DRIVERS OF MUNICIPAL BOND DEFAULTS DURING THE GREAT DEPRESSION

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by

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CERTIFICATION OF APPROVAL

I certify that I have read and approved *Drivers of Municipal Bond Defaults during the Great Depression* by Marc D. Joffe and that in my opinion this work meets the criteria for approving a thesis submitted in partial fulfillment of the requirements of the degree: Master of Public Administration at San Francisco State University.

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Approximately 4800 municipal bond issuers defaulted on interest or principal payments during the Great Depression. Although municipal bond defaults have been quite rare over the last 70 years, some commentators have suggested that another large wave of municipal bond defaults will occur in the near future.

This paper assesses the likelihood of such a credit event by analyzing the Depression experience. It also reviews techniques used to gauge default risk for municipal bonds and analogous asset classes, with an eye toward determining which methods are most effective.

Statistical analysis relies upon a list of Depression-era city defaults collected by the author from contemporary bond manuals, trade publications and other historical sources. This list is used in conjunction with a database of municipal fiscal data compiled from historical censuses of local governments. This data set provides a collection of exogenous financial variables that may be predictive of default. Econometric analysis is performed on the data set with the goal of building a logistic regression model that can be used to estimate default probabilities for current municipal bond issuers. The paper also includes a discussion of the Depression-era municipal bond environment and its relevance (or lack thereof) to the current situation.

I certify that this Abstract is a correct representation of the content of this thesis.

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Chair, Thesis Committee Date

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Chapter One: Introduction

Over the last 70 years, interest or principal payment defaults on municipal bonds have been rare. This is especially true of general obligations bonds – those backed by the full faith and credit of a state, county, city or other governmental unit with taxing authority. By contrast, there were about 4800 reported municipal bond defaults during the 1930s (ACIR 1973; Fons, Randazzo & Joffe, 2011). Recently, some observers have predicted a new wave of municipal bond defaults (CBS News, 2010), causing some investors to reduce their municipal bond holdings.

With the assistance of colleagues and a data entry vendor, the author collected information on approximately 5000 defaults from the period 1920 to 1939. The primary sources were contemporary *Moody's Municipal and Government Bond Manuals* (now published and owned by Mergent Corporation), and back issues of the *Daily Bond Buyer* and weekly *Bond Buyer*. The author also found and catalogued defaults from state-level bond listings and other documents housed in state archives, Reconstruction Finance Corporation records, local newspaper accounts and other sources.

In all, the compiled data includes population, revenue, expenditure, asset, and debt data for about 10,000 defaulting and non-defaulting issuers during this period. The primary sources of this data are Census publications and the *Moody's Municipal and Government Bond Manuals.*

In their book, *This Time is Different*, Carmen Reinhart and Kenneth Rogoff (2009) marshaled older data in their analysis of banking and sovereign debt crises. Due to the paucity of recent defaults, a similar approach is warranted for US municipal bonds. In contrast to some areas of fixed income - such as mortgage backed securities - institutional change in the municipal sphere over the last century has been incremental rather than revolutionary. Political and budgetary processes at the state and local level have evolved relatively slowly in the context of a stable national political framework. Older municipal defaults are thus more relevant to modern experience than older defaults in other asset classes.

The goal of this thesis is to mine the Depression-era municipal bond default record to learn whatever insights it can offer for present day credit research. This is done by providing a history of the 1930s municipal credit crisis and by developing a quantitative default probability model. The thesis also contains a review of the literature on municipal default modeling and rating. The literature review also references corporate default modeling – a more developed field that can serve as a guide for researchers interested in applying advanced econometric techniques to the study of municipal and sovereign credit.

Chapter Two: The Depression Era Municipal Default Wave[1]

According to US Treasury statistics reported by *The Bond Buyer*, the dollar volume of municipal bonds outstanding more than quadrupled between 1913 and 1931 – a period during which the CPI rose 54%. The boom in municipal issuance during this period is largely attributable to the inception of the federal income tax and the popularization of automobile travel. Municipal bond interest was exempt from income taxes since the levy's 1913 inception, creating demand for these securities among high income investors. On the supply side, automobiles created a need for paved roads – which states, counties and cities often financed with bonds. Communities also used bonds to finance drainage, irrigation and levee projects to support agricultural developments and to fund school construction.

