Water resources and bond funds risk

Marta Álvarez
Professor
Institute of Statistics and Computerized Information Systems
School of Business Administration
University of Puerto Rico
Río Piedras Campus
PO Box 23332
San Juan, PR 00931
Tel. 787.764.0000, Ext. 3142, 3130

Javier Rodríguez
Professor
Graduate School of Business Administration
School of Business Administration
University of Puerto Rico
Río Piedras Campus
PO Box 23332
San Juan, PR 00931
Tel. 787.764.0000, Ext. 87118, 87129

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Abstract

In this paper we examine the relationship between single-state municipal-bond funds risk and water scarcity in the US. With limited water resources, crumbling water infrastructure and water-rights legal battles, water resources in the US (and the world) has become a highly sought-off commodity. We compare the risk profile of funds from states with limited water resources with those from states with plenty of water resources. We find that funds from states from the South and the West of the US are indeed riskier that funds from other geographical regions. This result is consistent with the evidence of limited water resources in these two regions of the US.

Keywords: Water resources, risk, mutual funds, US municipal bonds

Introduction

Water is a scarce and un-replicable resource. The World Health Organization (WHO) estimates that one in three people around the globe is affected by inadequate access to water. The United States (US) is not an exception. Frequent water shortages and droughts in the US cost billions of dollars in the agriculture sector of the economy. Also, public water resources in the West, Southwest and the Southeast are more threatened than in other regions of the US, prompting legal battles over dwindling resources. Albeit this, water usage in the US is by far one of the highest in the world. Data from the US Geological Survey shows that the average American uses between 80-100 gallons of water per day. In comparison, Europeans use 60-80 gallons, and residents from most African countries use less than 20 gallons per day. If we consider the water use to prepare the food and products consumed, the typical American consumes an average of 1,157 gallons per day. In comparison, residents from the BRIC nations use the following average number of gallons per day: Brazil 230, China 301, Russia 388 and India 423.

A long list of popular press articles discuss the causes and long lasting effects of the water shortage crisis in the US[1]. Additionally, Barnet (2011) and Glennon (2010) present very convincing anecdotal and statistical evidence showing that limited water supply and decaying water infrastructure in the US is a real problem, specially to agriculture-intensive California, resort-infested Nevada, and golf course-dotted Arizona. The level of decay of the US water infrastructure is significant. Reports show that more than 30 percent of all water pipes in the US are between 40 and 80 years old[2]. And the American Society of Civil Engineers assigned a "D-" grade to the US drinking water infrastructure, and asserts that more than $1 trillion is needed just

[1] See for example: Western States Agree to Water-Sharing Pact, New York Times, on-line Edition, December 10, 2007 or Is the US Reaching Peak Water?, Forbes, on-line Edition, September 7, 2011.
[2] Experts: US Water Infrastructure in Trouble, CNN International, on-line Edition, January 21, 2011.

to replace aging pipes around the nation. Increase in population in water scarce areas of the South and the Wests is another cited treat to the diminishing water resources in the US[3].

A debate was generated by a study done by CERES, an advocate group that supports a sustainable global economy, and the firm Water Asset Management, which invest in global water-related firms and assets. The study alerted investors about the hidden risks inherent in municipal bonds from states with dwindling water resources and involved in court battles with neighboring states for water rights[4]. Municipal bonds help finance most of the nation water supply infrastructure. These include: water utility bonds, electric power public utility bonds and public utility bonds. The study warned bond investors about underestimated bond business and financial risk due to limited state-level water resources, crumbling utilities infrastructure and climate change. They argue that bond ratings agencies fail to correctly take into consideration water-risk factors when rating municipal bonds. All major bond rating agencies rejected the results of the study proclaiming that they do factor in water-related factors when evaluating municipal bonds. Some of the cities mentioned in the report also issued statements arguing that the report fail to correctly portray the risk level of each city water resources and water infrastructure. The controversy received some attention from the media including a New York Times article on October 2010[5].

