Municipal Credit Ratings and Unfunded Pension Liabilities: New Evidence*

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***Abstract*:** This paper investigates whether a municipality's unfunded pension plan liabilities are associated with the municipality's credit rating. We answer this question by examining Moody's credit ratings for municipalities located within the state of Massachusetts. Focusing on a specific state helps us to avoid heterogeneity problems that have plagued prior studies employing multi-state data. Using panel data, and the ordered probit and ordered logit methodologies, our results demonstrate a significant negative relationship between unfunded liabilities and Moody's credit ratings. Furthermore, the standardized coefficients in both models are close in magnitude indicating robustness of the relationship. These results have public policy implications for municipalities.

Keywords: Municipal credit ratings, ordered logit, pension plan liabilities.
JEL classification: G180, H200, H700

1. Introduction

A municipality's credit rating is a crucial financial signal, and it increases in importance if the municipality relies or plans to rely on debt. This is because pension funds, banks and other financial institutions have restrictions on the debt instruments they can hold. Low credit ratings reduce the pool of funds that the municipality can draw on and this, in turn, raises the cost of debt financing to the municipality. Moreover, investors who can potentially invest in the municipality's debt will require higher returns to compensate them for the higher risk of default by the municipality.

Rating agencies consider many variables in determining a municipality's credit rating. These factors fall into four main categories: debt, financial, socioeconomic, and management factors. Although the literature on the effect of these factors is extensive, how unfunded pension plan liabilities affect the credit worthiness of a municipality is mixed and a clear resolution does not yet exist.[1]

Anecdotal evidence suggests that this is not a trivial issue. According to a *New York Times* article, Walsh (2006) reports that it is estimated that state and local governments owe their retirees $375 billion more than what has accumulated in their pension trust funds. In addition,

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[1] In the literature review that follows, we elaborate on why we believe this question remains unanswered.

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signs of public pension crises appear on the horizon, on both state and local government levels. As examples, consider the following: 1) in 2003, San Diego became involved in lawsuits and investigations for shortchanging its city's employee pension fund for years, and 2) according to Mancini and Martire (2006), by the end of 2006, the state of Illinois had accumulated more than 42.2 billion dollars of unfunded liabilities, the largest in the nation. This level of unfunded liabilities was $12.6 billion greater than the sum attributed to the state of Ohio, the second largest state in terms of unfunded liabilities. Further, it was greater than the nation's average of $7.2 billion by $35 billion.

The problem is not limited to the United States. Evidence from Britain's public sector pension liabilities indicates a similar debilitating situation. Record (2006) reports that:

> While the official government estimate of public sector pension liabilities is £530 billion, an estimate using more realistic assumptions than the government uses would be £1,025 billion. This sum is over 80 per cent of GDP and over twice the size of the official national debt. These commitments must be honoured by government, and thus pension liabilities should be regarded in the same way as the official national debt. Little can be done about the size of liabilities accumulated to date. (Record, 2006, p. 13).

Many other issues add to the funding problems of public pension plans such as the lack of uniformity with respect to financial disclosure. The likely result is that rating agencies will add a premium to states' or local governments' default risk as a result of this ambiguity. The default risk of public pension plans is exacerbated in their promises to their retirees, particularly for defined benefits plans. One clear risk measure is thus the level of unfunded liabilities. It is only to be expected that this metric should play a role in how rating agencies determine a municipality's credit rating.

Consequently, this leads to the primary research question of this paper. Specifically, we investigate whether the level of unfunded liabilities of pension plans affect the ratings of municipalities. Our examination focuses on municipalities in the state of Massachusetts. We employ ordered probit and ordered logit techniques for this purpose, and our results clearly support the hypothesis that an increase in unfunded liabilities decreases the credit rating of the municipality. The predicted probabilities indicate that after controlling for other known influential variables, increasing (decreasing) the funding level increases (decreases) the probability of a superior credit rating. Thus, municipalities that rely on debt financing should consider whether the savings they net from skimping on fully funding their pension plans are sufficient to overcome the higher costs of debt that arise from lower credit ratings.

This paper proceeds as follows. Section two reviews the literature, while section three presents the data and hypotheses. In section four, we discuss the model and empirical methodology. The results are presented and discussed in section five. Our conclusions are found in the last section.

2. Literature Review

The literature in the area of municipal credit ratings falls into three categories. The first examines the factors that influence credit ratings. The second concerns the choice of models for credit ratings. The third compares the different rating agencies with regard to the differences in factors that influence their ratings. Lipnick *et al.* (1999) pointed out that Moody's uses variables that fall into four broad categories to estimate the credit worthiness of municipalities. These

categories are: debt, financial, socioeconomic, and administrative variables. Previous studies used different variables that fall in these four categories in order to simulate credit ratings. Besides these categories, an analyst's personal judgment will also influence the rating to a certain degree. Recently, neural networks techniques are being employed to investigate the effect of human factors on ratings (see Chaveesuk *et al.* 1999). Since our research question overlaps the first two strands, we discuss the milestones in these areas.

First, Carleton and Lerner (1969) developed a statistical scoring system in order to predict Moody's ratings for municipal bond issues which produced mixed results. Morton and McLeavey (1978) employed socioeconomic variables to group similar municipalities and used cluster analysis to classify each municipality into a different rating group. Their classification was similar to Moody's only for the top rated municipalities. Aronson and Marsden (1980) attempted to predict Moody's ratings for a sample of a twenty four large cities in the United States using discriminant analysis. They reported results showing a correct classification rate of 83%. However, Cluff and Farnham (1985) argued that their results were biased upward because the sample was not representative. Raman (1981) and Copeland and Ingram (1982) found that the financial statement (i.e., accounting) numbers were a good predictor of municipal bond ratings but not as strong as the results obtained in studies of corporate bond ratings.

Wescott (1984) argued that the economic environment is more important in assessing the credit worthiness of a city's general obligation bonds than the independent consideration of its accounting ratios. He employed both financial ratios and socioeconomic variables, and found that the joint relationship of accounting numbers and socioeconomic measures did not improve the ability to explain municipal general obligation bond ratings. Wescott concluded that the lack of success of municipal bond-ratings studies may be attributed to the subjective nature of the bond rating process. Cluff and Farnham (1985) employed probit analysis on a larger and more varied dataset (976 cities and 23 independent variables) and found that population characteristics and housing stock are important determinants of credit ratings.[2]

The samples employed in those studies pertain mostly to cities that are located in different states, and our intention here is to employ a sample of municipalities that are concentrated within the state of Massachusetts. This is advantageous since it guarantees financial disclosure consistency among municipalities as it is mandated by Massachusetts' General Law.[3] Further, state laws that govern aid to municipalities will be uniform across the municipalities in that state. We also employ new variables as well as re-examine others that have been previously employed. These variables are calculated on a municipality level and are expected to convey some information about the determinants of municipalities' credit ratings.

Although research exists on the effect of pension plan liabilities on bond ratings, the lack of data measuring these liabilities has been a limiting factor. Since most of the public pension funds are defined benefit plans, unfunded liabilities could arise. The pension plan's revenues come from two sources: (a) employee and employer contributions, and (b) investment revenues from assets held by the pension plan. These revenues are used to pay for current retiree benefits and for additional investments. If the pension plan's present value of assets exceeds the present value of its obligations to retirees, it is overfunded. On the other hand, if the reverse occurs, it is underfunded. If certain thresholds for this underfunding level are exceeded, an increase in municipal taxes may be necessary to pay the retirees or restore the pension plan to a reasonable funding level.

[2] See also Moon and Stotsky (1993).
[3] We elaborate on this advantage subsequently in the data section.

From a credit assessment perspective, the question to be raised here is, "Do unfunded liabilities of public pension plans affect credit ratings, and as a result, borrowing costs?" Copeland and Ingram (1983) constructed two financial ratios to estimate the effects of pension liabilities on ratings and found no results supporting a relationship between them. They concluded: "An empirical assessment of the association between various pension ratios and bond ratings, bond yields, and market risk revealed little explanatory power in the pension variables." (p.147).

