

# **Municipal Bond Risk Ratings**

**An Analysis of the Determinants and Rating Process**

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## Thesis Statement

In recent years, the legitimacy of bond ratings given by top rating agencies has been under extreme scrutiny by the general public and the government. The faith and trust that the public puts into credit rating agencies such as Standard & Poor's, Moody's, and Fitch is based on the notion that they will publically assign unbiased risk ratings which truly reflect the creditworthiness of thousands of municipalities. Since creditworthiness is an unobservable variable, it often appears that the determinants behind these municipal bond ratings are undecipherable. However, through the use of a range of economic, financial, fiscal, and demographic variables built into a complex econometric model, municipal bond ratings may be explained and the future of these ratings may be more effectively predicted.

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## **I. Introduction**

The Global Financial Crisis of 2007-2009 left an overall feeling of distrust in the bond rating process among the general public, investors, and Congress. During the financial crisis, leading rating agencies such as Moody's Investors Service, Standard and Poor's Rating Service, and Fitch Ratings assigned top ratings, which imply high creditworthiness, to mortgage backed securities (MBS's). Many of these securities were inaccurately rated as they actually had low credit quality and a high risk of default. Because of this unsound assignment of ratings, a severe destabilization of the bond insurance industry occurred over the past six years. The misrepresentation of high risk securities and the destabilization of the bond insurance industry call into question the true motivation of the rating agencies and the accuracy of their assigned credit ratings. Since rating agencies are paid for their services, allowing for bond issuers to "shop around" for the best credit rating, the question remains; "Is there a conflict of interest within the credit rating process?" Additionally, the whole rating process is criticized as lacking transparency and comprehensibility, making it difficult for investors to make informed, accurate decisions. In this paper, these claims are investigated and the accuracy of the credit rating process is assessed.

In order to wholly evaluate the accuracy and transparency of the credit rating process, this paper first introduces basic concepts regarding the municipal bond market. This introduction to municipal bonds is crucial to understanding the nature of municipal securities and the role they play in the financial world. Following this section, the analysis of credit ratings is explained in depth. An exploration into the rating agencies, their methodology, and the criticism they face sets the stage for the empirical analysis performed. Finally a model is developed, via least squares estimation and probit analysis, which mimics the rating process of rating agencies,

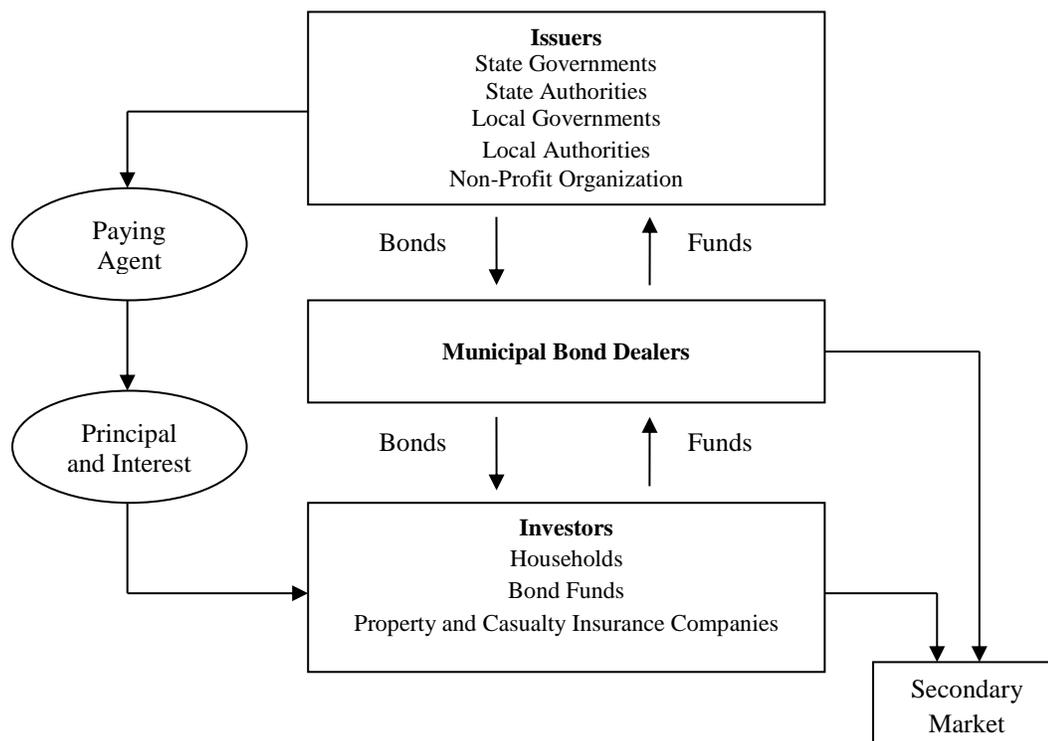
particularly Moody's. By modeling the underlying creditworthiness of New York State municipalities, one is able to analyze the transparency and legitimacy of the bond rating process and predict how these ratings will affect the prices of bonds in the future. Furthermore the econometric model developed in this paper investigates Moody's use of economic, financial, fiscal, and demographic determinants which affect the credit ratings for New York State municipalities.

## **II. What is a Municipal Bond?**

A municipal bond is a tax-exempt debt instrument which represents an agreement between an investor, the bond holder, and an issuer, the municipality. The issuer of the bond may be any state or local government including, but not limited to, states, cities, counties, towns, villages, school districts, and special districts. The tax-exempt nature of municipal bonds makes them attractive to a variety of investors, or bond holders, including households, household proxies, property and casualty insurance companies, and commercial banks. Investors in high federal and state tax brackets are most likely to invest in municipal bonds due to their tax-exempt nature. An initial investment, called the principal, is lent by the bond holder to the issuer in order to finance special projects or developments such as the construction of public school buildings, government office buildings, hospitals and nursing homes, streets and highways, bridges, and sewage treatment plants. A fixed repayment schedule is agreed upon; usually lasting anywhere from 1 to 40 years, throughout which the principal plus an accumulated interest is paid back to the investor.\

**a.) The Primary Market**

This process of issuing the bond, selling that bond to an investor, and repaying the original amount that was invested plus interest involves several individuals and institutions that work within the municipal bond market. Table 1 gives an overview of the primary market and its flow of funds. As previously stated, the process begins when a state or local government unit has a special project or capital improvement which needs to be financed. The bond is then brought to market by a bond dealer through a process called underwriting. There are two ways in which an underwriter, who is usually part of a commercial bank or a securities firm, can bring the new bond issue to market. The first, called a competitive sale, is when numerous underwriters submit bids, offering various interest rates and yields for the bond. The underwriters can either bid individually or as part of a group, called a syndicate. The benefit of joining a syndicate lies in the dispersion of risk. If the loan were to default, the assumed loss would be spread out across the whole syndicate. The underwriter or syndicate who offers the lowest coupon rate generally holds the winning bid and is given the responsibility to either sell the bond to investors or assume the risk of holding it in inventory until it sells. The difference between what the underwriter pays for the bond and what the bond sells for serves as the profit, or loss, for the dealer. The second way for an underwriter to bring a municipal bond to market is through a negotiated sale. In this case, an individual underwriter or a single syndicate go directly to the issuer of the bond and negotiate on a coupon rate. The negotiated rate should be the lowest possible interest rate for the issuer, while still being attractive enough for investors to want to purchase the bond. As illustrated in Table 1, after the investor buys the bond from the dealer, the issuer then pays the principal and interest to the bondholder through an outside agent.

**Table 1: Flow of Funds in Primary Market<sup>1</sup>**

<sup>1</sup>O'Hara, Neil. The Fundamentals of Municipal Bonds. 6<sup>th</sup> Ed. Hoboken, NJ: John Wiley & Sons, 2012.

## b.) The Secondary Market

Once the bond is sold to an investor, the investor has two choices. He can either hold the bond until maturity or can enter the secondary market where trading takes place. This ability to trade or resell a municipal bond for a premium, usually no more than a year's interest, provides the investor with liquidity, which minimizes risk and makes the primary market more attractive.<sup>2</sup> The bond is usually sold back to a municipal securities dealer for a price which may differ from what was originally paid. The price of the bond may change depending on the following factors;

<sup>2</sup>Smith, Wade S. The Appraisal of Municipal Credit Risk. New York: Moody's Investors Service, Inc., 1979.

1. Changes in general economy-wide interest rates,
2. Changes in the credit rating of the security,
3. Market conditions or overall attitude regarding the market for the particular type of security involved.

If any of these factors change, the value of the bond may also change.

