MODELING THE FINANCIAL HEALTH OF PUBLIC WATER SYSTEMS

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Abstract. The purpose of this paper is to present a theory and a model for assessing the financial health of public water systems. Using financial information from 25 water utilities in Georgia, the paper seeks to identify the causal relationships between the financial performance of a water utility and its fiscal position. The need for a theoretical understanding of water utility financial health is the result of the increasingly stringent performance requirements under the Safe Drinking Water Act (SDWA). The issue has become particularly important for small water systems which will be exposed to significant financial demands. A set of financial ratios was developed and tested in a model that was based on liquid asset theory. The model contained five variables designed to account for liquid assets, current debt, cash-flow, and level of expenses. The variables fit the need of water utilities to provide an adequate level of operation and maintenance to meet current and future system needs as well as SDWA standards.

INTRODUCTION

Over the next ten years, the financial health of community water and wastewater systems will be severely tested by the costs of complying with federal and state drinking water regulations. As the Safe Drinking Water and Clean Water Acts affect water systems, the financing of necessary treatment facilities will become difficult. Consequently, public water systems will require methods to monitor their financial condition as they seek funding for treatment system expansion and development.

National compliance costs for new drinking water regulations during the 1990s are estimated to be $18 billion per year with 69% of these costs falling on small systems. Of the 60,000 public water systems in the U.S., over 51,000 of them (82%) serve less than 3,300 people. For small systems serving less than 100 houses (about 63% of all US water systems) monitoring costs are expected to exceed the current cost of water (Wade Miller, Inc. 1991). As these events unfold, it will be necessary to better predict water system financial health. The purpose of this paper is to develop a theory and model for assessing the financial performance of public water systems.

A THEORETICAL BASIS FOR MODEL DEVELOPMENT

The development of water utility financial performance begins with the issue of viability. A viable water system has been defined as one that is self sustaining and has the commitment as well as the financial, managerial, and technical capabilities to reliably meet performance requirements on a long-term basis (Cromwell, et al 1992). Two general weaknesses have been identified regarding non-viable systems. First, they are under capitalized. These systems generally have no reserve or depreciation fund mechanism to provide for capital replacement. Second, non-viable systems inadequately provide for operation and maintenance, leading to SDWA violations (Wade Miller, Inc. 1991).

These two weaknesses lead to two vital questions regarding system performance:

Can the system pay for its capital needs?

Can the system cover the full cost of water?

If these are the two most important questions, then two types of financial analysis must be present in any theory of performance: (1) a measure to document the ability to raise capital, and (2) a cash-flow analysis to demonstrate revenue sufficiency (Cromwell, et al 1992).

Debt Service Coverage

The first proposition of this paper then is that the best measure of system financial performance is debt service coverage. Debt coverage is defined as the net revenue available for debt service divided by interest and principal (net revenue is equal to gross revenue from water services minus operating and maintenance expenses, but before depreciation). Using coverage as the measure of system performance addresses the system's primary financial obligation: can it pay for capital needs? A system, to be financially sound, must demonstrate the ability to generate sufficient revenue to cover current operating and maintenance obligations plus the repayment of loans. In meeting its coverage requirements, the second major function of a system's finances is addressed: the cash flow necessary to meet obligations and pay debt.

While looking at industrial firms, Beaver used a water analogy in defining the use of a cash flow model. A utility can be viewed as a reservoir of liquid assets, supplied by inflows and drained by outflows. The reservoir serves as a cushion or buffer against variations in flows. Utility solvency is defined in terms of the probability that the reservoir will be exhausted, at which point the firm will not be able to pay its obligations.

The relationship between cash flow and financial ratios thus depends first on the size of the reservoir. The second important concept is the inflows supplied to or outflows drained from the reservoir by current operations. The third concept is the debt held by the utility which is a measure of the potential drain on the reservoir. Finally the fourth concept is the fund expenditures for an operation and the amount of liquid assets draining from the reservoir by operating expenditures. Beaver then states four propositions:

1. The larger the reservoir, the smaller probability of failure.
2. The larger the cash-flow from operations the smaller the probability of failure.
3. The larger the amount of debt held, the greater the probability of failure.
4. The larger the fund expenditures for operations, the greater the probability of failure.