The Security and Exchange Commission (SEC) estimates that the market value of all outstanding US municipal bonds is roughly $2.8 trillion, and roughly two-thirds of this in hands of individual investors[6]. Investors hold municipal bonds directly or indirectly through mutual funds, exchanges traded funds, and other investment companies. One of the most important holders

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[3] America's Water: An Exploratory Analysis of Municipal Water Survey Data, accessed in www.growingblue.com.
[4] To access the study go to: http://www.ceres.org/issues/water/aqua-gauge/examples-of-water-risk.
[5] "Water Scarcity and Bond Risk, Study Warns," October 20, 2010, New York Times online edition.
[6] Information on municipal bonds provided by the SEC in http://www.sec.gov/answers/bondmun.htm.

of municipal bonds are mutual funds. In fact, data from the Investment Company Institute (ICI) shows that, as of the end of 2013, mutual funds hold close to 22 percent of all municipal securities[7]. For the same year, the municipal bond mutual funds market was estimated by the ICI in $498.19 billion or approximately 15 percent of all bond mutual funds.

In this study we want to contribute to the discussion prompted by CERES and the firm Water Asset Management, by examining the risk of open-end single-state municipal bond mutual funds (single-state muni-bond funds) in relation with the risk inherent in the state water resources and infrastructure. In other words, are single-state municipal bond mutual funds from states with limited water resources and in-risk water infrastructure riskier, than single-state municipal bond mutual funds from water-rich states? Single-state municipal bond mutual funds are one of the many US municipal bond mutual funds available to investors. Are non-diversified and geographically-constraint mutual funds which invest mostly in municipal bonds issued by the state, cities, counties, and many other governmental agencies (Redman and Gullet 2007).

There are only a few studies solely devoted to municipal bond funds. In an early study, Kihn (1996) shows that, after controlling for the effect of interest-rate call and put periods, low-grade municipal bond funds outperform high-grade funds. Singh and Dresnack (1998) report that, when state taxes are significant, investors do benefit from investing in state-specific municipal bond funds. More recently, Redman and Gullet (2007) find that portfolio concentration is significant for municipal bond funds, but its influence on taxable fund returns is negligible. Finally, Rakowski and Deng (2014) examine single-state municipal bond mutual funds, and find that local managers underperform their non-local counterparts. The authors note however, that local managers have advantages in illiquid, compact and highly populated markets.

[7] ICI annual report available in: www.ici.org.

In the next section we present the sample of mutual funds included in the study, followed by a description of the methodology we use to estimate mutual fund risk.

Data

Our sample funds include all single state-municipal mutual funds from the CRSP Mutual Fund Survivorship Bias Database from 1999 to 2013. To be included in the sample, the fund must have monthly returns available for at least a year. We form an equally weighted portfolio for all the funds from one state. Table 1 shows the number of funds by state included in the sample. The table also shows the distribution of the states included in the study by the four regions and nine divisions as defined by the US Census Bureau. We examine a total of 2048 funds, from 26 different states and a median number of 53 funds per state. However, funds enter and exit the state-portfolio in different times. For example, for the case of the state of Alabama a total of 13 funds are included in the portfolio but not necessarily all 13 funds are in existence at the same time. In terms of the distribution by regions, eleven states are from the South region of the US, and the remaining 15 states included in the sample are evenly distributed in the Midwest, Northeast, and West regions.

To have a better sense of the sample of funds, Table 2 report descriptive statistics of several well-known mutual fund characteristics, and of the monthly return series. To reach at the values in Table 1, for each variable, we first compute the average value for each fund in the state-sample and then compute the median across all funds in the sample. The statistics in Table 2 are based on the median of all variables, except the return variables which are based on average monthly returns. The single-state municipal funds in the sample have an average of $19 million in total assets (TNA). These funds turnover (turnover ratio) their portfolios at an average rate of 21 percent. The average expense ratio is 1 percent and have an average annual yield of 3.4 percent. The average monthly return is 0.3 percent, with a 1.3 percent standard deviation.

In the next section we present the methodology we use to estimate mutual fund risk, followed by the empirical results.