As municipal bond trading is part of an over-the-counter market, bond transactions occur between bond dealers almost instantly through either voice or electronic exchanges. The advancement of technological innovations has had a great impact on this aspect of the bond market. The management of portfolios, access to financial information, and application of analytical tools has become much easier and more efficient through the use of computers, cell phones, and other forms of technology. However, this new level of technological usage throughout the bond market has also required a new level of regulation and advisement. For example, due to regulations put in place by the U.S. Securities and Exchange Commission (SEC) in June 2009, these instantaneous exchanges must be reported to the Municipal Securities Rulemaking Board (MSRB) and displayed on the Electronic Municipal Market Access website within fifteen minutes of the trade.<sup>3</sup> This illustrates the role which regulators play in the municipal bond market. The significance of regulation is expanded upon in our next section.

### **c.) Regulations**

Like all financial markets, the municipal bond market is heavily regulated by several government agencies. One of the top regulating agencies is the U.S. Securities and Exchange Commission (SEC). The SEC was founded shortly after the stock market crash of 1929. In order for the economy to recover, Congress and President Franklin D. Roosevelt realized that the

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<sup>3</sup>O'Hara, Neil. The Fundamentals of Municipal Bonds. 6<sup>th</sup> Ed. Hoboken, NJ: John Wiley & Sons, 2012.

public's faith in the government and in the economy had to be restored. This was to be achieved through the passing of the Securities Act of 1933, the Securities Exchange Act of 1934, and ultimately the creation of the SEC. The founding of the SEC reinforced a sense of security and confidence among investors. As officially stated by the SEC, "The mission of the U.S. Securities and Exchange Commission is to protect investors, maintain fair, orderly, and efficient markets, and facilitate capital formation."<sup>4</sup> By administering and enforcing a series of securities laws, the SEC ensures that the municipal bond market maintains its transparency. This means that investors have access to public financial information which is necessary for making informed decisions on the securities they hold.

In their desire to protect investors, the SEC oversees a smaller regulatory organization called the Municipal Securities Rulemaking Board (MSRB). Established in 1975 under Congress, the MSRB has regulated and standardized several aspects of the municipal bond market by setting certain rules and regulations for securities firms, dealers, banks, and advisers. The rulemaking standards of the MSRB can be organized into the following five categories; professional conduct, fairness practices, consistency throughout the market, market transparency, and internal administration.<sup>5</sup> The category of market transparency is heavily concentrated on and is evident through the MSRB's Electronic Municipal Market Access (EMMA) website. This free website provides the public with access to municipal disclosures, securities ratings, interest rates, market trends, and general information on securities. This allows the investor to obtain a comprehensive knowledge on the risks and benefits of investing in a municipal security.

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<sup>4</sup> "The Investor's Advocate:How the SEC Protects Investors, Maintains Market Integrity, and Facilitates Capital Formation." How the SEC Protects Investors, Maintains Market Integrity, and Facilitates Capital Formation (Securities and Exchange Commission). 24 April 2013. <http://www.sec.gov/about/whatwedo.shtml>

<sup>5</sup>"Market Regulation." 24 April 2013. <http://www.msrb.org/About-MSRB/Programs/Market-Regulation.aspx>

In order to rigorously enforce the rules and regulations put in place by the MSRB, an independent regulator was formed in July 2007. The Financial Industry Regulatory Authority (FIRA) mission statement explains that they are “dedicated to investor protection and market integrity through effective and efficient regulation of the securities industry”.<sup>6</sup> In addition to providing investors with education about the municipal bond market, FIRA exerts much of its energy in recognizing, investigating, and disciplining those firms and individuals who bring harm to investors. In 2012 this discipline came in the form of 294 individuals being barred, the suspension of 549 brokers, and more than \$68 million in fines levied.

#### **d.) Types of Municipal Bonds**

The two most common types of municipal bonds are general obligation bonds (GO’s) and revenue bonds. General obligation bonds are secured by the full faith and credit of the issuer. This means that the issuer is expected to use all of its generated revenue, unless specified otherwise, in paying the bondholders back. They are generally considered to be less risky than revenue bonds as the municipality has the power to raise taxes if they are in risk of defaulting. The tax revenues which are used for repayment of the bond are normally generated in the form of property taxes for municipalities. For states, on the other hand, these funds come in the form of sales and income taxes.

The second category of municipal bonds is the revenue bond. These bonds are sold in order to finance a specific project, such as the construction of a bridge or highway. The revenues which are generated from the tolls charged to users are then used in the repayment of bondholders. Financial expert and author Neil O’Hara breaks revenue bonds down into six categories: “utilities; health care, higher education, and other not-for-profits; housing;

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<sup>6</sup> FINRA.org, 24 April 2013. <http://www.finra.org/AboutFINRA/>

transportation; and industrial development”.<sup>7</sup> These bonds are considered riskier than GO’s as they depend upon the revenues generated by these projects. Because of this increased level of risk, revenue bonds carry a higher interest rate, and thus produce a higher yield.

### e.) How Risky are Municipal Bonds?

The main risk of owning a municipal bond or any other debt instrument lies in the possibility that the issuer might not be able or willing to pay back the principal and interest according to the bond contract. In other words, the issuer, or the debtor, could default on the loan. This is classified as a credit risk. While the risk of default is a crucial consideration for some bonds, it is not as significant in the municipal bond market. Over time, the risk of default occurring on a municipal bond has been extremely rare. This is mainly due to the fact that state and local governments have the power of taxation. Table 2, shown below, from the 2008 Municipal Bond Fairness Act, illustrates the rarity of municipal bond default through a comparison of cumulative historic default rates of municipal bonds and corporate bonds.

**Table 2: CUMULATIVE HISTORIC DEFAULT RATES [In percent]<sup>8</sup>**

Rating categories	Moody's		S&P	
	Muni	Corp	Muni	Corp
Aaa/AAA.....	0.00	0.52	0.00	0.60
Aa/AA.....	0.06	0.52	0.00	1.50
A/A.....	0.03	1.29	0.23	2.91
Baa/BBB.....	0.13	4.64	0.32	10.29
Ba/BB.....	2.65	19.12	1.74	29.93
B/B.....	11.86	43.34	8.48	53.72
Caa-C/CCC-C.....	16.58	69.18	44.81	69.19
Investment Grade.....	0.07	2.09	0.20	4.14
Non-Invest Grade.....	4.29	31.37	7.37	42.35
All.....	0.10	9.70	0.29	12.98

<sup>7</sup>O'Hara, Neil. *The Fundamentals of Municipal Bonds*, 6<sup>th</sup> Ed. Hoboken, NJ: John Wiley & Sons, 2012.

<sup>8</sup>“House Report 110-835 - MUNICIPAL BOND FAIRNESS ACT.” House Report 110-835 - MUNICIPAL BOND FAIRNESS ACT. 24 April 2013.

The probability of default may be caused by a weakening of the issuer's credit. The creditworthiness or credit quality of the issuer could decline, thus causing the market price of the bond to drop and result in a possible capital loss for the investor. Credit quality is reflected in the municipal bond risk rating which is assigned to each bond after a thorough analysis by a leading rating agency.

The second category of municipal bond risks are market risks. This includes an interest rate risk, which is the possibility that market interest rates could rise, causing the price of the bond to fall. If the investor chooses to sell the bond in the secondary market, he runs the risk of selling at a lower price than when the bond was originally purchased. Another type of market risk is that of inflation risk. During times of high inflation, the inherent value of the bond will fall. Moreover, the investor runs the risk of there being an absence of marketability for his particular security at a particular time. Without an interested purchaser, the bond loses liquidity, making it difficult for the investor to sell the bond for cash.<sup>9</sup>

A third risk that comes with investing in the municipal bond market deals with the tax-exempt nature of municipal securities. In general, all levels of income are taxed in the United States. This includes wages and salaries, interest income, dividends, and capital gains on stocks and bonds. However, the interest gained from municipal bonds is in most cases exempt from local, state, and federal taxation. Although this is the current situation, investors always run the risk that the United States government could impose a tax on municipal bonds. The federal income tax could theoretically be extended to the municipal bond market. As clarified in the article *America's Municipal Risks* from *The Economist*, although many states believed the federal government did not have the power to tax municipal bonds, "a Supreme Court ruling in

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<sup>9</sup>O'Hara, Neil. The Fundamentals of Municipal Bonds, 6<sup>th</sup> Ed. Hoboken, NJ: John Wiley & Sons, 2012.