Marks and Raman (1985) used information about state and municipal pensions that correlate with unfunded liabilities of pension funds and found a significant relationship on the state level but not for municipalities. Maher and Thompson (1998) found that pension liabilities on the balance sheet do not impact market risk beyond what is included in the bond rating. For corporate bond ratings, Carroll and Niehaus (1998) found evidence supporting an asymmetric effect wherein the underfunding of defined benefit plans affects the rating negatively, more so than any positive effect associated with overfunding.

Given the above discussion, the published evidence on *municipal credit ratings per se indicates that there is no relationship* (see Copeland and Ingram 1983; Marks and Raman 1985) to unfunded pension liabilities. Specifically, the three financial ratios employed by Copeland and Ingram (1983) which include: 1) total plan receipts to total payments, 2) total plan assets to total expenditures, and 3) total expenditures to total fire and police departments' salaries, did not result in any significant relationship with credit ratings. Also, the ratio of total plan assets to total benefit payment employed by Marks and Raman (1985) was significant only on the state level. It is our objective to re-examine this issue using better data and econometric techniques. Specifically, we estimate a model for municipal credit ratings that accounts for the unfunded liabilities of the pension plan in each municipality.

This study differs from others by employing actuarial estimates of unfunded liabilities that have been calculated by the pension plan according to standardized methods imposed by The Public Employee Retirement Administration Commission (PERAC) in the state of Massachusetts. In addition, we employ a new set of variables that are unique in that they are measured at the municipality level and have never been used in previous studies. The unique data thus enable a more meaningful empirical analysis to be performed.

3. Data and Hypotheses

In order to develop a sound estimation model of credit ratings, the data must be consistent across municipalities. This avoids estimation problems associated with heterogeneity. Municipalities in different states do not have unified conventions with regard to public pension financial reporting requirements. Therefore, we believe that analyses employing data from municipalities from different states could be erroneous since these municipalities may use different accounting methods in reporting their financial statements leading to heterogeneity in the data.[4] However, within any single state, municipalities will follow a uniform accounting method based on state laws governing financial disclosures. Thus, we contend that employing data for municipalities within a particular state may lead to more consistent empirical tests due to homogeneity in the data.

[4] This may be the reason why prior studies may not have been able to discern a relationship between unfunded liabilities of pension plans and municipal ratings.

We concentrate our analysis on a sample derived from 351 municipalities located within the state of Massachusetts. The primary advantage here is that this state has standardized methods for municipal financial disclosures. The Department of Revenue (DOR) in the state of Massachusetts collects municipal data on financial, debt, and socioeconomic variables every year and presents them in a consistent manner, making cross-sectional and time-series comparison easy.

More importantly, by law, the Public Employee Retirement Administration Commission (PERAC) of Massachusetts supervises all the public pension plans in the state. Section 5.01 from PERAC Records and Reports Regulations states:

> 840 CMR 5.00 is the standard rule for records and reports which shall be required by the Public Employee Retirement Administration Commission. Except as otherwise provided by the Commission or by supplementary rules of a particular retirement board approved by the Commission pursuant to 840 CMR 14.02, all records and reports shall be required as of the dates outlined in 840 CMR 5.00 and as outlined in M.G.L. c. 32. (Employee Retirement Administration Commission (PERAC), www.mass.gov/perac/)

Therefore, we emphasize the point that the sample we employ has the advantage of consistency in the data with respect to the financial, debt, and socioeconomic variables, as well as the variable of interest, the pension funding status. Additionally, we employ an unbalanced panel that spans a reasonably long period from 1991 to 2006, which should contain a wide variation in the ratings as well as the level of unfunded liabilities.

For the credit ratings, we initially started out with a sample of Moody's ratings for 351 municipalities in Massachusetts. The Moody's ratings schedule for our sample has nine categories starting from C at the bottom, and going up to Aaa at the top. Table 1 illustrates this hierarchy of ratings.

In 1997, Moody's modified its rating schedule by adding subscripts 1, 2, and 3 for the categories below Aaa to identify whether the municipality is in the top, the middle, or the lower range of the particular rating category. However, in order to maintain consistency between the ratings before and after 1997, we ignore this modification, and employ only the broad rating categories.[5]

Importantly, we note here that the rating we employ is the rating for uninsured revenue bonds.[6] For our sample, there are 3798 rating observations distributed over municipalities and the study period. There are 155 observations with an Aaa rating, 786 are Aa, 2342 are A, 489 are Baa, 25 are Ba, and only one which is B rated. This means that our analysis will be restricted to six categories starting from B to Aaa. Also, it is clear from the distribution of the ratings that the majority of the observations are in the A rating category. The ratings are recoded numerically from 1 for the lowest (most inferior credit quality), to 6 for the top and the average value of the recoded ratings was 4.20, which corresponds to the A category.

However, we note that the estimation sample will not include all of the 3798 rating observations. This is because we do not have data on actuarial valuation for the unfunded liabilities for every year of our sample period. In fact, prior to the implementation of GASB No.25 which was effective in 1996 and the creation of the PERAC, retirement systems were

[5] The only effect this should have, if any, is to weaken our results. Thus, this should not be an impediment to our study.

[6] We ignore insured municipal debt because the rating on such debt reflects the rating of the insurance company that insures the debt issue, and has little to do with the financial standing of the municipality *per se*.

reporting the actuarial valuation for the unfunded liabilities only once every three years. After 1996, retirements systems started reporting their actuarial valuations for the unfunded liabilities every two years as mandated by GASB No.25. A point to note here is that few municipalities report it every year as recommended by Chapter 32 of Massachusetts General Law.[7] In Table 2, we present the distribution of data for each variable in each year. Given that some variables have missing values for different years, our final sample dataset ends up being an unbalanced panel.

Table 1: Hierarchy of Moody's Ratings

Moody's Rating	*Definition*
Aaa	Issuers or issues rated Aaa demonstrate the strongest creditworthiness relative to other US municipal or tax-exempt issuers or issues.
Aa	Issuers or issues rated Aa demonstrate very strong creditworthiness relative to other US municipal or tax-exempt issuers or issues.
A	Issuers or issues rated A present above-average creditworthiness relative to other US municipal or tax-exempt issuers or issues.
Baa	Issuers or issues rated Baa represent average creditworthiness relative to other US municipal or tax- exempt issuers or issues.
Ba	Issuers or issues rated Ba demonstrate below-average creditworthiness relative to other US municipal or tax-exempt issuers or issues.
B	Issuers or issues rated B demonstrate weak creditworthiness relative to other US municipal or tax- exempt issuers or issues.
Caa	Issuers or issues rated Caa demonstrate very weak creditworthiness relative to other US municipal or tax-exempt issuers or issues.
Ca	Issuers or issues rated Ca demonstrate extremely weak creditworthiness relative to other US municipal or tax-exempt issuers or issues.
C	Issuers or issues rated C demonstrate the weakest creditworthiness relative to other US municipal or tax-exempt issuers or issues.

Notes: **"US Municipal Ratings:** Moody's US Municipal ratings are opinions of the investment quality of issuers and issues in the US municipal market. As such, these ratings incorporate Moody's assessment of the default probability and loss severity of these issuers and issues. The default and loss content for Moody's municipal long-term rating scale differs from Moody's general long-term rating scale. Historical default and loss rates for obligations rated on the US Municipal Scale are significantly lower than for similarly rated corporate obligations. It is important that users of Moody's ratings understand these differences when making rating comparisons between the Municipal and Global Scales." **"US Municipal Long-Term Debt Ratings:** Municipal Ratings are based upon the analysis of five primary factors related to municipal finance: market position, financial position, debt levels, governance, and covenants. Each of the factors is evaluated individually and for its effect on the other factors in the context of the municipality's ability to repay its debt."
Source: www.moodys.com. US municipal Long-Term debt ratings are defined by Moody's as follows:

Accordingly, Table 3 provides the distribution of ratings for our final sample of 346 observations with non-missing values for all the variables we employ in our estimation models. There are 37 observations with an Aaa rating, 84 are Aa, 162 are A, 62 are Baa, and only one is Ba rated. The distribution of ratings in the estimation sample resembles the ratings distribution for the whole sample in that there are more ratings in the upper categories.