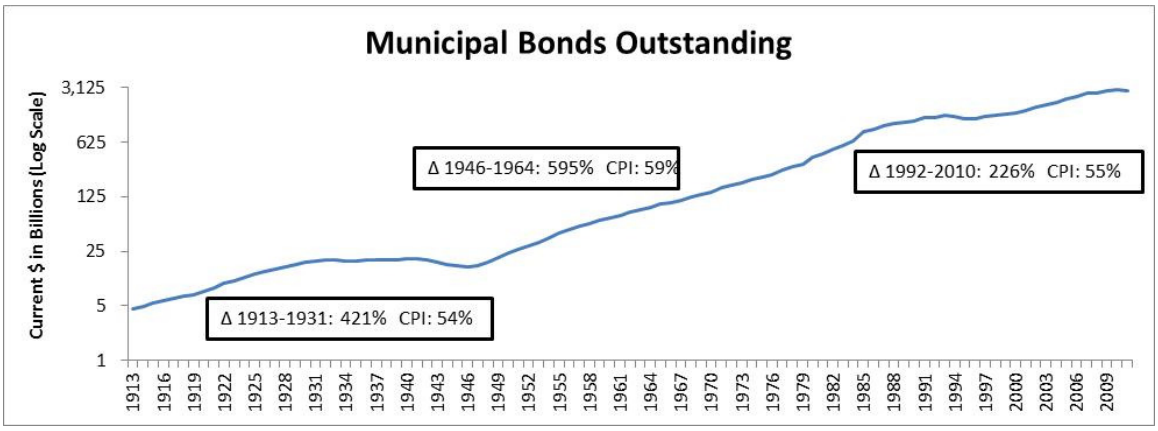
While municipal bond issuance was strong throughout this period, it accelerated after restrictions on issuance were relaxed after the end of World War I. During 1918, a Capital Issues Committee operating under the auspices of the Federal Reserve controlled issuance of municipal and corporate securities in order to limit competition with Treasury bonds required for wartime finance. Between 1918 and 1924, annual issuance of municipal bonds more than tripled, rising from $736 million to $2.4 billion.

Those concerned about today's municipal credit quality correctly point to the rapid growth in municipal bonds outstanding in recent years. But, as Figure 1 shows, the growth in municipal bonds outstanding between 1913 and 1931 far exceeded the rate of increase

[1] This section is adapted from the author's contribution to Kroll Bond Rating Agency's municipal bond default study (Fons, Randazzo & Joffe, 2011).

over the eighteen years up to 2010 – and both of these booms were outpaced by growth following World War II, during the years 1946 to 1964. While the pre-Depression municipal bond boom ended with a spike in defaults, the post-War expansion was not followed by a similar circumstance.

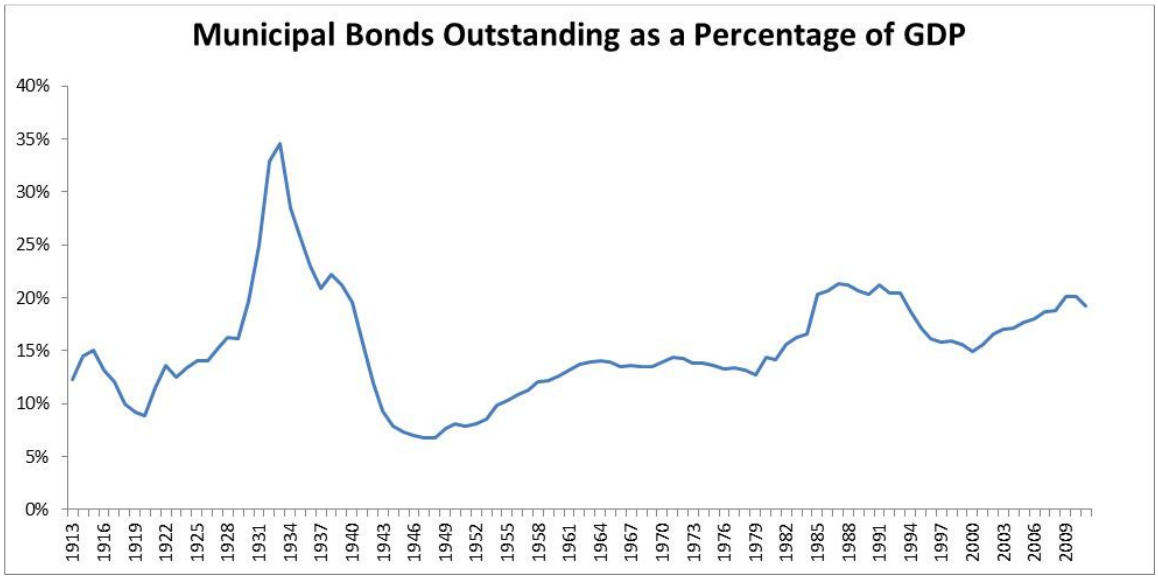
Figure 1 - Municipal Bonds Outstanding



Sources: Bond Buyer Municipal Bond Statistics, SIFMA, Bureau of Economic Analysis.