These four propositions can be used to develop a cash-flow model of water utility financial health. For each of the four propositions, a class of financial ratios can be identified. From the four, the proposed model is:

Debt Service Coverage = f (Size of Liquid Assets, Cash-flow, Debt, Expenditures).

This model includes those indicators that signify whether the utility can meet its financial commitments, the degree to which resources are being used to achieve a desired result (meet capital payments) and the degree of financial security. The model also conforms to the two outstanding issues in utility finance: capital requirements and the resources to meet all obligations.

DATA AND MODEL

For this paper, financial information was obtained from 25 water utilities in Georgia. These utilities were in the process of preparing information in order to sell bonds or refinance old issues in 1992-1993. All data were for fiscal year 1991 through 1993. As measured by number of connections, nine of the utilities had less than 1,000 connections, eleven had between 10,000 to 50,000 and five had more than 50,000 customers. From the income statements and balance sheets of each utility, 24 data categories were collected ranging from net income to retained earnings. From these 24 data points, 57 financial ratios were constructed that generally fell into the categories prescribed in the model.

The first step is to eliminate the ratios that are clearly similar and over lapping. These are ratios that have similar numerators or denominators, measuring nearly identical data. This process reduced the ratio population to 27. The next step was to put these 27 ratios in to one of the four categories in the model. For this paper, four ratios were representative of the size of liquid assets, eleven cash flow ratios were identified, along with three debt-ratios and nine expenditure ratios.

The number of variables calls for statistical methods to narrow the field further in order to test the model and avoid multicollinearity. Factor analysis was used to reduce the variable set within each of the four model categories. The factor extraction method employed was principal component analysis: a multivariate technique for examining relationships among several quantitative variables. The principal component procedure is particularly useful in summarizing data and detecting linear relationships.

The results of the principal component analysis produced one factor each for size, debt and expenses and two factors for cash flow. From those results, the ratio with the highest factor loading was chosen for Ordinary Least Squares (OLS) estimation of the model.

To represent the size of the reservoir the principal component analysis indicated the most significant variable was the well-known current ratio. This measure provides an easily obtainable indication of the magnitude of the liquid assets available to the utility. The size of debt facing a utility was represented by the also familiar debt to equity ratio. The debt ratio is one of six most important variables used by Moody's to assign bond ratings to water utilities. It determines how much internally generated cash is available for capital expenditures and debt amortization (payback). Two cash-flow variables were most significant in the factor analysis: interest coverage and a return on assets measure. Return on assets is a standard financial ratio measuring the income generating ability of the utility's assets. This variable has been proven to be extremely useful in assessing firms performance in several past multivariate studies (Altman, 1968, 1973). In the Beaver study, the return on asset ratio was the second most powerful variable in terms of predicting financial health. The interest coverage variable, similar to debt coverage, is an indicator of whether the utility can cover its debt requirements. This measure is also one of the six most important variables used by Moody's. That factor analysis isolated this variable as significant is another indication that coverage and cash-flow are the vital aspects of utility financial health. Finally, as a representative of the level of expenditures, the factor analysis indicated a type of operating ratio as most significant. The ratio operating revenue/operating income is an indicator of expenses since operating income equals total operating revenues minus operating expenses plus depreciation. The higher this operating ratio the higher revenue is than expenses.

The results of the factor indicate that three of the five ratios selected (return on assets, current ratio and debt to equity) were the same as were used in Beaver's liquid asset model as well as numerous other studies (Jones; Zavgren). The two other variables (interest coverage and operating ratio) are particularly significant to water utilities since they directly address the need to be able to finance debt and control costs.

RESULTS

To test the theory prescribed in this paper the empirical model was specified as:

(1) $C_i = \beta_o + \beta_1 CR_i + \beta_2 LEV_i + \beta_3 INT_i + \beta_4 ROA_i + \beta_5 OR_i + \varepsilon_i$

where:

C_i = debt service coverage of the i^{th} water utility;
CR_i = current ratio; i^{th} utility;
LEV_i = debt to equity ratio; i^{th} utility;
INT_i = interest coverage; i^{th} utility;
ROA_i = return on assets, i^{th} utility;
OP_i = operating ratio, i^{th} utility.