[7] Given our results to be discussed later in the paper, the lack of timeliness in reporting of pension plan liabilities is cause for concern.

Table 2: The Number of Available Observations for Each Variable in Each Year

For Year	Moody's Credit Ratings	Unfunded Liabilities as % of Equalized Valuation	Single Family Tax Bill	State aid as % of Total Revenues	Total Stability Factors as % of Equalized Valuation	Debt Service as % of Budget	Debt Service as % of Equalized Valuation	Number of Births as % of Total Population	Unempl-oyment Rate	Excess Capacity as % of Maximum Levy	Registered Voters Democrat as % of Total Registered Voters	Retired Health Insurance as % of Equalized Valuation
1991	207	2	265	351	351	351	351	351	351	351	0	351
1992	211	10	339	351	351	351	351	351	351	351	351	351
1993	213	7	339	351	351	351	351	351	351	351	351	351
1994	218	6	340	351	351	351	351	351	351	351	351	351
1995	227	12	340	351	351	351	351	351	351	351	0	351
1996	229	15	340	351	351	351	351	351	351	351	351	351
1997	236	15	340	351	351	351	351	351	351	351	0	351
1998	239	27	340	351	351	351	351	351	351	351	351	351
1999	245	26	340	351	351	351	351	351	351	351	0	351
2000	251	32	340	351	351	351	351	351	351	351	351	351
2001	252	35	340	351	351	351	351	351	351	351	0	351
2002	262	35	340	351	351	351	351	351	351	351	351	351
2003	260	30	340	351	351	351	351	351	351	351	0	351
2004	257	45	340	351	351	351	351	351	351	351	351	351
2005	233	31	340	351	351	350	351	351	351	351	0	351
2006	258	53	351	351	351	351	351	351	351	351	351	351
Total	3798	381	5374	5616	5616	5615	5616	5616	5616	5616	3159	5616

Notes:

This represents the number of observations available for each variable based on the complete data set. The data for the unfunded liabilities are taken from Public Employees Retirement Administration Commission (PERAC) in the State of Massachusetts. The data for the other variables are taken from the Department of Revenue (DOR) in the State of Massachusetts. The observations included in the estimation are based on the availability of data for unfunded liabilities as a percentage of equalized valuation.

Table 3: Frequency Distribution of Ratings in the Estimation Sample

	Aaa	Aa	A	Baa	Ba
1991	0	1	1	0	0
1992	0	2	4	3	0
1993	0	2	2	1	1
1994	0	3	1	1	0
1995	1	3	4	4	0
1996	1	4	4	3	0
1997	1	4	7	2	0
1998	2	6	11	6	0
1999	2	6	9	6	0
2000	3	8	14	3	0
2001	4	3	20	7	0
2002	4	9	14	4	0
2003	4	3	17	4	0
2004	5	10	19	7	0
2005	2	7	14	3	0
2006	8	13	21	8	0

Notes: The Moody's ratings data are obtained from the municipal data bank of the Massachusetts department of revenue. Also, they are available from Moody's website as uninsured Long-Term municipal debt ratings. As can be seen, the lowest rating in the estimation sample (the sample after deleting missing observations) is Ba. However, for the complete sample, the lowest rating is B. This is the reason for having 6 ratings codes (6 for AAA and 1 for B) in our econometric estimations.

The unfunded actuarial accrued liability is the difference between the actuarial accrued liability[8] and the actuarial valuation of assets. The data for the unfunded liabilities is taken from public pension periodical reports. In Massachusetts, each pension system is governed by a retirement board, and all boards, although operating independently, are governed by Chapter 32 of the Massachusetts General Laws. This regulation imposes uniform benefits, uniform contribution requirements and uniform accounting and funds structure for all systems.

In Table 4, we present descriptive statistics for the variables in our sample. Although not shown in Table 4, the mean value for the unfunded liabilities is $55,654,300, the standard deviation is $62,196,049, and the median value is $32,181,188. The minimum value of the unfunded liabilities is -$31,012,134 (over funded) and the maximum is $372,700,000. Thus, there is considerable variation in this variable of interest to our study.

For larger municipalities, it is possible that the independent variables will have values that are different by orders of magnitude. This will make comparisons between different municipalities of different sizes difficult. Therefore, we control for the size variation between municipalities by scaling the variables by the equalization valuation (Eqz). According to the DOR[9], Eqz is defined as follows:

[8] According to DOR, it is the portion of the actuarial present value of pension plan benefits which is not provided by future normal costs or employee contributions. It is the portion of the actuarial present value attributable to service rendered as of the valuation date.

[9] Department of Revenue of the state of Massachusetts: www.mass.gov

Table 4: Descriptive Statistics of the Estimation Sample

Variable	Mean	Median	Standard Deviation	Number Of Observations
Unfunded Liabilities as % of Equalized Valuation	0.03	0.01	0.05	381
Average Single Family Tax Bill	2932.02	2595.00	1449.39	349
State aid as % of Total Revenues	0.25	0.19	0.16	381
Total Stability Factors as % of Equalized Valuations	0.002	0.001	0.002	381
Debt Service as % of Budget	0.03	0.001	0.04	381
Debt Service as % of Equalized Valuations	0.003	0.002	0.003	381
Unemployment Rate	0.05	0.04	0.02	381
Number of Births as a % of Total Population	0.01	0.01	0.002	381
Excess Capacity as a % Maximum Levy	2.19	0.10	3.98	381
Registered of Voters Democrat as a % of Total Registered Voters	0.38	0.35	0.14	230
Retired Health Insurance Costs as % of Equalized Valuation	0.00	0.00	0.00	381
Rating code	4.27	4.00	0.89	346

Notes: The descriptive statistics below are based on the sample after deleting missing observations. The data for the unfunded liabilities are taken from Public Employees Retirement Administration Commission (PERAC) in the State of Massachusetts. The data for the other variables are obtained from the Department of Revenue (DOR) in the State of Massachusetts.

> A municipality's Eqz is the sum of the estimated fair market value for each property class plus an estimate of new growth, resulting in values indicative as of January 1.

Moreover, DOR goes into defining the importance of Eqz by the following statement:

> The Eqz is a measure of the relative property wealth in each municipality. Its purpose is to allow for comparisons of municipal property values at one point in time, adjusting for differences in local assessing practices and revaluation schedules.

And finally, the DOR indicates in their definition, the uses of Eqz as:

> Eqz has historically been used as a variable in the allocation of certain state aid distributions, the calculation of various states and counties assessments to municipalities, and the determination of municipal debt limits.

Therefore, we use the ratio of the unfunded liabilities to the equalized valuation in each municipality instead of the raw value of the unfunded liabilities in order to eliminate the effect of size variation between the communities. In other words, the equalized valuation is used to deflate the raw unfunded liability amount to arrive at the unfunded liabilities as a percentage of the equalized valuation. Note that this is now the variable of interest for our investigation into unfunded liabilities for our hypothesis tests. As shown in Table 4, the mean value of the unfunded liabilities as a percentage of the equalized valuation is 0.03, the standard deviation is 0.05, and the median value is 0.01.

Rating agencies claim that: (a) they consider subjective factors that cannot be quantified, (b) they consider more variables than current models have incorporated, and (c) the rating process is too complicated to be reduced to a few equations. However, previous studies have shown that approximately two-thirds of the variation in ratings can be predicted on the basis of a

fairly small number of variables (see Ederington 1985). Therefore, we incorporate other explanatory variables that fit into the debt, financial, socioeconomic, and administrative categories.

The first set of variables is the financial category. In this category, we employ three variables, which are: (a) average single family tax bill, (b) state aid as a percentage of total revenues, and (c) total stability factors as a percentage of the equalized valuation. As per DOR guidelines, the average single family tax bill is computed by

> dividing the combined single family assessed value by the number of single family parcels for each community and then multiplying the average value by the residential tax rate and dividing by one thousand.