Methodology

Our method are similar to those of use by Koski and Pontiff (1999) in their examination of the use of derivatives by mutual fund managers. We study the relationship between state-level water resources and single-state municipal-bond funds risk. We estimate three different portfolio risk variables. That is, total risk (TR), measured as the standard deviation of monthly fund returns; systematic risk (SR), measured as the beta coefficient from a market model regression, and idiosyncratic risk (IR), as the standard deviation of the residual terms from a market model regression. To estimate SR and IR, we estimate a single-factor model as follows:

$$R_F - R_f = \alpha_F + \beta_F\left(R_B - R_f\right) + \varepsilon_F \quad , \qquad (1)$$

where: R_F is the fund's monthly return, R_f is the monthly risk free rate, R_B is the monthly return on the benchmark, α_F is the intercept of the equation and the measure of risk adjusted performance, β_F is the coefficient of systematic risk, and ε_F is the unexplained component of the model and the source of idiosyncratic risk. We use two benchmarks in the model presented by equation 1. First, we use S&P Municipal Bond Index ("Market" index) to represent the aggregate municipal bond market. Second, we use the S&P Municipal Bond Utility Index ("Water" index). This benchmark is the best index to represent water-related risk in the US municipal bond market. The index consist of bonds from the public power, water and sewer, resources recovery, and other utility sectors[8].

[8] Information on S&P Dow Jones Indices and S&P Municipal Bond Indexes can be found in www.spindices.com.

Monthly returns of these indexes are come from Bloomberg. The monthly return of state-portfolios of funds in the sample is the response variable in the model.

We compare the risk profile of funds from states in geographical areas known for limited water resources like the West and the Southeast with funds from states with plenty of water resources. In this step we want to answer the question: are single-state muni-bond funds from states with limited water resources indeed riskier?

Empirical results

Table 3 shows descriptive statistics for the three measures of mutual fund risk for the complete sample of single-state municipal-bond funds. The average total risk is 1.3 percent, as measure by the average standard deviation of returns across all the funds in the sample. Panel A of Table 3 reports the results when equation 1 is estimated using the S&P Municipal Bond Index or the market index. The average value of systematic risk is 0.95 and the average idiosyncratic is 0.002. Panel B of Table 3 shows the results based on the S&P Municipal Bond Utility Index or water index. The average systematic and idiosyncratic are 0.84 and 0.003 respectively.

Although not reported in the table, we find that at the individual state-portfolio of fund level, we find that South Carolina and Florida have the largest levels of total risk and systematic risk based on the market index, while Connecticut and Ohio have the lowest. Regarding idiosyncratic risk based on the market index, Texas and California show the largest level, while Kentucky and Massachusetts have the lowest. Based on the water index, Virginia show the largest value followed by Massachusetts; Georgia and Missouri have the lowest. Finally, if we look at idiosyncratic based on the market model estimated with the water index as the benchmark, Ohio and Oregon have the highest value, while New York and Arizona the lowest.

We compared the risk profile of funds from states in geographical areas known for limited water resources with funds from states with plenty of water resources. We want to answer the question: are single-state municipal-bond funds from states with limited water resources indeed riskier? Table 4 presents the results to the Kruskal-Wallis test, a non-parametric procedure used to compare the medians of more than two groups. Also, Figure 1 to Figure 3 present the Boxplots for the three measures risks by geographical region. The median of the total risk is statistically different for the South and Northeast regions. In conjunction with The Boxplot in Figure 1, we can say that single-state municipal-bond funds from the states in South are riskier than the funds from the other regions. This is result is consistent with the evidence of water resources shortage in the South of the US. We know consider the results on systematic risk based on the Municipal or market index and the water. Figure 2 shows the Boxplot for the systematic risk by regions which must be consider together with the results in Table 4. Regardless of the benchmark used, we can conclude that funds from the South and the West display significantly higher systematic risk than funds from the states belonging to other regions of the US. This result is also consistent with evidence of limited water resources in the Southern and Western regions of the US.

Finally, Figure 3 shows the Boxplot for idiosyncratic risk based on both indexes. The results based on the market index are consistent with the previous results. That is, funds from South and the West are riskier than funds from states belonging to other regions of the US. However, we find no statistical difference in median idiosyncratic risk based on the water index. Although we are more interested in which funds are riskier, it is worth mentioning that funds from states in the Northeast are significantly safer than funds from states belonging to other regions. This results holds for all risk measures, except idiosyncratic risk based on the water index.

Conclusion

In this paper we examine the relationship between single-state municipal-bond funds risk and water scarcity in the US. Our analysis is based on three measures of mutual fund risk: total, systematic, and idiosyncratic. We examine funds from 26 different states, distributed in four geographical regions of the US. We find that funds from states from the South and the West of the US are indeed riskier that funds from other regions. This result is consistent with the evidence of limited water resources in these two regions of the US.