1987 implied that this tax-exemption was not a constitutional right but no more than a matter of public policy, which Congress had the power to change.”<sup>10</sup>

#### **f.) Bond Insurance**

Although the scope of this paper focuses on the underlying rating of bonds before they are insured, the concept of bond insurance is imperative to the comprehension of the municipal securities market in general and to the understanding of the financial world’s sudden interest in the credit rating process. In order to reduce the risk that comes with owning a municipal bond, a municipality can choose to have their issue insured. Economic expert Gao Liu explains that a bond issuer can purchase insurance in exchange for the agreement that the insurer will “assume the responsibility of paying the interest and principal when, and if, the insured issue defaults.”<sup>11</sup> When a bond insurer assumes the risk of default the riskiness of the bond diminishes, the credit quality improves, and the risk rating upgrades. The insured bond will now take on the credit rating that is assigned by the insurance company. Because the probability of default on the bond would ultimately affect the insurer’s creditworthiness, the insurer has great incentive to provide an accurate, honest, unbiased rating. On the other hand, rating agencies are seemingly unaffected by the ratings they provide.

The trust that has been put into insurance companies has been replaced by a profound sense of distrust over the past five years. Since the subprime mortgage crisis occurred in 2008, most bond insurance companies have either suffered a downgrading in their credit ratings or are no longer in business. When top rated insurance companies such as MBIA Insurance Corporation and AMBAC Assurance Corporation had decided to insure billions of dollars worth

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<sup>10</sup>“America’s Municipal Risks.” *The Economist*, Vol. 319, No. 7712 (Jun., 1991), pp. 81.

<sup>11</sup>Liu, Gao. “Municipal Bond Insurance Premium, Credit Rating and Underlying Credit Risk.” Unpublished essay, (Jun., 2011), pp. 1-31.

of mortgage backed securities, they did not foresee such a crisis. They were forced to make good on all of the defaulted securities at the same time. As the crisis hit and the amount of mortgage defaults increased at an alarming rate, so did the exposure of these insurance companies. Unfortunately, the capital needed to compensate for this exposure was unobtainable. This lack of capital had driven insurers either to seek a bailout from the federal government or, in some cases, to close their doors for good. This incident resulted in a tremendous loss of confidence by the public in bond insurance and rating agencies, and is reflected through the downgrading of several insurance company credit ratings. The difference in ratings assigned by Moody's to the top bond insurers from 2008 and 2013 are presented in the following table.

**Table 3: Moody's Financial Guarantor Ratings<sup>12</sup>**

	As of 04/04 /2008		As of 2/28/2013	
	Rating	Trend	Rating	Trend
<b>ACA Financial Guaranty Corp.</b>	N/R	N/A	N/R	N/A
<b>Ambac Assurance Corp.</b>	Aaa	<b><u>Negative Outlook</u></b>	N/R	<b><u>WITHDRAWN</u></b> as of 4/7/11
<b>Assured Guaranty Corp.</b>	Aaa	<b><u>Stable</u></b>	A3	<b><u>Stable Outlook</u></b> as of 1/17/2013
<b>CIFG</b>	A1	<b><u>Stable</u></b>	N/R	<b><u>WITHDRAWN</u></b> as of 11/11/2009
<b>Financial Guaranty Insurance Company</b>	Baa3	<b><u>Possible Downgrade</u></b>	N/R	<b><u>WITHDRAWN</u></b> as of 3/24/2008
<b>Assured Guaranty Municipal Corp. (formerly FSA, Inc.)</b>	Aaa	<b><u>Stable</u></b>	A2	<b><u>Stable Outlook</u></b> as of 1/17/2013
<b>MBIA Insurance Corporation</b>	Aaa	<b><u>Negative Outlook</u></b>	Caa2	<b><u>Developing Outlook</u></b> as of 11/19/2012
<b>Radian Asset Assurance</b>	Aa3	<b><u>Negative Outlook</u></b>	Ba1	<b><u>Negative Outlook</u></b> as of 4/20/2012
<b>Syncora Guarantee (formerly XL Capital Assurance)</b>	A3	<b><u>Possible Downgrade</u></b>	N/R	<b><u>WITHDRAWN</u></b> as of 11/8/12

N/R - Not Rated

N/A - Not Applicable

**Moody's:** Guarantors with Negative Outlooks can maintain the rating for 6-12 months. Guarantors on Review for Possible Downgrade may experience further ratings action within a shorter time period.

<sup>12</sup>Moody's.com. 28 February 2013. <http://www.moody's.com/researchandratings>

Table three vividly illustrates the beating insurance companies faced during the financial crisis of 2007-2009. A prime example of the effects felt by bond insurers is that of MBIA Insurance. From the table we see that in April of 2008 MBIA had a top rating of Aaa. By February 2013 however, this rating fell all the way to the junk rating of Caa2. This giant downgrade has not been uncommon for other insurance companies over the past five years. In fact, some insurance companies were hit so hard by the crisis that they are now either unrated or no longer exist as a corporation.

### **III. Credit Rating Analysis**

#### **a.) The Agencies**

The risk ratings assigned to municipal bonds are most commonly provided by three leading rating agencies; Moody's Investors Service, Standard & Poor's Rating Services (S&P), and Fitch Ratings, which were established in 1909, 1940, and 1913, respectively.<sup>13</sup> The risk rating assigned by the rating agency is expected to be an honest and unbiased reflection of the creditworthiness of the issuer. If the bond is considered to be risky, thus having a high probability of default, it means the creditworthiness of the issuer is low, and they will receive a low credit rating. Although these three leading organizations follow similar practices when analyzing risk ratings, the format of the ratings is not uniform. This paper will use the rating classifications of Moody's Investors Service as they are the longest standing rating agency. Moreover, the model used in this paper will only consider bonds which are given an investment grade rating. The distribution of Moody's credit ratings is shown in Table 4.

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<sup>13</sup>O'Hara, Neil. The Fundamentals of Municipal Bonds. 6<sup>th</sup> Ed. Hoboken, NJ: John Wiley & Sons, 2012.

**Table 4: Moody's Rating System<sup>14</sup>**

Credit Risk Level	Moody's Credit Rating
<b>Investment Grade</b>	
Strongest creditworthiness	Aaa
Very strong creditworthiness	Aa1
	Aa2
	Aa3
Above-average creditworthiness	A1
	A2
	A3
Average creditworthiness	Baa1
	Baa2
	Baa3
<b>Noninvestment Grade</b>	
Below-average creditworthiness	Ba1
	Ba2
	Ba3
Weak creditworthiness	B1
	B2
	B3
Very weak creditworthiness	Caa1
	Caa2
	Caa3
Extremely weak creditworthiness	Ca
Weakest creditworthiness	C

### b.) The Rating Process

The rating process begins when the issuer of a new bond approaches the rating agency (in particular Moody's) expressing interest in having a bond rated. An initial meeting between one or more analysts from Moody's and the issuer takes place either on site or through a teleconference. At this meeting, the analysts review the issuer's background, financial statements and projections, management structure, industry trends, national economic standings and other relevant topics. Following this meeting, the analysts at Moody's continue to analyze

<sup>14</sup>Moody's.com. 30 January 2013. <http://www.moody's.com/researchandratings>

the issuer's creditworthiness, follow up with questions and clarifications, and finally present the issue to the Moody's rating committee.

The official website of Moody's Investor Services states that the role of the ratings committee is to, "introduce as much objectivity into the process as possible by bringing an understanding of the relevant risk factors and viewpoints to each and every analysis."<sup>15</sup> In order to sufficiently fill this role, the makeup of the committee may change depending on the size and complexity of the issue. With the recommendation of the analyst in mind, the committee will thoroughly review the analysis of the issue and assign a risk rating.

### **c.) Criticism**

The process of assigning risk ratings to municipal bonds has recently battled a series of criticisms and critiques. This paper will discuss two of the main criticisms of the risk rating process. The first criticism is based on the fact that general obligation bonds and corporate bonds were being rated differently. Referring to Table 2, one is able to see proof of this discrepancy in ratings. The cumulative default rate for Aaa municipal bonds in 2008 was 0.0% while for Aaa corporate bonds it was .52%. While these are both extremely small percentages of default, the default rate for Aaa corporate bonds is significantly higher than that of Aaa municipal bonds. Despite the fact that Aaa rated municipal securities are much less risky than Aaa rated corporate securities, they are each given the same rating. This wrongly leads investors to believe that municipal and corporate bonds are equally risky, when in fact the *least* creditworthy GO bonds are *more* creditworthy than corporate bonds with the *highest* credit quality. Moreover, since municipal bonds are being underrated, their yields are correspondingly too high, which is therefore driving their prices down.