We do not standardize this variable to reflect the size differences between municipalities because we contend that the division by the number of parcels in each municipality as described above takes care of this issue (i.e., it has already been scaled across the various municipalities). There are two possibilities as to how the single family tax bill variable will be associated with the credit rating. First, we argue that as the single family tax bill in the municipality increases, the credit rating should decrease. Specifically, if the tax is already high, there is little wiggle room to raise the taxes further to cover debt service, thereby exacerbating default risk. This logic would predict a negative association between the variable and credit rating. On the other hand, a high single family tax bill may be taken as an indication of a community with high median household income (which falls in the socioeconomic variables category). This higher income would imply a more prosperous community which would be able to better withstand any economic shocks. This would argue for a positive relationship between the single family tax bill and credit ratings. Given that both a negative and a positive relationship could exist, this boils down to an empirical question that must be examined. The mean value for the single family tax bill is $2,932.02, the standard deviation is $1,449.39, and the median is $2,595. To our knowledge, this variable has not been used previously to examine municipal ratings.

State aid as a percentage of total receipts indicates the degree of reliance on outside sources of income, over which the municipality has no direct control. These funds may be cut without much advance notice putting the municipality at risk of default. As such, these subsidies may not be a reliable source of funds in the future for debt service. Consequently, we argue that credit ratings should be negatively associated with the state aid variable. The mean value for state aid as a percentage of total revenues is 0.25, the standard deviation is 0.16, and the median is 0.19. State aid has also been used by Michel (1977) who reports an *insignificant* relationship to ratings. Wescott (1984) used the ratio of own revenue to the total revenues to indicate the reliance of the community on its own sources and found it to be *insignificant*. The ratio we use here is similar to their ratio but it proxies for the reliance of the community on outside sources of income.[10]

The total stability factors as a percentage of the equalized valuation signals the financial stability of the municipality in the future. Stability factors consist of three different funds: stabilization funds,[11] overlay reserves,[12] and free cash.[13] As the municipality increases its

[10] However, given that our data is uniquely concentrated on municipalities in Massachusetts, we believe that inter-state differences in aid policies that could have affected prior studies may not be a factor here.

[11] The stabilization fund is a fund within a municipal accounting system used to accumulate amounts for capital for other future spending purposes. Communities may appropriate into this fund an annual amount not to exceed ten percent of the prior year's tax levy or a larger amount with the approval of the Emergency Finance Board. The

accumulation in these funds, it becomes more financially stable and its credit rating should improve. We compute this variable as the sum of three funds scaled by the equalized valuation. To our knowledge, prior studies have never used this variable. As mentioned previously, since large municipalities can accumulate larger funds, we control for scale differences by dividing the stability factors by the equalized valuation in each municipality. The mean value for stability factors as a percentage of equalized valuation is 0.002, the standard deviation is 0.002, and the median is 0.001. These stability factors can be viewed as additional liquidity (i.e., slack) that the municipality can draw upon if necessary.

For the socioeconomic category, we employ the birth rate and the unemployment rate. The birth rate is calculated by dividing the number of births in each year by the population in the same year. We expect that as the birth rate increases, the rating decreases. This is justified by observing that the increase in the birth rate increases the municipality's burden with regard to health care and education infrastructure demands. Additionally, it is possible that some workers could choose to withdraw from the workforce to stay at home with their newborn, which reduces the community's income tax collection and share of state income taxes. The mean value for this variable is 0.01, the standard deviation is 0.002, and the median is 0.01.

The birth rate has been previously used by Wescott (1984) and found to be significant. However, other studies have used the raw population value. It has proved to be significant in each of Carleton and Lerner (1969), Horton (1970), Bahl (1971), and Morton (1976), while it was found to be insignificant in Rubenfeld (1973). Raw population values by themselves may not be sound empirical measures of socioeconomic factors. For example, larger municipalities are naturally expected to have larger populations. Therefore, in the interests of using a more consistent measure, we employ the population growth rate.

The unemployment rate variable is employed by Cheung (1996) and found to be significant while other studies used employment-related variables in order to test the diversification of the municipality (e.g., Wescott 1984). For our model, we employ the ratio of unemployed individuals to the labor force to estimate the effect of unemployment on the municipal rating. We argue here that municipalities with a high unemployment rate will have a lower credit rating. This is because a high unemployment rate reduces income taxes and reflects poor economic conditions in the municipality. For our sample, the mean value for the unemployment rate is 0.05, the standard deviation is 0.02, and the median is 0.04.

For the debt category, we employ two variables – (a) debt service as a percentage of the operating budget and (b) debt service as a percentage of equalized valuation. According to

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aggregate of the stabilization fund shall not exceed ten percent of the community's equalized value, and any interest shall be added to and become a part of the fund. A two-thirds vote of town meeting or city council is required to appropriate money from the stabilization fund (as per DOR).

[12] An account established annually to fund anticipated property tax abatements, exemptions and uncollected taxes in that year. The overlay reserve is not established by the normal appropriation process, but raised on the tax rate recapitulation sheet (as per DOR).

[13] This is defined as unrestricted funds from operations of the previous fiscal year that are certified by the Director of Accounts as available for appropriation. Remaining funds include unexpended free cash from the previous year, receipts in excess of estimates shown on the tax recapitulation sheet, and unspent amounts in budget line-items. Unpaid property taxes and certain deficits reduce the amount that can be certified as free cash (as per DOR).

DOR, the debt service amount includes the sum of interest on long-term, short-term, and other forms of debt, in addition to any amounts of long-term debt to be retired. We scale the debt service amount in two ways – first, as a percentage of equalized valuation, and second, as a percentage of operating budget.[14] The debt service as a percentage of operating budget captures the burden of the debt on the operating budget, while the debt service as a percentage of the equalized valuation captures the burden on the tax base of the municipality.

We argue here that both of the debt variables will have a negative effect on the municipality's rating. Specifically, the higher the debt service variables, the lower the credit rating. The mean value for debt service as a percentage of the budget and debt service as a percentage of the equalized valuation are 0.03 and 0.003, the standard deviations are 0.04 and 0.003, and the medians are 0.001 and 0.002, respectively.

The excess capacity as a percentage of the maximum levy is included as a proxy for the management factor that is usually considered by Moody's in their criteria for the municipalities' credit ratings. In Massachusetts, Proposition 2½, approved by voters in 1980, and first implemented in fiscal year 1982, directly addresses this issue. LeBovidge and Perry (2005) from DOR describe the main implications of Proposition 2½ as follows:

> Proposition 2½ places constraints on the amount of the levy raised by a city or town and on how much the levy can be increased from year to year. A levy limit is a restriction on the amount of property taxes a community can levy. Proposition 2½ established two types of levy limits: First, a community cannot levy more than 2.5 percent of the total full and fair cash value of all taxable real and personal property in the community which is referred to as the levy ceiling. Second, a community's levy is also constrained in that it can only increase by a certain amount from year to year. Proposition 2½ does provide communities with some flexibility. It is possible for a community to levy above its levy limit or its levy ceiling on a temporary basis, as well as to increase its levy limit on a permanent basis. A community can assess taxes in excess of its levy limit or levy ceiling by successfully voting a debt exclusion or capital outlay expenditure exclusion. The amount of the exclusion does not become a permanent part of the levy limit base, but allows a community to assess taxes for a certain period of time in excess of its levy limit or levy ceiling for the payment of certain debt service costs or for the payment of certain capital outlay expenditures.

The justification for using this variable as a proxy for the management factor is that Moody's may perceive a municipality to possess strong and persuasive management if the municipality has been able to increase its levy. From this point of view, as this variable increases, the rating should increase. The mean value for the excess capacity as a percentage of the maximum levy is 2.19, meaning that, on average, municipalities comply with Proposition 2½. The standard deviation is 3.98 and the median is 0.10[15]

[14] The total budget is the sum of municipal revenues in the following categories: Tax Levy, State Aid, Local Receipts and Other Receipts. These revenues are used to fund the operating budget of a community.

[15] The variable excess capacity as a percentage of maximum levy had a large outlier because that municipality was given special permission to exceed the limits of proposition 2.5. Whether this outlier was included or not in the estimation process, the coefficient on our variable of interest, Unfunded Liabilities as a percentage of equalized valuation, continued to be significant. This shows robustness of the relationship between unfunded liabilities and credit ratings.