Price inflation during the three periods was similar, but rates of real GDP growth varied. As shown in Figure 2, the pre-Depression growth in municipal bonds outstanding was far more consequential than the most recent expansion when expressed as a percentage of GDP. It should be noted, however, that the last portion of the upward spike in the post-1913 period was due to the rapid shrinkage of GDP between 1929 and 1933. Municipal bonds outstanding were essentially flat during the 1930s and early-to-mid 1940s.

Figure 2 - Municipal Bonds Outstanding as a Percentage of GDP



Sources: Bond Buyer Municipal Bond Statistics, SIFMA, Bureau of Economic Analysis.

Bank Closings, Bank Holidays and Municipal Bond Defaults

It is also worth considering that the peak in estimated municipal default rates coincided with a nationwide outbreak of bank failures and bank holidays. In a 1933 survey of 1,241 state, city and county financial officials, Martin Faust (1934, 1936) found that slightly more than half of their governmental units had funds in closed banks. The municipalities surveyed had a total of over $98 million tied up in these failed institutions. Faust estimates that the aggregate balance in failed banks for all state and local governments would have been $450 million – more than 2% of the principal outstanding on municipal bonds at the time. Contemporary accounts attributed many of the defaults to the closure of banks in which funds intended for bondholders had been deposited.

A major source of distress for municipalities in North Carolina, Louisiana, Arkansas, Tennessee and other southern states was the November 1930 collapse of Caldwell & Company and its affiliates. Founder Rogers Caldwell, dubbed the "J.P. Morgan of the South" had built a large business marketing municipal bonds issued by southern states. Bond proceeds were typically held at Caldwell's Bank of Tennessee until they were required by the issuer. According to John McFerrin's (1939) history of Caldwell and Company, most issuers required that their deposits be supported by high quality collateral – typically other municipal bonds. Caldwell often pledged such bonds as collateral initially, and then substituted illiquid, high-risk real estate bonds without notifying the issuer. In addition to following deceptive practices, Caldwell looted bank assets to finance an extravagant lifestyle.

On November 7, 1930, a Tennessee state audit declared Caldwell & Company insolvent. News of this declaration triggered runs on Caldwell and numerous affiliated banks throughout the South. In Tennessee alone, $9 million in county and municipal deposits were lost. Caldwell's failure triggered a run on affiliates, including Central Bank and Trust Company in Asheville, North Carolina, which was followed by runs on other area banks.

Property Tax Delinquencies

While the vast majority of the enumerated defaults occurred in special districts, school districts and small towns, the Depression-era did witness several spectacular

defaults by large issuers including Cleveland and Detroit. New York City, the nation's largest municipality back then, also experienced a brief default in December 1933, while Chicago initiated a refunding program in which bondholders felt obliged to exchange their holdings for longer-term issues. Cook County – which encompasses Chicago – also failed to pay scheduled principal and interest during this time, as did a number of independent taxing districts within the city's limits.

As statistics collected at the time by Dun & Bradstreet (Bird, 1936) suggest, major city defaults during the Great Depression were preceded by substantial spikes in tax delinquency rates. For example, the tax delinquency rate in Detroit rose from 10.8% in fiscal year 1930 to 17.2% in 1931, 25.0% in 1932 and 34.8% in 1933 – the year in which it defaulted. In New York and Chicago, delinquency rates peaked at 26.5% and 42.4% respectively.

Although many of the property tax delinquencies were undoubtedly the result of economic distress, the early 1930s was also a period of organized tax revolts. This long-forgotten tax resistance movement is described in David Beito's 1989 book *Taxpayers in Revolt*. Beito argues that the resistance was in large measure a reaction to substantial increases in property taxes during the preceding decade. This increased burden was often accompanied by stable or falling property values, since the 1920s was a time of weak real estate prices.

Beito traces the history of the property tax resistance movement in Chicago where anti-tax activism was most potent. The Chicago resistance was led by the Association of Real Estate Taxpayers (ARET), an organization originally formed by relatively affluent investors, but which later attracted broad support among the City's skilled blue collar workers worried about maintaining their foothold in the middle class. At its peak, ARET leaders hosted a thrice-weekly radio program and the organization had 30,000 members.

Beito also notes that tax resistance in Chicago and elsewhere became easier when the market for tax titles collapsed:

> *Heretofore, local and state governments had relied on the tax sale to coerce recalcitrants. In most states a tax sale would be declared when a period of time had elapsed after the property had gone into delinquency. At the sale, the tax title, in the form of a tax certificate, would be awarded to that bidder willing to pay all the delinquent taxes and penalties. The owner of the tax certificate … gained the right to collect future penalties from the delinquent property holder. If … the original owner could not meet these payments, the owner of the tax certificate would be issued a tax deed which could be used as a basis to sue for full title to the property. … This tax sale machinery had operated effectively in the years before the depression; in fact, there had been a thriving and highly profitable market in tax titles. … With the collapse of real estate values and subsequent glut of tax titles on the market, buyers could nowhere be found. In the*

absence of tax sales, delinquent property owners had little to fear until local governments implemented alternative enforcement mechanisms.