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<sup>15</sup> Moodys.com. 30 January 2013. <http://www.moodys.com/researchandratings>

Moody's response to this criticism came in 2010 with a recalibration of their municipal ratings. In the article "Recalibration of Moody's U.S. Municipal Ratings to its Global Rating Scale" Moody's explains how the process of recalibrating the municipal bond ratings to correspond with their global rating scale will ultimately simplify the act of comparing ratings across sectors.<sup>16</sup> For most state and local bonds, the calibration results in an increase in the ratings by about three notches. This means that a bond with an A2 rating will increase to an A1 rating. This increase does *not* reflect an increase in the credit quality of the bond, however. The increases are simply a matter of translating the current ratings to a completely different scale of ratings. Once the recalibration has been put into effect, the process of comparing municipal bonds to corporate bonds will be much more simplified and accurate.

The second criticism that rating agencies have endured over the past five years is that the rating process is not as transparent and comprehensible as it is made out to be. The rating process is meant to be understandable for investors so that they have a way to make educated, coherent decisions on the securities in which they invest their money. The complexity of the rating process, however, had gotten so extreme that neither investors nor regulators could decipher what was influencing the rating outcomes. In order to respond to this criticism, Moody's released a series of documents which carefully explained the rating process and determinants. One of these papers is elaborated upon in the next section.

#### **d.) Moody's Methodology**

In October of 2009 Moody's released an official document clarifying the rating methodology of general obligation bonds issued by U.S. local governments.<sup>17</sup> This

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<sup>16</sup> Moody's Investors Service, "Recalibration of Moody's U.S. Municipal Ratings to its Global Rating Scale," *Ratings Methodology*, Moody's U.S. Public Finance. (Mar., 2010), pp. 1-15.

<sup>17</sup> Moody's Investors Service, "General Obligation Bonds Issued by U.S. Local Governments," *Rating Methodology*, Moody's U.S. Public Finance.(Oct., 2009), pp. 1-28.

methodological paper is one of many which were released in response to severe criticism from the SEC, Congress, and the general public. Part of the criticism focused on the nontransparent and incomprehensible nature of the ratings process.<sup>18</sup> In order to ensure that their ratings process was perfectly transparent and comprehensible, Moody's used this paper to clarify what factors are considered in their analysis of creditworthiness, what approach is taken when analyzing these factors, and how these factors correspond to the bond's assigned risk rating.

Moody's breaks down their methodological approach into the analysis of four general rating factors. These factors include economic strength, financial strength, management and governance, and debt profile. A weighted average approach is taken when analyzing these factors and is distributed in the following way:

Economic strength	40%
Financial strength	30%
Management and Governance	20%
Debt Profile	10%

Moody's explains that economic strength has the greatest influence on credit quality due to the fact that "the property tax base is the source of bondholder security and the economy provides the source of leverage to support municipal operations."<sup>19</sup> Incorporated in the tax base analysis are the following four subcategories of economic strength: size and growth trends, the type of economy, the socioeconomic and demographic profile, and the workforce profile. These subcategories can further be broken down to more specific subfactors. The size and growth trend consists of the size of the tax base, the trend of historic growth, and the potential for future growth. The type of economy considers the industry concentration, level of stability, and

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<sup>18</sup>Palumbo, George and Mark P. Zaporowski. "Determinants of Municipal Bond Ratings for General-Purpose Governments: An Empirical Analysis." *Public Budgeting & Finance*, Vol. 32, No. 2 (Summer 2012), pp. 86-102.

<sup>19</sup>Moody's Investors Service, "General Obligation Bonds Issued by U.S. Local Governments," *Rating Methodology*, Moody's U.S. Public Finance.(Oct., 2009), pp. 1-28.

taxpayer concentration. Moreover, the socioeconomic and demographic profile incorporates population trends, poverty levels, per capita full value assessment, and income. Finally, the workforce profile mainly consists of the unemployment rate.

Second greatest in weight in Moody's analysis of credit quality is financial strength. This category of variables focuses on financial trends, which illustrate the financial stability of the locality over the business cycle. One rating subfactor of financial strength that is analyzed is the balance sheet and liquidity which incorporates the general fund balance as a percentage of revenues and liquidity trends. These determinants show the locality's ability to account for unexpected current and future financial obligations or liabilities with the financial reserves they are presently holding. An additional subfactor considered is that of the revenue generating flexibility of the municipality. Paired with the amount of local control over expenditures, these subfactors make up what is called "operating flexibility."<sup>20</sup> The final subcategory reviewed when measuring financial strength is the "budgetary operations" category. This involves analyzing trends of operations that are structurally balanced, the municipality's exposure to sources of revenue which are sensitive to change in the economy, property tax rates, and the locality's exposure to reductions in state aid. This section gauges the level of risk that is mitigated by management's budgeting structure.

The third largest factor, with twenty percent in weight, in Moody's rating methodology is management and governance. Management strategies and procedures are put into place in order to keep general obligation credit ratings stable over the business cycle. The first subfactor considered when measuring this level of stability is "financial planning and budgeting" factor. In order to understand the strength of the management's projection skills and stability through

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<sup>20</sup> Moody's Investors Service, "General Obligation Bonds Issued by U.S. Local Governments," *Rating Methodology*, Moody's U.S. Public Finance.(Oct., 2009), pp. 1-28.

times of economic distress, Moody's analyzes the issuing government's trends of budget versus actual performance, adoption and compliance with certain policies and regulations, and practices concerning multi-year budgeting. The second subfactor focuses on the debt management and capital planning of the issuing local government. Similar to the previous subfactor, debt management and capital planning includes the analysis of multi-year planning, management practices and policies for mitigating risk, and the existence of and adherence to policies. The final three subfactors which conclude Moody's analysis of management and governance include economic forecasting, the structure of the issuing government, and full and timely disclosure of financial documents.

The final ten percent of the factors considered in Moody's analysis of general obligation bond credit ratings is based on the debt profile of the local government. The debt burden faced by the government is examined in the following two ways: the net *direct* debt as a percentage of full value and the net *overall* debt as a percentage of full value. Also considered is the structure and composition of the debt which is broken up into the amortization rate and the liquidity and budgetary risks taken on by the locality. Moody's also considers the debt service of the locality as a percentage of total operating expenditures and the pension funding ratio to interpret the management of debt and other liabilities.

#### **e.) Rating Changes**

##### **i.) Causes**

Rating agencies, such as Moody's, regularly review outstanding ratings in order to ensure an accurate and up-to-date analysis of the credit quality of local governments. By monitoring financial activity, analyzing annual financial documents, and inspecting management, rating agencies are able to update the public, investors, and the government on any significant changes

in the locality's credit profile which will affect their creditworthiness, and ultimately the value of the bond. Moody's rating methodology document explains, "while economic factors carry the greatest weight in Moody's rating assignments, we have seen that over time, financial changes are most likely to drive rating movements."<sup>21</sup> This implies that financial changes are more volatile than the gradual effects of economic changes. Due to the gradual nature of changes within the economy, management is able to respond to the changes, control the situation, and uphold their current credit rating.

In order to make the public aware of potential changes in credit ratings, Moody's provides a rating outlook, which is an opinion on the future of a rating. As Moody's explains, "rating outlooks fall into the following four categories: Positive (POS), Negative (NEG), Stable (STA), and Developing (DEV-contingent upon an event)."<sup>22</sup> Moody's also provides a "watchlist" which lists certain bond ratings that are under review and should be expected to change shortly thereafter.

## **ii.) Effects**

The effects of credit rating changes have been the topic of study for economists for many years. In 1991, a panel study by Brandeis University Professor John Capeci tested the hypothesis that there exists both a direct effect of changes in credit quality on changes in borrowing rates and an indirect effect generated through changes in credit ratings. Although these estimated effects appeared to be large in magnitude, Capeci's empirical results proved the

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<sup>21</sup> Moody's Investors Service, "General Obligation Bonds Issued by U.S. Local Governments," *Rating Methodology*, Moody's U.S. Public Finance.(Oct., 2009), pp. 1-28.

<sup>22</sup> Moody's Investors Service, "General Obligation Bonds Issued by U.S. Local Governments," *Rating Methodology*, Moody's U.S. Public Finance.(Oct., 2009), pp. 1-28.

effects to be statistically insignificant.<sup>23</sup> Nevertheless, the relationship between changes in credit quality and changes in borrowing rates should still be examined.

In a 1991 article written by Roger D. Stover, the effects that changes in bond ratings have on bond prices were studied. Stover found, through path analysis, that the “bond rating assumes considerable importance in the pricing of municipal debt.”<sup>24</sup> In order to investigate the relationship between bond ratings and bond prices, one must first establish the relationship between borrowing rates and bond prices. The following formula relates bond prices and the yield to maturity:

$$P = \sum_{t=1}^n \frac{C_t}{(1 + YTM)^t} + \frac{M}{(1 + YTM)^n}$$

where P=price, C=coupon, n=years to maturity, t=index of period, M=maturity value of the bond, and YTM=yield to maturity. We see from this equation that the price of the bond and the yield to maturity are inversely related. Theoretically one understands that as a bond’s credit quality decreases, thus becoming more risky, the yield promised to the investor must increase. Therefore a direct relationship between credit ratings and bond prices is established; as the credit rating of a bond decreases, the borrowing rate increases, and the price of the bond ultimately decreases.