Retiree health benefits provision may be considered another major problem that municipalities may face in the future. Municipalities, through their public pension systems may promise health benefits to their employees after retirement. If the pension system is underfunded, these promises will be a burden on the municipalities when they come due. By including this variable, we test whether retirement health benefits affect the credit rating. We hypothesize that as the costs of the retiree health insurance increase, the rating should decrease. The mean value for retirement health insurance is $238,821.73, the standard deviation is $23,065.02, and the median is $8,747.[16] We note here that, to our knowledge, ours is the first study to examine the effect of retiree health benefits on municipal credit ratings.

Casual observation suggests that political affiliation may determine financial policy. For example, Republicans are known to favor policies stressing tax reduction and smaller government, while the opposite seems to be true for Democrats. This informal insight may affect our empirical examination and must be controlled for. Specifically, we argue that municipalities with Democratic majorities may be more liberal in public spending on social programs leaving fewer resources for debt service, and as a result, this might affect credit ratings negatively. We employ the ratio of the registered voters who are Democrats as a percentage of the total voter base as our proxy variable for political affiliation. On average 38% are registered Democrat, 13% are registered Republican, and 49% are registered for others or not enrolled. These figures suggest that Massachusetts has a Democratic majority, while a larger number are not committed to any major party.[17]

4. Model and Methodology

A municipal credit rating can be viewed as a measure that is constructed from a continuous, unobserved underlying index which measures the propensity to default. Empirically, we see only the rating that this index generates but we do not observe the operational process determining the index. Each rating class corresponds to a certain range on the underlying index; a higher rating corresponds to a higher range on that index. Thus, the credit rating is an ordinal representation of that index (see Long and Freese 2006). For our empirical model, we assume that the unobservable index is a linear function of the municipality's observable characteristics, the unfunded liabilities, and an error term. Specifically, we assume:

$$y_{it}^{*} = \alpha + \beta' X_{it} + \gamma' UAAL_{it} + \varepsilon \qquad (1)$$

where y_{it}^{*} is the unobservable index; X_{it} represents other explanatory variables other than the unfunded liabilities; and *UAAL* represents the unfunded liabilities for each plan in each municipality over the study period. The subscript, *i*, represents the municipality, while the subscript, *t*, indexes the time period for the observation.

In the credit rating context, linear probability models are not useful to analyze the rating because we have more than two categories for the credit rating, starting from Aaa and ending in

[16] In our empirical estimations, we deflate the raw dollar amount by the equalization value to enable comparability across municipalities of different size. The mean and median for this deflated variable as shown in Table 4 are very small.

[17] We examined the correlation between the variables we proposed above and found that the correlations are reasonably low enough such that we do not expect multicollinearity to be a problem. The highest correlation occurs between debt service as a percentage of budget, and debt service as percentage of equalized valuation. Consequently, these two variables are not employed simultaneously in our empirical models.

B for our sample. Also, the polychotomous model that makes use of multinomial probit or multinomial logit does not take into account the inherent order that characterizes the credit rating scale. Therefore, we need a model that considers the inherent ordered ranking of a polychotomous, ordinal, and unobserved creditworthiness index.

Ordered Multinomial Probit (OMP) and Ordered Multinomial Logit (OML) models overcome the defects of alternate methods because they consider the inherent order and the polychotomous nature of the creditworthiness index. Also, these methods assume the range of the unobserved underlying index between the observed rating classes is unknown. The difference between OMP and OML is the assumption about the probability distribution function which underlies the rating. The first makes use of the cumulative normal distribution while the second employs the logistic distribution. As mentioned before, the index y^* is unobserved. What is observed is *y*, the credit rating that results from this index. Specifically, we assume that:

$$y = Aaa \text{ if } y^* \geq \mu_5\,, \qquad y = Aa \text{ if } \mu_5 > y^* \geq \mu_4\,, \ldots \text{etc}$$

where μ_i represents the partitioning boundaries or cut points on the domain of the underlying index, y^*. The estimation is performed using maximum likelihood which is characterized by the following asymptotic properties: consistency, normal distribution, and efficiency. As mentioned before, the character-based ratings (Aaa, Aa, and A...) were recoded into a number as (6, 5, 4...) and the probability of getting each of the ratings classes is defined as the following:

$$prob(y = Aaa\,, \text{or } 6) = \phi(\mu_5 - \beta' x)$$

$$prob(y = Aa\,, \text{or } 5) = \phi(\mu_4 - \beta' x) - \phi(\mu_5 - \beta' x), \ldots$$

$$prob(y = B\,, \text{or } 1) = 1 - \phi(\mu_1 - \beta' x)$$

where ϕ is the appropriate cumulative distribution function (CDF). The maximum likelihood function is thus:

$$L(y|x) = \sum_{k=1}^{n} \Bigg\{ Y_{5k} log\phi(\mu_6 - \beta' x_k) + \sum_{i=2}^{4} Y_{ik} \log[\phi(\mu_i - \beta' x_k) - \phi(\mu_{i-1} - \beta' x_k)] + Y_1 \log[1 - \phi(\mu_1 - \beta' x_k)] \Bigg\} \tag{2}$$

This says that $Y_{ik} = 1$ if the realization of the k^{th} observation is the rating *i*, otherwise $Y_{ik} = 0$. Once the maximum likelihood function is formed, the estimation of $\beta' s$ and $\mu' s$ can be undertaken such that the likelihood function is maximized.

Two important issues must be considered when performing the estimation. First, the direction of change of probabilities as a result of a change in the explanatory variable, x, is not uniform. If β is positive, then an increase in x will increase the probability of getting the top rating class Aaa, while it decreases the probability of getting the bottom rating class, B. For the other rating classes, the effect on the probabilities might be in any direction. Second, β probit or logit does not represent the change in the probability for a given outcome due to a unit change in the relevant explanatory variables. Therefore the marginal change in y^* with respect to x_{it} is calculated as follows:[18]

$$\frac{\partial y^*}{\partial x_{it}} = \beta_{it} \tag{3}$$

[18] See Long & Freese (2006).

Since y^* is latent, it must be noted that the marginal change cannot be interpreted without standardizing by the estimated standard deviation of y^*, where y^* is the solution to the maximum likelihood function:

$$\hat{\sigma}^2_{y^*} = \hat{\beta}' \, \widehat{Var}(x) \, \hat{\beta} + Var(\varepsilon) \tag{4}$$

where $\widehat{Var}(x)$ is the covariance matrix for the observed $x's$, $\hat{\beta}$ is the ML estimate of the coefficient vector, and $Var(\varepsilon) = 1$ for ordered probit and $\pi^2/3$ for ordered logit. Then, the standardized coefficient for x_{it} is:

$$\beta_k^{sy^*} = \frac{\beta_k}{\sigma_{y^*}} \tag{5}$$

which can be interpreted as: for a unit increase in x_{it}, y^* is expected to increase by $\beta_k^{sy^*}$ standard deviations, with all other variables held constant. The fully standardized coefficient is:

$$\beta_k^s = \frac{\sigma_k \beta_k}{\sigma_{y^*}} = \sigma_k \beta_k^{sy^*} \tag{6}$$

Eq. (6) can be interpreted as: - for a one standard deviation increase in x_{it}, y^* is expected to increase by β_k^s standard deviations, holding all other variables constant.

In the following, we define the empirical model that we employ. The dependent variable is the numerical transformation of the character-based rating, which we call ratings code.[19] The independent variables include the variable of interest, the unfunded liabilities as a percentage of equalized valuation, as well as other characteristic variables of the municipality, as discussed earlier.

$$\begin{aligned} ratings\ code\ =\ & \alpha + \gamma(uaal\ \%\ Eqz) + \beta_1(average\ single\ family\ tax\ bill) \\ & + \beta_2(state\ aid\ \%\ of\ total\ revenues) \\ & + \beta_3(total\ stability\ factors) + \beta_4(debt\ service\ \%\ budget) \\ & + \beta_5(debt\ service\ \%\ Eqz) + \beta_6(unemployment\ rate) \\ & + \beta_7(birth\ rate) + \beta_8(excess\ capacity\ \%\ maximum\ levy) \\ & + \beta_9(registered\ voters\ democrat\ \%\ total) \\ & + \beta_{10}(retired\ health\ insurance\ costs\ \%\ eqz) \end{aligned} \tag{7}$$

where *uaal* is the unfunded accrued actuarial liabilities and *Eqz* is the municipality's equalized valuation. Also, it should be mentioned here that we either include debt service as a percentage of the budget or debt service as a percentage of equalized valuations, but never both concurrently.