For equation (1) the expected signs for all the ratios except leverage is positive. The debt to equity ratio is expected to have an inverse relationship to coverage. As the amount of a systems debt increases, the principal and interest payable each year also increases, decreasing the coverage ratio until the net revenue available for debt service increases. The parameters of the equation were estimated using OLS.

Estimated results for equation (1) are shown in table 1. For all the variables except leverage, the coefficients were of the expected sign. However, since the coefficient for leverage was not significant at any reasonable level, it could be zero. Also, the coefficient for the current ratios was not significant. However, the entire equation was highly significant and explained 89% of the variation in debt coverage. Since interest coverage is a variable that measures nearly the same financial information as debt coverage, equation (1) was also estimated without that variable. The results were similar to the above. The coefficients for current ratio and leverage were not significant and the coefficients for return on assets and operating ratio were significant and of the correct sign. The coefficient estimate for return on assets was 40.77 and for operating ratios, 0.34. The R^2 for the equation without interest coverage dropped slightly to .83 but the F test again indicated a highly significant equation estimation.

One problem with utilizing a list of financial ratios in assessing a firm's performance is that there is reason to believe that a high degree of correlation will exist between

Table 1. Results of the Water System Financial Performance Model

Variable and Statistics	Estimated Coefficient β's	t-Statistics
Current ratio	0.03	0.933
Leverage	0.37	0.285
Interest coverage	0.12*	3.068
Return on assets	25.24*	3.837
Operating ratio	0.31*	4.309
F value	27.89	
R^2	89.13	

* Indicates significant at the 1% level.

the ratios. A test of the multicollinearity in this model showed that the only correlation among the independent variables occurred between leverage (debt to equity) and the intercept. This further explains the negative coefficient on the variable given this interaction between it and the intercept.

To further service categories an ordered probit model was estimated. The results of the probit model indicated a significant equation with a Chi-Square (4) of 17.28 and significance level of 0.0017. The probit model correctly predicted the number of utilities in each category: four utilities with coverage between 0 and 1.5, six between 1.5 and 2, six between 2.0 and 3.0 and seven in category coverage 3.0 and above. When looking at the individual utilities, the model correctly place 15 of the 23 utilities in the correct category, a 65% predictive capability. Of the eight utilities not correctly placed, seven were the result of underestimating the coverage. Of those seven, five utilities were placed in the category of coverage between 0 and 1.5 when they should have been in either category 1 (3 utilities) or 2 (2 utilities).

CONCLUSIONS

The purpose of this paper was to provide a theory of ratio analysis to assess water utility financial performance. The theory proposed was based on liquid asset models proposed by Beaver and others. The model seeks to account for the two components of a utility's financial viability; its ability to raise capital and its ability to cover the full costs of providing water services to its customers.

The model employed financial ratios to measure system performance. Financial ratios have long been used in agricultural, banking, manufacturing, and other sectors to judge the health of an industry. However, most of the literature using financial ratios have been empirical studies. This paper began with the proposition that financial ratios should be selected on some theoretical basis coupled with demonstrated empirical evidence of their usefulness.

What the results indicate for a water utility tracks closely to what financial advisors and the USEPA recommends for keys to financial health. As noted in their *Managers Guide*, the EPA suggested if managers have only 15 minutes a day, they should keep track of debt coverage and an operating ratio. Also suggested from this study, they should monitor the current ratio, debt to equity and return on assets. All of these should be charted over time because the trend in these ratios is more important than one year's data. For all of these variables, a constant trend points to good financial performance more than high numbers one year followed by erratic movements over time.

Issues of financial health are taking on more importance in view of rising costs due to the Safe Drinking Water Act as well as issues of viability. System managers need to monitor the probability of system weaknesses to initiate corrective action. For most, it is evident which utilities are genuinely non-viable and which are presently healthy. The results of this and a larger study to follow will be of particular use for those systems somewhere between the two extremes. The purpose is to provide managers with readily available tools to track system financial performance in order to assure the future viability of the system and the provision of water to the public.

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