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<sup>23</sup>Capeci, John. “Credit Risk, Credit Ratings, and Municipal Bond Yields: A Panel Study.” *National Tax Journal*, Vol. 44, No. 4 (Dec., 1991), pp. 41-54.

<sup>24</sup>Stover, Roger D. “Bond Ratings and New Issue Municipal Bond Pricing: Path Analysis Results.” *Quarterly Journal of Business and Economics*, Vol. 30, No. 1 (Winter, 1991), pp. 3-17.

## IV. Econometric Model

### a.) Statistical Methods

In order to properly analyze municipal bond ratings, several different statistical methods may be employed. These methods are used to understand the marginal impact of each determinant of the risk rating. The most common procedure applied to discrete-choice problems such as that of the municipal bond ratings is multiple regression analysis. A regression model is most applicable to the credit rating problem as it is a discrete choice problem which recognizes a causal, rather than conjoint, relationship between the dependent and independent variables.<sup>25</sup> Common applications of multiple regression analysis include the use of ordinary least-squares (OLS), as well as logit and probit models. While these three techniques each have their own benefits, as well as limitations, for the purpose of this paper we will focus only on OLS and probit analysis.

Although probit analysis is commonly known as the most appropriate technique to use for credit ratings, the method of ordinary least squares (OLS) may also be considered for use. In OLS regression, parameters are selected which minimize the difference between the predicted values and the actual data values. When applied correctly, OLS provides the best linear, unbiased estimators. However, this qualifier “when applied correctly” is most crucial to an accurate interpretation of results. In order to truly obtain the best unbiased, efficient estimators through the application of OLS, a series of assumptions must be initially satisfied. A verification that the following assumptions hold for the error term of the regression model is required before OLS can be appropriately applied:

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<sup>25</sup>Cluff, George S. and Paul G. Farnham. “A Problem of Discrete Choice: Moody’s Municipal Bond Ratings.” *Journal of Economics and Business*, Vol. 37, No. 4 (Dec., 1985), pp. 277-302.

- $\varepsilon_i \sim N(0, \sigma^2)$ : The error terms must be normally distributed with expected value 0 and a constant variance  $\sigma^2$  (the error terms are homoskedastic).
- $\text{Corr}(\varepsilon_i, \varepsilon_j) = 0$  for all  $i \neq j$ : The error terms must be IID: independently, identically distributed.
- $\text{Corr}(\varepsilon_i, X_i) = 0$ : There must be no relationship between the error term and the independent variables.<sup>26</sup>

While OLS is certainly an appropriate estimation method when the above assumptions hold, it is not the preferred method when applied to bond ratings since the assumption of normal and homoskedastic error terms usually fails to hold. If OLS were still to be utilized regardless of the violation of these assumptions, the whole analysis could be flawed. The presence of a heteroskedastic error term will lead to biased standard errors, possible misinterpretations of statistical findings, and to the acceptance of inaccurate conclusions. While these violations could possibly be remedied through the application of certain diagnostic transformations, for the purpose of bond ratings the error terms are better left uncorrected and the probit model should instead be employed.

A second reason why OLS is unsound when applied to the municipal bond rating problem is due to the assumption that credit risk is divided into intervals of exactly equal length. This assumption does not necessarily hold for the model used in this paper. The credit ratings are assigned the following values of  $R_i$  based on the unobservable riskiness of the issue  $R_i^*$ :

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<sup>26</sup>Gujarati, Damodar N. and Dawn C. Porter. Basic Econometrics. 5<sup>th</sup> Ed. New York: The McGraw-Hill Companies, Inc., 2009.

$R_i = 1$	if $R_i^* \leq \mu_1$	Aaa
$R_i = 2$	if $\mu_1 < R_i^* \leq \mu_2$	Aa1
$R_i = 3$	if $\mu_2 < R_i^* \leq \mu_3$	Aa2
$R_i = 4$	if $\mu_3 < R_i^* \leq \mu_4$	Aa3
$R_i = 5$	if $\mu_4 < R_i^* \leq \mu_5$	A1
$R_i = 6$	if $\mu_5 < R_i^* \leq \mu_6$	A2
$R_i = 7$	if $\mu_6 < R_i^* \leq \mu_7$	A3
$R_i = 8$	if $\mu_7 < R_i^* \leq \mu_8$	Baa1
$R_i = 9$	if $\mu_8 < R_i^* \leq \mu_9$	Baa2
$R_i = 10$	if $\mu_9 < R_i^* \leq \mu_{10}$	Baa3
$R_i = 11$	if $\mu_{10} < R_i^* \leq \mu_{11}$	Ba1
$R_i = 12$	if $R_i^* > \mu_{11}$	Ba2

Although the values assigned to the dependent variable are discrete integers, this coding is simply a matter of convenience and should not be taken as an exact measure of the default risk. The discrete values of  $R_i=1, R_i=2, \dots, R_i=12$  correspond to the credit ratings Aaa, Aa1, ..., Ba2, respectively. Therefore, as the quantitative values increase, the creditworthiness decreases and the bond is considered to be of higher risk. The importance however is that it is not necessarily true that the credit quality differs in equal increments. For example, a rating of  $R_4$  does not mean it is twice as risky as a rating of  $R_2$ . This characteristic provides a distinction between the OLS and probit techniques. As economist George S. Cluff explains, "Although ordinary-least squares (OLS) regression analysis and N-chotomous probit analysis both assume the same type of causality, OLS assumes that the risk continuum is divided into categories of equal length."<sup>27</sup> Clearly, this assumption is invalid for the bond ratings and thus the method of OLS cannot be appropriately applied.

The other regression technique previously mentioned is that of logit analysis. While there are no flaws apparent in the application of a logistic model to the bond rating process as there are with the use of OLS, the probit model is still the preferred technique. This is due to the

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<sup>27</sup>Cluff, George S. and Paul G. Farnham. "A Problem of Discrete Choice: Moody's Municipal Bond Ratings." *Journal of Economics and Business*, Vol. 37, No. 4 (Dec., 1985), pp. 277-302.

complex nature of the interpretation of parameter coefficients using logit analysis. Glenn Hoetker emphasizes this complexity in his paper “The Use of Logit and Probit Models in Strategic Management Research: Critical Issues.” He explains that in a review of scholarly papers which use logit and probit models, it was found that, “over half of the papers modeling an interaction between independent variables provided inappropriate or incomplete interpretations of the resulting coefficients.”<sup>28</sup> These erroneous interpretations may then lead to incorrect conclusions. While the parameter coefficients in both probit and logistic models are subject to this misinterpretation, for the scope of this paper we will chose the lesser of two evils. The logistic function adds an additional layer of complexity to interpreting the coefficients, thus making the probit model more desirable.

### **b.) The Probit Model**

Although the assignment of municipal bond risk ratings is a multinomial case, for the sake of developing an understanding of probit analysis, I will use the case of a dichotomous dependent variable to explain issues involved in estimation. The probit regression model is generally a discrete binary choice model in which the dependent variable can take on one of two values, namely 0 or 1. The inverse cumulative density function (CDF) of the standard normal distribution:

$$F(X) = \int_{-\infty}^{x_0} \frac{1}{\sqrt{2\sigma^2\pi}} e^{-(x-\mu)^2/2\sigma^2}$$

is used to predict the behavior of the dependent variable, which in this case is the probability of default. Since creditworthiness is an unobservable quantity, it must be determined through a

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<sup>28</sup>Hoetker, Glenn. “The Use of Probit Models in Strategic Management Research: Critical Issues.” *Strategic Management Journal*, Vol. 28, No. 4 (Apr., 2007), pp. 331-343.