References

Álvarez, Marta and Javier Rodríguez, 2012, Performance and Diversification Value of Water-Related Open-end Mutual Funds, *Social Responsibility Journal*, forthcoming.

Álvarez, Marta and Javier Rodríguez, 2013, The Performance of Firms in the Water Industry, working paper – University of Puerto Rico.

Barnett, Cynthia. *Blue Revolution: Unmaking America's Water Crisis*. Beacon Press, 2011.

Glennon, Robert Jerome. *Unquenchable: America's water crisis and what to do about it*. Island Press, 2010.

Kihn, John. "The financial performance of low-grade municipal bond funds." *Financial Management* (1996): 52-73.

Koski, Jennifer Lynch, and Jeffrey Pontiff. "How are derivatives used? Evidence from the mutual fund industry." *The Journal of Finance* 54.2 (1999): 791-816.

Rakowski, David A., and Saiying Deng. "Geography and Local (Dis) Advantage: Evidence from Muni Bond Funds." *Available at SSRN 1571380* (2014).

Redman, Arnold L., and Nell S. Gullett. "Impact of fund, management and market characteristics on bond mutual fund performance." *Journal of Asset Management* 7.6 (2007): 429-442.

Singh, Sandeep, and William H. Dresnack. "Market knowledge in managed municipal bond portfolios." *Financial Services Review* 6.3 (1997): 185-196.

Table 1 Number of funds in the sample by state, region and division

State	Region	Division	Number of funds
Alabama	South	East South Central	13
Arizona	West	Mountain	54
California	West	Pacific	424
Colorado	West	Mountain	35
Connecticut	Northeast	New England	56
Florida	South	South Atlantic	112
Georgia	South	South Atlantic	41
Kansas	Midwest	West North Central	16
Kentucky	South	East South Central	19
Louisiana	South	West South Central	13
Maryland	South	South Atlantic	59
Massachusetts	Northeast	New England	118
Michigan	Midwest	East North Central	81
Minnesota	Midwest	West North Central	77
Missouri	Midwest	West North Central	28
New Jersey	Northeast	Mid-Atlantic	115
New York	Northeast	Mid-Atlantic	327
North Carolina	South	South Atlantic	52
Ohio	Midwest	East North Central	120
Oregon	West	Pacific	31
Pennsylvania	Northeast	Mid-Atlantic	130
South Carolina	South	South Atlantic	17
Tennessee	South	East South Central	23
Texas	South	West South Central	17
Virginia	South	South Atlantic	62
Washington	West	Pacific	8

Table 2 Descriptive Statistics of the single-state Municipal Funds

Variable	Mean	Median	Standard deviation	Coefficient of Variation (%)
Total Net Assets (TNA)	19.00	18.62	10.06	52.95
Turnover Ratio	0.20972	0.20433	0.04267	20.34
Expense Ratio	0.009866	0.009520	0.001426	14.45
Yield	0.03443	0.03264	0.00734	21.33
Mean Return	0.002903	0.002972	0.000285	9.81
Standard deviation of the returns	0.012505	0.013005	0.001822	14.57

Table 3 Risk Measures of single-state Municipal Funds

Panel A: Municipal Fund Index as Benchmark

Risk	Mean	Median	Standard deviation	Coefficient of Variation (%)
Total Risk	0.012505	0.013005	0.001822	14.57
Systematic Risk	0.9532	0.9958	0.1367	14.35
Idiosyncratic Risk	0.002160	0.002087	0.000787	36.44

Panel B: "Water" Index as Benchmark

Region	Mean	Median	Standard deviation	Coefficient of Variation (%)
Total Risk	0.012505	0.013005	0.001822	14.57
Systematic Risk	0.8367	0.8771	0.1217	14.54
Idiosyncratic Risk	0.003475	0.003448	0.000986	28.36

Table 4 Geographical Regions with statistically significant median differences for the Total, Systematic and Idiosyncratic risks

	Total Risk	**Municipal Fund Index Systematic Risk**	**Municipal Fund Index Idiosyncratic Risk**	**Water Index Systematic Risk**	**Water Index Idiosyncratic Risk**
Regions where medians are statistically different at 0.05 level	South, Northeast	South, Northeast; West, Northeast	South, Northeast	South, Northeast; West, Northeast	None