5. Results and Discussion

As mentioned before, two estimation techniques were used in modeling the effect of unfunded liabilities on municipal credit ratings. The first method is ordered probit, and the second one is ordered logit. The difference in the two methods is in the underlying probability distribution function and the likelihood function that is maximized. There are five models for each estimation method. The first model is a simple one that employs only the variable of interest in our study, the unfunded liabilities amount as a percentage of the equalized valuation, as the independent variable. The second model includes the debt service as a percentage of operating budget as a proxy for the debt factor in addition to the other independent variables. The third model is the

[19] As mentioned before and for estimation purposes, we recode the rating categories to be 6 for the highest rating category Aaa, 5 for Aa, 4 for A, 3 for Baa, 2 for Ba, and 1 for B.

same as the second one but excludes registered Democrat voters as a percentage of the total registered voters. The fourth model includes debt service as a percentage of the equalized valuation as a proxy for the debt factors and all the other independent variables. Finally, the fifth model is the same as the fourth one but excludes registered Democrat voters as a percentage of the total registered voters.

In Table 5, we provide results for the ordered probit method showing standardized coefficients. We begin with a broad brush discussion of the results. The first row of Table 5 indicates that all Models 1 through 5 show a negative relationship between unfunded liabilities as percentage of equalized valuation and the ratings variable at the 0.01 significance level. The following variables: 1) state aid as percentage of total revenues, 2) unemployment rates, and 3) excess capacity as a percentage of maximum levies, are all significant at the 0.01 level and have the expected signs. The single family tax bill variable is also significant and has a positive sign suggesting that the rating agency considers this variable to be an indicator of how economically wealthy the community is, and its ability to withstand economic shocks. Debt service as percentage of budget employed in the second and the third model, though having the expected sign, appears insignificant in the second model while it is significant at 0.01 level in the third model. At the 0.05 level, total stability as percentage of equalized valuation is significant in the third model, and retired health insurance costs is significant in Models 2 and 4, while it is insignificant in Models 3 and 5. The following variables: 1) debt service as percentage of equalized valuation, 2) number of births as percentage of total population, and 3) registered Democrat voters as percentage of total voters, is insignificant in all models.

We next follow up the broad brush discussion above by focusing on the third model that has the highest explanatory power among all the models. It should be noted here that the standardized coefficient relates a one standard deviation change in the independent variable to standard deviation change in the dependent variable. Therefore, this permits a comparison of magnitudes between the independent variables as to the degree of their relationship with the dependent variable. As for our main variable of interest, an increase in the ratio of unfunded liabilities to equalized valuation by one standard deviation leads to a decrease in the credit ratings variable by 0.15 of its standard deviation (first row, Model 3). For other independent variables, the effect of a one standard deviation increase in: 1) the average single family tax bill, 2) state aid as percentage of total revenues, 3) total stability factors, 4) debt service as percentage of budget, 5) unemployment rate, and 6) excess capacity as percentage of maximum levy, is a change equal to: 0.22, -0.61, 0.09, -0.11, -0.16, and 0.14 standard deviation of the rating, respectively. Importantly, average single family tax bill and state aid as percentage of total revenues have the largest standardized coefficients among all the independent variables. What this implies is that municipalities that must depend on the largesse of the state instead of their own intrinsic resources are (justifiably) rated worse.

Table 5: Standardized Coefficients for Ordered Probit

Independent Variables	Exp Sign	Model 1	Model 2	Model 3	Model 4	Model 5
Unfunded Liabilities % Equalized Valuations	-	-0.2222 (3.89)**	-0.142 (2.94)**	-0.1511 (4.02)**	-0.1445 (2.98)**	-0.152 (4.01)**
Average Single Family Tax Bill	-/+		0.2033 (3.34)**	0.2239 (4.75)**	0.2338 (3.90)**	0.2676 (5.69)**
State aid % Total Revenues	-		-0.622 (7.95)**	-0.6117 (9.54)**	-0.5771 (7.37)**	-0.5644 (8.98)**
Total Stability Factors % Equalized Valuations	+		0.083 (1.56)	0.091 (2.11)*	0.0765 (1.43)	0.0825 (1.92)
Debt Service as % of Budget	-		-0.0995 (1.88)	-0.1102 (2.83)**		
Debt Service % Equalized Valuations	-				-0.0658 (1.05)	-0.0405 (1.02)
Unemployment Rate	-		-0.2052 (3.43)**	-0.1642 (3.88)**	-0.2022 (3.35)**	-0.1568 (3.65)**
Number of Births % Total Population	-		-0.0031 (0.06)	-0.034 (0.82)	-0.019 (0.34)	-0.0637 (1.55)
Excess Capacity % Maximum Levy	+		0.1372 (2.71)**	0.1435 (3.62)**	0.1508 (2.99)**	0.1477 (3.73)**
Registered of Voters Democrat % Total Registered Voters	-		0.0698 (1.32)		0.072 (1.33)	
Retired Health Insurance Costs % Equalized Valuations	-		-0.1166 (2.31)*	-0.0504 (1.30)	-0.1213 (2.39)*	-0.0436 (1.08)
/cut1		-2.92682 (0.326921)	-7.07303 (1.160526)	-8.13521 (0.938147)	-6.7726 (1.122205)	-7.69268 (0.899277)
/cut2		-1.06938 (0.090461)	-3.58473 (0.80783)	-4.33585 (0.654277)	-3.3955 (0.796406)	-4.11773 (0.642056)
/cut3		0.262292 (0.076442)	-1.06933 (0.733217)	-1.43605 (0.574429)	-0.9293 (0.727738)	-1.3102 (0.568435)
/cut4		1.145504 (0.094614)	0.910521 (0.769391)	0.413787 (0.590935)	1.044704 (0.763058)	0.545626 (0.585069)
Number of Observations		346	191	314	191	314
Wald Test: chi2(1)=		15.16	113.78	183.68	114.9	185.48
Prob > chi2 =		0.0001	0	0	0	0
LR chi2(1) =		15.2	201	351.99	198.54	344.72
Prob > chi2 =		0.0001	0	0	0	0
Log likelihood =		-429.4039	-138.6684	-212.0884	-139.8957	-215.7254
Pseudo R2 =		0.0174	0.4202	0.4535	0.4151	0.4441

Notes: *, ** significant at 0.05 and 0.01 levels, respectively.

Credit Rating Code is the dependent variable. The data for the unfunded liabilities are taken from Public Employees Retirement Administration Commission (PERAC) in the State of Massachusetts. The data for the dependent variable and the other independent variables are obtained from the Department of Revenue (DOR) in the State of Massachusetts. The coefficients are the fully standardized coefficients and show the standard deviation change of the dependent variable as a result of a change in the independent variable by one unit of its standard deviation. Absolute value of z statistics and standard errors for cut points in parentheses

In Table 6, which reports the results for the ordered logit model showing standardized coefficients, all models show a significant negative relationship between our variable of interest, the unfunded liabilities as percentage of equalized valuations, and the ratings at the 0.01 significance level. The following variables: 1) average single family tax bill, 2) state aid as percentage of total revenues, and 3) excess capacity as a percentage of maximum levy, are significant at 0.01 level. The total stability factors as percentage of equalized valuation variable is significant at the 0.05 level in the second and fourth models while it is significant at the 0.01 level in the third and fifth models. Debt service as percentage of budget, which is employed in the second and the third model, though having the expected sign, is insignificant in the second model while it is significant at the 0.01 level in the third model. The unemployment rate is significant at the 0.05 level in the second and the third model, while retired health insurance cost is significant at the 0.05 level in the second model and at the 0.01 level in the fourth model, but insignificant in models 3 and 5. The following variables: 1) debt service as percentage of equalized valuation, 2) number of birth as percentage of total population, and 3) registered Democrat voters as percentage of total are insignificant in all models.