linear combination of one or more independent variables. This linear combination is expressed in the following model:

$$R_i = \beta_0 + \beta_1 X_{1i} + \dots + \beta_k X_{ki} + \varepsilon_i$$

where  $X_{1i}, X_{2i}, \dots, X_{ki}$  are the explanatory variables,  $\beta_0$  is the constant,  $\beta_1, \dots, \beta_k$  are the parameter coefficients, and  $\varepsilon_i$  is the error term. For simplicity, let us assume that we are only interested in whether the bond will default or not. Let  $Y=1$  if the bond defaults and let  $Y=0$  if it does not. A critical value  $R_i^*$  must be determined and assumed to be normally distributed with an equal mean and variance to that of  $R_i$ . This value serves as a cutoff point such that if  $R_i$  is greater than  $R_i^*$  the bond will default and if  $R_i$  is less than  $R_i^*$  it will not. Applying the standard normal CDF, the probability that  $Y=1$  is given by

$$P_i = P(Y = 1|X) = P(R_i^* \leq R_i) = P(Z_i \leq \beta_0 + \beta_1 X_i + \dots + \beta_k X_{ki}) = F(\beta_0 + \beta_1 X_i + \dots + \beta_k X_{ki})$$

Below, it is shown that by taking the inverse of the normal CDF we can now discover information about the dependent variable  $R_i$  and the parameters  $\beta_0, \beta_1, \dots, \beta_k$ .

$$R_i = F^{-1}(R_i) = F^{-1}(P_i) = \beta_0 + \beta_1 X_i + \dots + \beta_k X_{ki}$$

The parameters of the regression equation are estimated by the method of maximum likelihood and help us to interpret the marginal impact each determinant has on the risk rating. The likelihood function is given by:

$$L = \prod_{i=1}^n P_i^{Y_i} (1 - P_i)^{1-Y_i}.$$

By taking the natural log we are given the following log likelihood function:

$$\ln(L) = \sum_{i=1}^n Y_i \ln\left(\frac{P_i}{1-P_i}\right) + \sum_{i=1}^n \ln(1 - P_i).$$

In order to find the maximum likelihood estimator of any given parameter, this equation is then differentiated with respect to that  $\beta$ , set equal to zero, and solved for that particular  $\hat{\beta}_{ML}$ . Since these derived equations are nonlinear, a complex iterative procedure is necessarily to solve for each estimate of  $\beta$ .<sup>29</sup>

### c.) Related Literature

In 1985, George Cluff and Paul Farnham used probit analysis to model Moody's municipal bond rating process.<sup>30</sup> Twenty-three municipal characteristics were used to form a bond rating model, which included one debt factor, three financial factors, fourteen economic factors, two administrative factors, and three geographic variables. Using the data from 976 U.S. cities, the determinants that were found to be statistically significant included all of the debt and financial factors, along with eight of the economic variables. The contribution of Cluff and Farnham mainly centered on their argument that probit analysis, rather than ordinary least squares, is the appropriate application to the discrete choice problem of credit ratings.

The use of a probit model was once again presented in 2012 by Canisius College professors George Palumbo and Mark Zaporowski.<sup>31</sup> The model found in this paper was built on data from 965 municipal and county governments from across the United States. Eleven economic, demographic, financial, and fiscal variables were found to significantly impact the underlying creditworthiness of these municipalities. Moreover, the probit analysis proved to be

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<sup>29</sup> See Maddala, G. S. Limited-Dependent and Qualitative Variables in Econometrics. Cambridge: Cambridge University Press, 1983.

<sup>30</sup> Cluff, George S. and Paul G. Farnham. "A Problem of Discrete Choice: Moody's Municipal Bond Ratings." *Journal of Economics and Business*, Vol. 37, No. 4 (Dec., 1985), pp. 277-302.

<sup>31</sup> Palumbo, George and Mark P. Zaporowski. "Determinants of Municipal Bond Ratings for General-Purpose Governments: An Empirical Analysis." *Public Budgeting & Finance*, Vol. 32, No. 2 (Summer 2012), pp. 86-102.

extremely beneficial in the interpretation of the marginal impact that each of these variables had on credit quality.

#### **d.) The Data Set**

The empirical analysis in this paper is solely based on New York State data. This data was collected from the United States' Census, the Bureau of Labor Statistics (BLS), and the Bureau of Economic Analysis (BEA). These three sources provide copious amounts of data that are available to the general public. As explained by Palumbo and Zaporowski, "the emphasis on publicly available information allows individual governments and investors to replicate the analysis, to monitor the rating process, and to project changes in underlying creditworthiness."<sup>32</sup>

The New York State data used to build the bond rating model includes 123 counties which can be further broken down into 3,443 local governments. These local governments include cities, villages, towns, school districts, and specials districts across New York State. However, due to incomplete information, the data from only 381 local governments were included in the final model.

#### **e.) The Credit Rating Model**

Using the rating methodology of Moody's Investors Services, in order to accurately model the credit rating process series of economic, demographic, financial, debt, and administrative factors were considered. The following model can be used to estimate municipal bond risk ratings:

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<sup>32</sup>Palumbo, George and Mark P. Zaporowski. "Determinants of Municipal Bond Ratings for General-Purpose Governments: An Empirical Analysis." *Public Budgeting & Finance*, Vol. 32, No. 2 (Summer 2012), pp. 86-102.

$$\begin{aligned}
 RATING = & \beta_0 + \beta_1 DIRDEBT + \beta_2 FVALUEASS + \beta_3 POP2010 + \beta_4 PCINCOME \\
 & + \beta_5 MEDHOUSVAL + \beta_6 WAGESALEMPL + \beta_7 PCHPOP + \beta_8 UNEMPRAT \\
 & + \beta_9 TOT TAX + \varepsilon_i
 \end{aligned}$$

where:

- *rating* is the numerical code assigned to the underlying risk ratings (1 = Aaa, 2 = Aa1, ..., 12 = Ba2)
- *dirdebt<sub>i</sub>* is the 2010 direct net debt outstanding for municipality *i*, measured in thousands of dollars
- *fvalueass<sub>i</sub>* is the 2010 full value assessment for municipality *i*, measured in thousands of dollars
- *pop2010<sub>i</sub>* is the 2010 population, measured in number of people from municipality *i*
- *pcincome<sub>i</sub>* is the 2010 per capita family income for municipality *i*, measured in dollars
- *medhousval<sub>i</sub>* is the 2010 median housing value for municipality *i*, measured in dollars
- *wagesalempl<sub>i</sub>* is the wage and salary employment, or number of jobs in 2007 in municipality *i*
- *pchpop<sub>i</sub>* is the percentage change in population from 2006 to 2010 for municipality *i*
- *unemprat<sub>i</sub>* is the 2010 unemployment rate for municipality *i*
- *tottax<sub>i</sub>* is the total 2010 tax revenue for municipality *i*, measured in thousands of dollars
- $\varepsilon_i$  is the error term for municipality *i*
- $\beta_i$ 's are parameters to be estimated

## Expectations

*A priori* one would expect the majority of these explanatory variables to have negative coefficients, thus implying an indirect relationship between the variable and the coded value assigned to the each risk rating. The direct debt and unemployment factors are the only variables expected to have a positive coefficient. If there is an *increase* in the amount of debt the municipality is carrying, the risk of default also *increases*. This increased risk implies a *decrease* in credit quality, which results in an *increased* numerical code. Therefore, direct debt is expected to have a direct relationship with the coded risk rating values, giving the coefficient a positive sign. Unemployment, being a key indicator of a municipality's economic performance, is also expected to have a positive coefficient. As unemployment rates *increase*, there is a *decrease* in the overall economic stability of the locality. Moreover, as unemployment

*increases*, there is an increased burden on the government to provide social welfare and assistance programs to the general public. This extra expense results in an increase of the riskiness of the municipality, thus *increasing* the numerical code assigned to high risk ratings.

Conversely, one may predict the full value assessment variable to have negative coefficient. As property values from a municipality *increase* the creditworthiness also *increases*, thus resulting in a *decreased* coded value. Both the 2010 population and the percent change in population from 2006 to 2010 are expected to have negative coefficients. An *increase* in population reflects positive economic growth, thus *increasing* the creditworthiness of the municipality and *decreasing* the risk rating coded value. Similarly, an *increase* in the median housing value and per capita income reflect an *increase* in the overall wealth of the locality. Areas with higher wealth have a more flexible power of taxation, particularly in their ability to increase property taxes if needed. Moreover, as explained in Moody's report *Rating Methodology: General Obligation Bonds Issued by U.S. Local Government*<sup>33</sup>, in areas of greater wealth, there is also a greater level of spending power, thus resulting in higher sales tax revenue. The stable tax base which comes along with an area of higher wealth thus creates an *increased level* of credit quality for the municipality. This *increased* creditworthiness is reflected in a *decreased* coding value, giving both the median housing value and per capita income variables a negative coefficient. The same argument follows for the total tax explanatory variable. Finally, the wage and salary variable also has the *a priori* expectation of having a negative coefficient. As the number of jobs *increases*, the overall wealth of the municipality also increases, making it less likely to default. This *increases* its creditworthiness which is represented through a *decrease* in the risk rating's coded value.