Appendix

Figure 1: Boxplot for Total Risk by Region

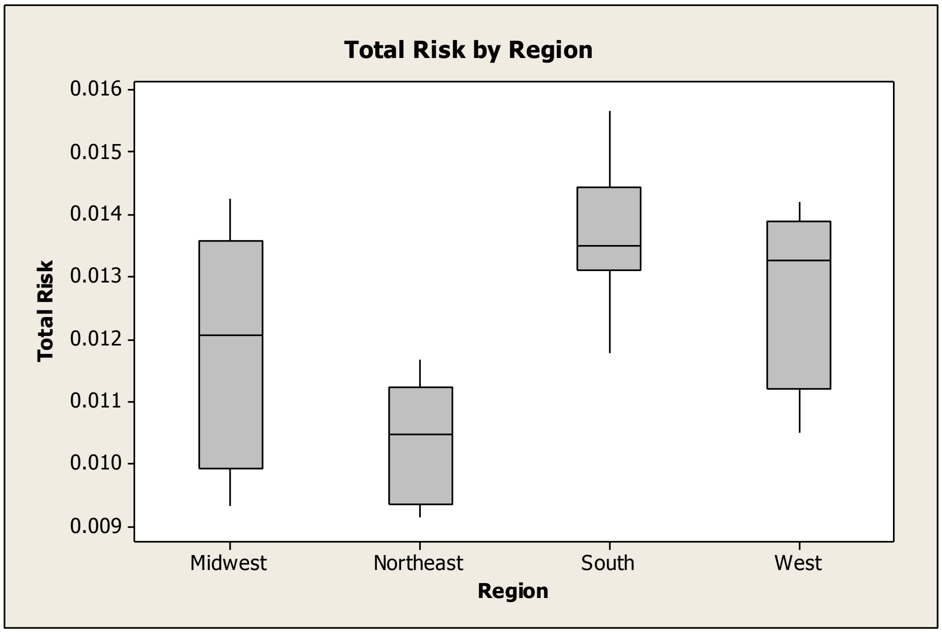

Figure 2: Boxplot for Systematic Risk by Region

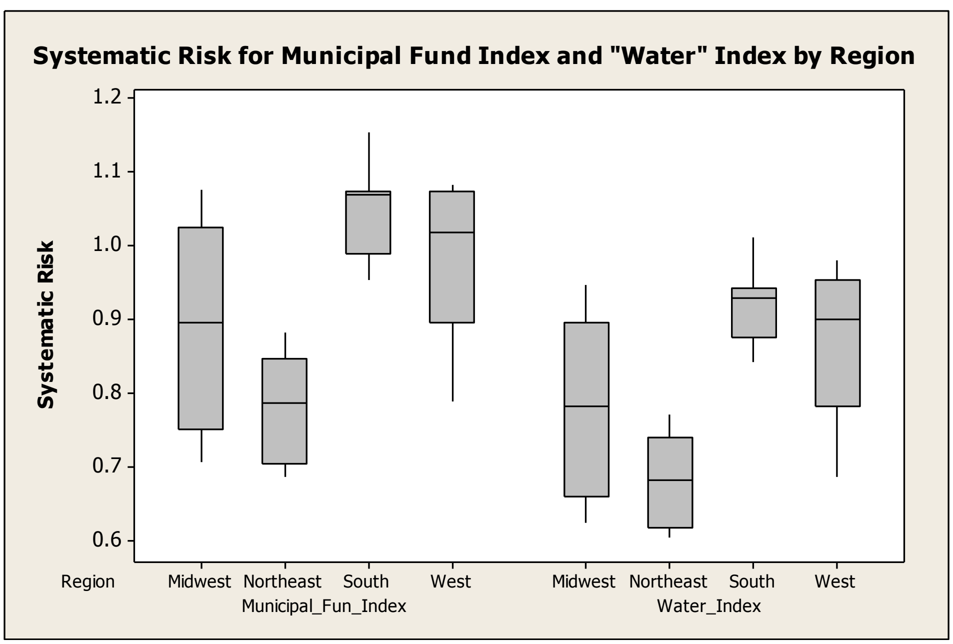

Figure 3: Boxplot for Idiosyncratic Risk by Region