Our discussion of the ordered logit results will be based on the standardized coefficients from the third model which has the highest explanatory power among all the models. One standard deviation increase in the ratio of unfunded liabilities to equalized valuation leads to a decrease by 0.16 standard deviation of credit ratings. This is very similar to the findings with the ordered probit model in Table 5. With regards to other independent variables, the effect of a one standard deviation increase in: 1) the average single family tax bill, 2) state aid as percentage of total revenues, 3) total stability factors, 4) debt service as percentage of budget, 5) unemployment rate, and 6) excess capacity as percentage of maximum levy, is a change equal to: 0.22, -0.67, 0.12, -0.10, -0.10, and 0.15 standard deviation of the ratings respectively. Importantly and similar to the ordered probit results, average single family tax bill and state aid as a percentage of total revenues have the largest standardized coefficients among all the independent variables. It is pertinent to notice here that thus far, we have not included year dummies in these models. This is because we did not suspect that there would be any systematic changes in the relationship over time, or in any specific year. Nonetheless, for robustness, we estimated models with year dummies to show that even after controlling for time variation, we still have significant results with regard to the effect of unfunded liabilities on the credit rating.

In Tables 7 and Table 8, we present the standardized coefficients for the ordered probit and ordered logit models, respectively after including year dummies. As can been seen, the coefficient of the variable of interest, unfunded liabilities to equalized valuation, remains significant at the 0.01 level in all models. The results of these models attest to the importance of unfunded liabilities as a determinant of ratings, and therefore, by extension, to the borrowing cost faced by municipalities. This result is robust even after the inclusion of other control variables typically deemed to be influential in determining municipal credit ratings.

Importantly, our findings suggest that municipalities and states that have accumulated huge sums of these unfunded liabilities should pay more attention to the funding status of their defined-benefit plans. Specifically, the savings obtained from underfunded plans must be weighed against higher future borrowing costs as a result of lower municipal credit ratings. Also, other results indicate that a municipality with decent financial, debt, socioeconomic, and management conditions which relies on its own resources more than outside resources is rated much higher. Conversely, a municipality with poor financial and socioeconomic conditions must rely heavily on external resources (like state aid) to finance its expenditures, and is thus rated

worse. Accumulating increasing sums of unfunded liabilities increases the probability of being assigned lower credit ratings, and decreases the probability of higher ratings.

Table 6: Standardized Coefficients for Ordered Logit

Independent Variables	Exp Sign	Model 1	Model 2	Model 3	Model 4	Model 5
Unfunded Liabilities % Equalized Valuations	-	-0.1843 (3.35)**	-0.1536 (3.32)**	-0.1602 (4.34)**	-0.1562 (3.40)**	-0.1615 (4.33)**
Average Single Family Tax Bill	-/+		0.2138 (3.37)**	0.2284 (4.79)**	0.244 (3.95)**	0.2741 (5.76)**
State aid % Total Revenues	-		-0.6764 (7.67)**	-0.6674 (9.09)**	-0.6245 (7.29)**	-0.6243 (8.69)**
Total Stability Factors % Equalized Valuations	+		0.1139 (2.12)*	0.1229 (2.85)**	0.1131 (2.12)*	0.121 (2.78)**
Debt Service as % of Budget	-		-0.0899 (1.72)	-0.0967 (2.58)**		
Debt Service % Equalized Valuations	-				-0.0919 (1.53)	-0.0471 (1.31)
Unemployment Rate	-		-0.1228 (2.04)*	-0.1017 (2.26)*	-0.1109 (1.86)	-0.0851 (1.91)
Number of Births % Total Population	-		-0.0213 (0.40)	-0.0409 (1.05)	-0.0298 (0.57)	-0.0651 (1.70)
Excess Capacity % Maximum Levy	+		0.1472 (3.01)**	0.1536 (4.06)**	0.1618 (3.36)**	0.1563 (4.17)**
Registered of Voters Democrat % Total Registered Voters	-		0.0937 (1.82)		0.0908 (1.76)	
Retired Health Insurance Costs % Equalized Valuations	-		-0.1288 (2.54)*	-0.0427 (1.19)	-0.1334 (2.64)**	-0.0327 (0.88)
/cut1		-6.09885 (1.004672)	-14.229 (2.397034)	-16.8896 (2.120049)	-14.0152 (2.387396)	-16.1806 (2.089782)
/cut2		-1.7507 (0.160276)	-6.40487 (1.517457)	-8.24458 (1.275389)	-6.01539 (1.490336)	-7.72201 (1.245283)
/cut3		0.432375 (0.124547)	-1.63918 (1.345561)	-2.51002 (1.062182)	-1.2707 (1.32857)	-2.13524 (1.051488)
/cut4		1.960169 (0.179792)	1.964989 (1.437753)	0.836031 (1.099384)	2.345572 (1.42287)	1.254481 (1.091064)
Number of Observations		346	191	314	191	314
Wald Test: chi2(1)=		11.19	94.09	144.21	94	143.96
Prob > chi2 =		0.0008	0	0	0	0
LR chi2(1) =		12.9	210.68	367.73	210.03	362.32
Prob > chi2 =		0.0003	0	0	0	0
Log likelihood =		-430.551	-133.824	-204.221	-134.152	-206.923
Pseudo R2 =		0.0148	0.4405	0.4738	0.4391	0.4668

Notes:

*, ** significant at 0.05 and 0.01 levels, respectively.

Credit Rating Code is the dependent variable. The data for the unfunded liabilities are taken from Public Employees Retirement Administration Commission (PERAC) in the State of Massachusetts. The data for the dependent variable and the other independent variables are obtained from the Department of Revenue (DOR) in the State of Massachusetts. The coefficients are the fully standardized coefficients and show the standard deviation change of the dependent variable as a result of a change in the independent variable by one unit of its standard deviation. Absolute value of z statistics and standard errors for cut points in parentheses

Table 7: Standardized Coefficients for Ordered Probit With Fixed Year Effects

Independent Variables	Exp Sign	Model 1	Model 2	Model 3	Model 4	Model 5
Unfunded Liabilities % Equalized Valuations	-	-0.2156 (3.75)**	-0.1337 (2.85)**	-0.1518 (4.15)**	-0.1333 (2.85)**	-0.1513 (4.12)**
Average Single Family Tax Bill	-/+		0.1634 (2.71)**	0.1695 (3.63)**	0.164 (2.72)**	0.1683 (3.59)**
State aid % Total Revenues	-		-0.5623 (6.50)**	-0.5122 (7.69)**	-0.5541 (6.20)**	-0.5112 (7.51)**
Total Stability Factors % Equalized Valuations	+		0.1366 (2.47)*	0.1395 (3.21)**	0.1359 (2.46)*	0.1346 (3.06)**
Debt Service as % of Budget	-		-0.0037 (0.05)	-0.096 (1.70)		
Debt Service % Equalized Valuations	-				-0.0197 (0.32)	-0.0302 (0.74)
Unemployment Rate	-		-0.426 (4.67)**	-0.4226 (6.22)**	-0.4239 (4.66)**	-0.4256 (6.23)**
Number of Births % Total Population	-		-0.0363 (0.66)	-0.0663 (1.68)	-0.0338 (0.61)	-0.0662 (1.67)
Excess Capacity % Maximum Levy	+		0.1374 (2.75)**	0.1498 (3.91)**	0.1382 (2.77)**	0.1472 (3.87)**
Registered of Voters Democrat % Total Registered Voters	-		0.1014 (1.26)		0.0996 (1.26)	
Retired Health Insurance Costs % Equalized Valuations	-		-0.1049 (2.16)*	-0.0637 (1.69)	-0.1041 (2.15)*	-0.0553 (1.44)
/cut1		-3.11605 (0.583421)	-9.75491 (1.810003)	-12.1676 (1.516148)	-9.76568 (1.776015)	-11.8681 (1.501167)
/cut2		-1.19296 (0.477184)	-5.4667 (1.415251)	-7.27992 (1.167713)	-5.43634 (1.394288)	-7.02709 (1.153658)
/cut3		0.157734 (0.473033)	-2.74628 (1.341611)	-4.0999 (1.096937)	-2.71385 (1.323211)	-3.86152 (1.085846)
/cut4		1.04934 (0.476073)	-0.55646 (1.362645)	-2.04735 (1.083586)	-0.52836 (1.340968)	-1.81353 (1.073382)
Number of Observations		346	191	314	191	314
Wald Test: chi2(1)=		14.03	109.64	174.19	109.89	173.25
Prob > chi2 =		0.0002	0	0	0	0
LR chi2(1) =		23.72	224.54	391.37	224.64	388.99
Prob > chi2 =		0.0959	0	0	0	0
Log likelihood =		-425.144	-126.89638	-192.401	-126.847	-193.592
Pseudo R2 =		0.0271	0.4694	0.5042	0.4696	0.5012

Notes:

*, ** significant at 0.05 and 0.01 levels, respectively.

