0.386 (1.06)
R_{t-f-1}	-0.138 (0.0619)	-0.0350 (0.0699)	-0.208 (0.188)	0.181 (0.132)
REPUB	0.0205 (0.0107)	-0.0532 (0.0355)	0.0189 (0.0304)	-0.0363 (0.0726)
FIRSTYR	-0.0256 (0.00787)	0.00281 (0.0505)	-0.0110 (0.0407)	0.0749 (0.0959)
ELECTYR	-0.0307 (0.0116)	0.0315 (0.0404)	-0.0368 (0.0361)	-0.0402 (0.0810)
GOVAGR	0.00509 (0.00732)	0.0921 (0.0415)	-0.00291 (0.0340)	0.0635 (0.0792)
D-W	0.959	2.22	1.99	2.27
R^2	0.45	0.40	0.27	0.30
p(all coefficients = zero)	0.00	0.0620	0.00494	0.0821

*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] correction for autocorrelation.

Table 3b
Strong Tests of Rationality: Massachusetts*

	Short Forecasts (1) Own Revenues	(2) Grants	Long Forecasts (3) Own Revenues	(4) Grants
Constant	0.0736 (0.0268)	0.115 (0.0832)	0.0367 (0.0756)	0.213 (0.114)
INC_{t-2}	-0.560 (0.529)	-1.84 (1.26)	-1.20 (1.22)	-2.06 (1.75)
POP_{t-1}	-0.859 (0.788)	1.61 (3.94)	-0.138 (1.36)	-1.27 (4.10)
CPI_{t-1}	-0.309 (0.331)	0.780 (0.917)	0.788 (0.860)	-0.225 (1.12)
EMP_{t-1}	0.146 (0.331)	-0.191 (0.744)	0.830 (0.789)	0.0318 (1.40)
R_{t-f-1}	-0.129 (0.0981)	-0.272 (0.162)	-0.150 (0.270)	0.0884 (0.1621)
REPUB	0.0183 (0.0122)	-0.0358 (0.039)	0.0484 (0.0664)	0.00288 (0.0431)
FIRSTYR	-0.0192 (0.0136)	-0.0203 (0.0403)	0.0586 (0.0321)	-0.0476 (0.0546)
ELECTYR	-0.0371 (0.0130)	0.0217 (0.0374)	-0.00335 (0.0269)	-0.0533 (0.0464)
GOVAGR	0.0223 (0.0113)	+	0.0331 (0.0454)	+
D-W	2.35	2.21	2.13	2.32
R^2	0.32	0.34	0.17	.34
p(all coefficients = zero)	0.00	0.427	0.00	0.229

*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] correction for autocorrelation.

+The time period used to estimate the grants equations was 1958-1987; during this period GOVAGR was perfectly collinear with other right hand side variables, and therefore had to be omitted. This problem did not arise in the longer period (1950-1987) used to estimate the own revenue equations.

Table 3c

Strong Tests of Rationality: Maryland*

	Short Forecasts (1) Own Revenues	(2) Grants	Long Forecasts (3) Own Revenues	(4) Grants
Constant	-0.00511 (0.00533)	-0.0199 (0.140)	0.0959 (0.0637)	-0.199 (0.428)
INC_{t-2}	0.0524 (0.0722)	0.284 (0.999)	0.520 (0.534)	2.67 (3.61)
POP_{t-1}	0.825 (0.219)	4.15 (3.17)	-1.38 (1.71)	-8.18 (7.40)
CPI_{t-1}	0.127 (0.0895)	-2.73 (1.60)	-1.04 (0.743)	-1.46 (2.84)
EMP_{t-1}	-0.0740 (0.125)	-2.060 (0.686)	-1.94 (0.771)	-2.32 (2.98)
R_{t-f-1}	-0.00120 (0.0137)	-0.175 (0.173)	-0.0777 (0.116)	-0.245 (0.305)
REPUB	-0.0116 (0.00986)	0.102 (0.0414)	0.0947 (0.0419)	+
FIRSTYR	0.0219 (0.00711)	0.0596 (0.0516)	0.154 (0.0526)	-0.0662 (0.0903)
ELECTYR	0.000818 (0.00696)	-0.0454 (0.0477)	0.0464 (0.0388)	-0.112 (0.170)
D-W	1.04	0.85	2.23	1.30
R^2	0.32	0.37	0.43	0.16
p(all coefficients = zero)	0.0	0.0	0.0002	0.0

*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] correction for autocorrelation. Also, the variable GOVAGR is perfectly collinear with other right hand side variables throughout all the sample periods considered here, and is therefore omitted.

+The time period used to estimate the equations for long forecasts of grant revenues was 1972-1987; during this period there were no Republican Governors in Maryland, and therefore the variable REPUB was omitted. This problem did not arise in the longer periods used to estimate the other equations.

Footnotes

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.
3. The analysis can just as well be conducted in terms of levels as percent changes; we follow Zarnowitz [1985] and others in using percent changes.
4. New York Times, May 26, 1988, p. B1.
5. Before 1973, the message was presented in mid-February.
6. An important example is the state income tax, which has only been in existence since the 1970s.
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: 1929-82, U.S. Government Printing Office, Washington, DC 1984, pp. 79-82,

and updated with various issues of the Statistical Abstract of the United States.

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].

9. 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.

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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