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<sup>33</sup>Moody's Investors Service, "General Obligation Bonds Issued by U.S. Local Governments." Rating Methodology, Moody's U.S. Public Finance. (Oct., 2009), pp. 1-28.

## Empirical Results

The parameter coefficients  $\beta_0, \dots, \beta_9$  are first estimated via ordinary least squares estimation and then through an ordered probit analysis. The results of the OLS estimation are displayed in Table 5. All of the expectations regarding the signs of the coefficients are confirmed via OLS, with an exception for the unemployment rate and the percent change in population. While the observed sign of the unemployment variable is not as expected, this variable is also found to be insignificant at even the ten percent level. The sign of the coefficient for the percent change in population is both surprising and significant. With a probability value of 0.0, the percent change in population is considerably significant to our model regardless of the unexpected positive coefficient.

**Table 5: OLS Estimation**

Dependent Variable: RATING				
Method: Least Squares				
Date: 04/11/13 Time: 19:17				
Sample (adjusted): 2 1580				
Included observations: 381 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	6.754901	0.713426	9.468263	0.0000
DIRDEBT	4.52E-08	3.62E-08	1.249655	0.2122
FVALUEASS	-5.00E-09	2.71E-09	-1.843821	0.0660
POP2010	-2.44E-08	7.94E-09	-3.071702	0.0023
PCINCOME	-3.38E-05	8.09E-06	-4.179138	0.0000
MEDHOUSVAL	-1.75E-06	5.99E-07	-2.925457	0.0037
WAGESALEMPL	-1.31E-06	4.75E-07	-2.748745	0.0063
PCHGPOP	0.000130	2.74E-05	4.743844	0.0000
UNEMPRAT	-0.079824	0.134671	-0.592733	0.5537
TOTTAX	-1.81E-08	6.84E-07	-0.026420	0.9789
R-squared	0.382543	Mean dependent var		4.446194
Adjusted R-squared	0.367564	S.D. dependent var		1.663974
S.E. of regression	1.323289	Akaike info criterion		3.424014
Sum squared resid	649.6558	Schwarz criterion		3.527499
Log likelihood	-642.2746	Hannan-Quinn criter.		3.465073
F-statistic	25.53903	Durbin-Watson stat		2.036605
Prob(F-statistic)	0.000000			

In addition to the unemployment variable, the direct debt, full value assessment, and total tax variables were all found to not be significantly different than zero at the five percent level.<sup>34</sup> However, if we increase this significance level to ten percent we may include the full value assessment variable in our model. Also noteworthy is the  $R^2$  value obtained via OLS. With an  $R^2$  of .3825, 38.25% of the variation in creditworthiness is explained by the variation in our explanatory variables. Since cross sectional data is being used, this is a reasonable value for  $R^2$ , implying that our model has sufficient explanatory power. The F-statistic provided in table five also illustrates the explanatory power of our model. As a joint significance test, the F-statistic determines whether the family of chosen independent variables has a significant effect on creditworthiness. With an F-statistic of 25.54 and a corresponding probability of 0.0, it is shown that our model has explanatory power.

We may interpret the estimated OLS coefficients in the following manner.

- *B<sub>0</sub>*: A all explanatory variables equal to zero, the credit rating of municipality *i* is 6.754901
- *Dirdebt*: A one billion dollar increase in direct debt leads to a .0452 increase in the credit rating of municipality *i*
- *Fvalueass*: A one billion dollar increase in full value assessment leads to a .005 decrease in the credit rating of municipality *i*
- *Pop2010*: A one thousand person increase in population leads to a .0000244 decrease in the credit rating of municipality *i*
- *Pcincome*: A one thousand dollar increase in per capita income leads to a .0338 decrease in the credit rating of municipality *i*

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<sup>34</sup> Several other economic, demographic, financial, and fiscal variables were also found to be insignificant to the modeling of creditworthiness. These variables include, but are not limited to, total revenue, sales taxes, state aid, total aid, total expenditures, and median income.

Moreover, many of the considered explanatory variables were omitted from the model due to high correlation. For example: the correlation between total tax and sales tax revenue is .971, the correlation between total tax and state aid is .998, and the correlation between total tax and total expenditures is .9996. Therefore, only total tax was included.

- *Medhousval*: A one thousand dollar increase in median housing value leads to a .00175 decrease in the credit rating of municipality  $i$
- *Wagesalempl*: An increase in one thousand jobs leads to a .00131 decrease in the credit rating of municipality  $i$
- *Pchpop*: A one percent increase in population from 2006 to 2010 leads to a .00013 increase in the credit rating of municipality  $i$
- *Unemprat*: A one percent increase in the unemployment rate leads to a .079824 decrease in the credit rating of municipality  $i$
- *Tottax*: A one billion dollar increase in total taxes leads to a .0181 decrease in the credit rating of municipality  $i$

As previously explained in the “Statistical Methods” section of this paper, the appropriate application of OLS estimation to municipal bond credit ratings depends upon assumptions about the error term holding. One problem that may arise when OLS estimation is performed lies within a violation of the assumption of homoskedastic residuals. While OLS still provides unbiased estimates in the presence of heteroskedastic residuals, the estimates are no longer of minimum variance and the standard errors of the estimated coefficients are biased. As a result of this biasness, the hypothesis tests and the t-ratios are no longer valid. In order to test the validity of the homoskedastic assumption and thus the reliability of our t-statistics, we perform the Breusch-Godfrey-Pagan Test.

The Breusch-Pagan-Godfrey procedure tests the following hypotheses:

$$H_0 = \text{Residuals are homoskedastic vs. } H_A = \text{Residuals are heteroskedastic.}$$

Five basic steps are taken when using the Breusch-Pagan-Godfrey test. First, by using the OLS regression model, the OLS residuals  $\hat{u}_1, \hat{u}_2, \dots, \hat{u}_n$  must be obtained. The maximum likelihood estimator of  $\sigma^2$  is now calculated by the following equation:  $\hat{\sigma}^2 = \sum \hat{u}_i^2 / n$ . From this we now calculate the variables  $p_i$ . These variables represent the residuals divided by our MLE estimates ( $p_i = \hat{u}_i^2 / \hat{\sigma}^2$ ). The next step is to regress  $p_i$  on the nonstochastic Z variables in the following manner:  $p_i = \alpha_1 + \alpha_2 Z_{2i} + \dots + \alpha_m Z_{mi} + v_i$  where  $v_i$  is the error term. From this regression

the explained sum of squares (ESS) must be found and the test statistic  $\theta$  is defined as  $\theta = \frac{1}{2}ESS$ . This test statistic follows the chi-square distribution with  $m-1$  degrees of freedom ( $\theta = \frac{1}{2}ESS \sim \chi^2_{m-1}$ ). Therefore if the computed value  $\theta$  exceeds the critical  $\chi^2$  value at the chosen significance level, the null hypothesis is rejected and the residuals are found to be heteroskedastic.<sup>35</sup>

**Table 6: Breusch, Pagan, Godfrey Test for Heteroskedasticity**

Heteroskedasticity Test: Breusch-Pagan-Godfrey				
F-statistic	0.770556	Prob. F(9,371)	0.6438	
Obs*R-squared	6.991244	Prob. Chi-Square(9)	0.6380	
Scaled explained SS	22.14444	Prob. Chi-Square(9)	0.0084	
Test Equation:				
Dependent Variable: RESID^2				
Method: Least Squares				
Date: 04/11/13 Time: 19:19				
Sample: 2 1580				
Included observations: 381				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.122157	2.385764	1.308661	0.1915
DIRDEBT	-1.05E-07	1.21E-07	-0.867905	0.3860
FVALUEASS	5.85E-09	9.07E-09	0.645090	0.5193
POP2010	2.01E-08	2.65E-08	0.756859	0.4496
PCINCOME	-4.41E-05	2.71E-05	-1.630249	0.1039
MEDHOUSVAL	3.02E-06	2.00E-06	1.507308	0.1326
WAGESALEMPL	-2.06E-06	1.59E-06	-1.295330	0.1960
PCHGPOP	-0.000107	9.15E-05	-1.169895	0.2428
UNEMPRAT	-0.131951	0.450353	-0.292996	0.7697
TOTTAX	-5.73E-07	2.29E-06	-0.250507	0.8023
R-squared	0.018350	Mean dependent var	1.705133	
Adjusted R-squared	-0.005464	S.D. dependent var	4.413165	
S.E. of regression	4.425206	Akaike info criterion	5.838407	
Sum squared resid	7265.087	Schwarz criterion	5.941892	
Log likelihood	-1102.216	Hannan-Quinn criter.	5.879466	
F-statistic	0.770556	Durbin-Watson stat	2.601293	
Prob(F-statistic)	0.643830			

<sup>35</sup>Gujarati, Damodar N. and Dawn C. Porter. Basic Econometrics. 5<sup>th</sup> Ed. New York: The McGraw-Hill Companies, Inc., 2009.