Credit Rating Code is the dependent variable. The data for the unfunded liabilities are taken from Public Employees Retirement Administration Commission (PERAC) in the State of Massachusetts. The data for the dependent variable and the other independent variables are obtained from the Department of Revenue (DOR) in the State of Massachusetts. The coefficients are the fully standardized coefficients and show the standard deviation change of the dependent variable as a result of a change in the independent variable by one unit of its standard deviation. Absolute value of z statistics and standard errors for cut points in parentheses

Table 8: Standardized Coefficients for Ordered Logit with Fixed Year Effects

Independent Variables	Exp Sign	Model 1	Model 2	Model 3	Model 4	Model 5
Unfunded Liabilities % Equalized Valuations	-	-0.1836 (3.31)**	-0.1452 (3.08)**	-0.162 (4.25)**	-0.1456 (3.09)**	-0.1628 (4.20)**
Average Single Family Tax Bill	-/+		0.1663 (2.68)**	0.1823 (3.72)**	0.1674 (2.71)**	0.1811 (3.71)**
State aid % Total Revenues	-		-0.6078 (6.31)**	-0.555 (7.48)**	-0.5885 (6.04)**	-0.5562 (7.41)**
Total Stability Factors % Equalized Valuations	+		0.16 (2.85)**	0.1623 (3.80)**	0.1567 (2.80)**	0.1593 (3.69)**
Debt Service as % of Budget	-		-0.0007 (0.01)	-0.1009 (1.74)		
Debt Service % Equalized Valuations	-				-0.044 (0.72)	-0.0391 (1.06)
Unemployment Rate	-		-0.3432 (3.58)**	-0.3506 (4.93)**	-0.3351 (3.52)**	-0.3488 (4.96)**
Number of Births % Total Population	-		-0.0419 (0.79)	0.0024 (1.84)	-0.0371 (0.70)	-0.0681 (1.77)
Excess Capacity % Maximum Levy	+		0.1404 (2.82)**	0.1507 (4.07)**	0.1434 (2.89)**	0.1458 (4.06)**
Registered of Voters Democrat % Total Registered Voters	-		0.0926 (1.17)		0.0852 (1.10)	
Retired Health Insurance Costs % Equalized Valuations	-		-0.1182 (2.41)*	-0.0628 (1.76)	-0.1179 (2.41)*	-0.0501 (1.39)
/cut1		-6.51252 (1.280321)	-18.3914 (3.554636)	-23.1751 (3.098272)	-18.6155 (3.53453)	-22.6982 (3.093697)
/cut2		-2.1441 (0.809138)	-9.30282 (2.579493)	-12.7628 (2.153556)	-9.25086 (2.533738)	-12.181 (2.108404)
/cut3		0.081186 (0.797643)	-4.21395 (2.412831)	-6.634 (1.989647)	-4.13543 (2.37086)	-6.05513 (1.953755)
/cut4		1.626143 (0.80529)	-0.32778 (2.470415)	-2.94826 (1.961741)	-0.26923 (2.420023)	-2.37376 (1.929619)
Number of Observations		346	191	314	191	314
Wald Test: chi2(1)=		10.94	90.04	139.21	90.71	137.78
Prob > chi2 =		0.0009	0	0	0	0
LR chi2(1) =		21.01	229.02	400.75	229.55	398.57
Prob > chi2 =		0.1781	0	0	0	0
Log likelihood =		-426.497	-124.657	-187.71	-124.394	-188.801
Pseudo R2 =		0.024	0.4788	0.5163	0.4799	0.5135

Notes:

*, ** significant at 0.05 and 0.01 levels, respectively.

Credit Rating Code is the dependent variable. The data for the unfunded liabilities are taken from Public Employees Retirement Administration Commission (PERAC) in the State of Massachusetts. The data for the dependent variable and the other independent variables are obtained from the Department of Revenue (DOR) in the State of Massachusetts. The coefficients are the fully standardized coefficients and show the standard deviation change of the dependent variable as a result of a change in the independent variable by one unit of its standard deviation. Absolute value of z statistics and standard errors for cut points in parentheses

6. Conclusion

There are increasing concerns about the impact of public pension funding in the United States and whether these systems can fulfill their obligations toward their retirees in the future. If these concerns are indeed real, then credit ratings agencies should incorporate the unfunded liabilities of public pension plans in assigning municipal credit ratings. In this vein, our paper investigates whether unfunded liabilities affect municipal credit ratings. Our empirical examination employs a methodology that, besides accounting for the unfunded liabilities, incorporates other variables that fall into the financial, debt, socioeconomic, and management categories; variables that have been shown to exert an effect on municipal ratings in prior literature.

We employ a sample that consists of the municipalities that are located in Massachusetts and spans the period from 1991-2006. Both ordered probit and ordered logit estimations provide consistent results, and support the view that credit ratings are strongly associated with unfunded liabilities, and that rating agencies place a weight on this variable when they assign the municipality's rating. The results indicate that an increase in the unfunded liabilities by one standard deviation is associated with a decreased rating in a range from -0.14 to -0.22 standard deviations of the rating for ordered probit models, and in a range from -0.15 to -0.18 for ordered logit models.

The results also demonstrate the importance of state aid and single family tax bill in determining the rating. Based on our results, these variables account for most of the variation in the rating. Stability factors are found to be significant and credit rating agencies may consider this variable as a good sign of future financial stability. In addition, the unemployment rate is found to be highly significant which attests to the importance of the improving the attractiveness of the municipality to business activities in order to increase employment and reduce the municipality's credit risk. With respect to the other independent variables, the results are mixed.[20]

The effect of retiree health benefits on the credit rating is found to be mixed. Further, the ability of the municipality to dedicate more taxes to service its debt and finance its capital projects is found to have a positive effect on the rating. Finally, we examined the effect of political affiliation on municipal credit rating and, though insignificant, the sign of the coefficient on the relevant variable suggests that Moody's perceives the Democratic majority as being a positive sign with regards to the rating. Presumably, this is because administrations under Democrats may be more likely to increase taxes to defray debt service costs, thereby reducing default risk.

In conclusion, we believe our results have important public policy implications for municipal governments. Specifically, municipalities face a tradeoff wherein an optimization problem presents itself. On the one hand, a municipality can contribute lower amounts to their public pension plan, and thereby save current revenue to devote to other purposes. On the other hand, this move will exacerbate the unfunded liabilities amount in the pension plan. We have shown in a robust fashion that municipal credit ratings are significantly affected by the funding status of their public pension plans. Thus, larger unfunded liabilities will result in more inferior ratings, and consequently, higher interest expense on the municipality's debt. The tradeoff that arises pits the savings from lower contributions to the pension plan against the higher interest expense triggered by lower ratings. Municipalities are well advised to consider these two aspects

[20] First, debt service as a percentage of budget is found to be highly significant in the third model for both ordered probit and ordered logit estimations, but not in any others. Second, although the variables, birth rate and debt service as percentage of equalized valuation, have the expected sign, they are insignificant.

in determining the funding status of their pension plan, as well as their borrowing plans for debt capital.

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