The results of the Breusch, Pagan, Godfrey test when applied to the bond rating model are shown in Table 6. With a  $\chi^2$  probability value of .6380, we fail to reject the null hypothesis and conclude that the residuals are homoskedastic.<sup>36</sup> Although it is determined that the homoskedastic residual assumption is not violated using the New York State data, the use of OLS estimation is not ideal. Due to the other complications previously discussed in the “Statistical Methods” section, it is in our best interest to perform the ordered probit analysis and compare these results with the obtained OLS estimates. The coefficients estimated via ordered probit analysis are shown in Table 7.

**Table 7: Ordered Probit Estimation**

Dependent Variable: RATING  
Method: ML - Ordered Probit (Quadratic hill climbing)  
Date: 04/11/13 Time: 19:18  
Sample (adjusted): 2 1580  
Included observations: 381 after adjustments  
Number of ordered indicator values: 11  
Convergence achieved after 15 iterations  
Covariance matrix computed using second derivatives

Variable	Coefficient	Std. Error	z-Statistic	Prob.
DIRDEBT	4.11E-08	2.91E-08	1.412899	0.1577
FVALUEASS	-4.55E-09	2.17E-09	-2.093872	0.0363
POP2010	-2.36E-08	6.36E-09	-3.714159	0.0002
PCINCOME	-3.62E-05	7.40E-06	-4.894909	0.0000
MEDHOUSVAL	-1.54E-06	5.02E-07	-3.074351	0.0021
WAGESALEMPL	-1.14E-06	3.82E-07	-2.969747	0.0030
PCHGPOP	0.000122	2.22E-05	5.488883	0.0000
UNEMPRAT	-0.089241	0.106003	-0.841870	0.3999
TOTTAX	-3.82E-08	5.53E-07	-0.068949	0.9450
Limit Points				
LIMIT_2:C(10)	-5.001575	0.622946	-8.028901	0.0000
LIMIT_3:C(11)	-4.309374	0.599638	-7.186628	0.0000
LIMIT_4:C(12)	-3.020038	0.579160	-5.214513	0.0000
LIMIT_5:C(13)	-2.229067	0.572190	-3.895673	0.0001
LIMIT_6:C(14)	-1.235393	0.568890	-2.171586	0.0299
LIMIT_7:C(15)	-0.377415	0.572645	-0.659073	0.5098
LIMIT_8:C(16)	-0.251554	0.574265	-0.438046	0.6614
LIMIT_9:C(17)	0.293667	0.587545	0.499821	0.6172

<sup>36</sup> Although not presented in this paper, White’s test for heteroskedasticity was also performed. A p-value for the chi-square test statistic was found to be .6795. From this p-value we draw the same conclusion as was drawn in the Breusch, Pagan, Godfrey test; the residuals appear to be homoskedastic.

LIMIT_10:C(18)	0.355793	0.589975	0.603064	0.5465
LIMIT_11:C(19)	0.668715	0.612337	1.092070	0.2748
Pseudo R-squared	0.165577	Akaike info criterion		3.150091
Schwarz criterion	3.346713	Log likelihood		-581.0923
Hannan-Quinn criter.	3.228104	Restr. log likelihood		-696.4005
LR statistic	230.6164	Avg. log likelihood		-1.525177
Prob(LR statistic)	0.000000			

All of the coefficients have the same signs that were found by using OLS estimation. Once again, percent change in population and unemployed were found to have unexpected coefficient signs. Moreover, direct debt, unemployment, and total tax were found to be insignificant at the five percent level. On the contrary, full value assessment, 2010 population, per capita income, median housing value, wage and salary employment, and percent change in population were found to have a statistically significant effect on creditworthiness.

## V. Interpretation of Results

Contrary to Cluff's assertion of "N-chotomous probit analysis as the most appropriate technique"<sup>37</sup> when modeling the municipal bond rating process, this study concludes that ordinary least squares provides very similar results to probit estimation. This conclusion is drawn based the following two reasons: (1) there is little difference between the results drawn from the OLS and probit estimations and (2) the OLS estimated coefficients have a much more straightforward interpretation, making it easier for the public to understand.

Our first claim that the OLS and probit estimators differ only slightly is evident through the results of our regression analyses found in tables five and seven. The signs of the coefficients are the same using both techniques, implying that each variable is found to have the same type of impact on creditworthiness, regardless of which method is used. Even more

<sup>37</sup>Cluff, George S. and Paul G. Farnham. "A Problem of Discrete Choice: Moody's Municipal Bond Ratings." *Journal of Economics and Business*, Vol. 37, No. 4 (Dec., 1985), pp. 277-302.

powerful evidence supporting our argument that there is little difference between the two estimation techniques is that the coefficients of each of the variables are almost identical for each analysis. For example, the estimated coefficient for direct debt is  $4.52E-08$  when estimated through OLS and  $4.11E-08$  when estimated through probit. Similarly, the median housing value OLS estimate is  $-1.75E-06$  while the probit estimate is  $-1.54E-06$ . These differences are so infinitesimal that they make no significant difference to our model. Furthermore, the largest differential between the results of the two techniques is for the unemployment variable where there is a mere .009417 difference.

Also supporting our first claim is the fact that, based on the t-statistic probabilities, the same factors are considered to be statistically significant in the application of both estimation techniques. Based on the results of both estimations, the variables which were found to be statistically insignificant at the ten percent level are direct debt, unemployment rate, and total tax. Therefore, each technique will accept the same factors as having explanatory power for our model of risk ratings.

The second reason why OLS estimation is preferred over probit analysis is based on the complexity of interpreting the probit estimated coefficients. The interpretation of the OLS coefficients is quite straightforward. For example, direct debt has a coefficient of  $4.52E-08$ . This implies that a one unit increase in direct debt leads to a  $4.52E-08$  increase in the dependent variable. This is not the same process that is taken with probit analysis however. The probit coefficients do not have a direct translation as the OLS estimates do. The coefficients found through probit analysis are instead substituted into a series of complex equations based on the normal distribution. The solutions to these equations reveal the marginal impacts which will result from changes in the explanatory variables. For each one unit change in a specific

independent variable, there is a collection of probabilities that will be calculated. More specifically, if there is a one unit increase in direct debt (or any other explanatory variable) probit analysis will find the resulting marginal impact in the probability of having an Aaa rating, an Aa1 rating, a Aa2, and so forth. The results of this procedure are exceptionally valuable when interpreting the implications that arise on rating changes due to changes in the explanatory variables. These results, however, are outweighed by the complex mathematical process that one needs to employ in order to obtain these results. It is for this reason that I focus on OLS estimation.

## **VI. Conclusion**

In the wake of the global financial crisis, the crash of the United States' housing market, and the destabilization of the bond insurance industry, investors and professionals have found motivation to more carefully examine the bond rating process. By examining the underlying credit ratings of 381 New York State municipalities, this paper has found that a combination of six economic and demographic variables significantly reflects the true credit quality of a municipality. While nine economic, demographic, financial, and fiscal variables were included in the given model, estimation techniques proved three of these factors to be insignificant. Direct debt, which is the only financial factor, total tax, which represents the municipality's fiscal health, and unemployment rate, which reflects the economic well-being of the locality, were all found to have an insignificant impact on the underlying credit ratings. The only factors found to significantly reflect the underlying creditworthiness of a municipality were the following economic and demographic variables: median housing values, full value assessment, wage and salary employment, per capita income, 2010 population, and percent change in population.

The parameter coefficients for the nine originally considered factors were estimated via two techniques: ordinary least squares (OLS) and probit analysis. After considering both estimation methods, this paper has found that ordinary least squares offers a more simple interpretation of the parameter coefficients of the bond rating determinants. While probit analysis may be theoretically preferred to OLS, the difference in the parameter estimates appears minimal across these two methods.

After running the regression of the bond rating model presented in this paper, the following conclusions may be drawn. The analysis of creditworthiness provided by leading rating agencies, particularly Moody's, appears to rely heavily on economic and demographic variables. Although both techniques provide sufficient results, the method of ordinary least squares is favored for estimating the coefficients of bond rating determinants due to their ease of interpretation. Moreover, while the bond rating process is still not entirely clear, the disclosure of methodological papers by Moody's, the public availability of data by the BEA, BLS, and Census Bureau, and the recent universal attention of the financial world given to the problem of credit ratings has certainly made the process more comprehensible and translucent for both investors and professionals.

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