As Table 1 also indicates, large cities were especially vulnerable to property tax delinquencies due to their heavy reliance on real estate taxes. According to 1931 Census data on which this table is based, the average city received about two thirds of its revenue from this one source.

Table 1 - Share of Total Revenues from Property Taxes, Cities Over 300,000, 1931

City	Property Tax Revenue Share
Baltimore, MD	66.8%
Boston, MA	69.3%
Buffalo, NY	69.6%
Chicago, IL	67.2%
Cincinnati, OH	58.9%
Cleveland, OH	67.4%
Detroit, MI	61.2%
Houston, TX	74.6%
Indianapolis, IN	86.8%
Jersey City, NJ	70.9%
Kansas City, MO	64.2%
Los Angeles, CA	52.5%
Louisville, KY	69.3%
Milwaukee, WI	67.1%
Minneapolis, MN	72.3%
New Orleans, LA	61.8%
New York, NY	70.8%
Newark, NJ	69.1%
Philadelphia, PA	71.8%

Pittsburgh, PA	81.2%
Portland, OR	65.7%
Rochester, NY	66.5%
San Francisco, CA	59.5%
Seattle, WA	47.5%
St. Louis, MO	62.5%
Washington, DC	56.1%

While over-reliance on one revenue source can be attributed to the relative lack of municipal finance sophistication at the time, part of the problem was beyond the control of city governments. According to Census statistics reported by C. E. Rightor (1938) in *Municipal Finance*, roughly 4-1/2% of major city revenue was derived from alcohol taxation in 1916. This revenue source disappeared with Prohibition, and did not return until the 18th Amendment was repealed in 1933. Additional policing costs associated with Prohibition-related organized crime must have further contributed to the cities' fiscal distress.

Public Employee Pensions

Contemporary concerns about municipal bond defaults are often linked to public pensions, but underfunding is not unique to our era. During the Great Depression, many retired government workers were eligible for pensions. In addition, some Southern states were still servicing Confederate pension bonds. According to the Moody's manuals, New Jersey's pension expenses accounted for 3.1% of the state's revenue in fiscal year 1932.

Arkansas had $9 million in outstanding pension bonds and Louisiana had $3 million outstanding.

Pensions were also an issue for some cities. Estimates published in *Municipal Finance* indicate that before the establishment of pensions, older municipal employees would continue to report for work even though they could no longer perform their jobs (at least not to the satisfaction of contemporary management). Supervisors, guided by a humanitarian impulse rather than a concern for the bottom line, were reluctant to fire these older employees. Administrators thus reached the conclusion that it would be less expensive to pension off the older workers at a percentage of their former salary (Buck, 1936).

Many cities had not yet created pension funds and those that did often failed to make actuarially appropriate contributions. A 1937 National Municipal League Consulting Service survey of Atlanta's finances reported serious underfunding in the city's pension three funds: .

> *It is obvious from these figures that the firemen's fund with a cash balance of $491.38 is no fund at all. Nor are the reserves of either the general or police funds even a faint approximation of what they should be to guarantee the payment from the fund of its probable obligations. ... Firemen this year who paid money into their pension fund saw it go out again immediately to pay other firemen's pensions. Their sacrifice in no way built up for them any protection. They have in*

> *fact nothing to rely on but the naked promise of the city as their security for old age. We would recommend therefore that in all the pension funds the employee's contribution be treated as a trust fund and invested for him in securities or in the purchase of an annuity.*

That said the NML consultants were not advocates of full funding:

> *We believe on the other hand that it is not necessary for a public body deriving its income from taxes to accumulate a fund as if it were a private insurance company. Unless there are some predictable sharp upturns in the curve of natural retirement there is no reason why the City should not pay pensions out of income. The integrity and solvency of the city should be a sufficient guarantee to the employee that the city will fulfill its pension contract. In fact if the city went bankrupt any fund it might have accumulated would probably disappear in the crash.*

Atlanta public employee pensions at the time were generous – at least by the standards of today's private sector. Employees could retire on 50% of their salary after 25 years of service, regardless of age. Survivor benefits were also provided. Atlanta avoided default during the Depression and evidence reviewed thus far does not attribute any case of municipal default during the 1920-1939 timeframe to employee pensions. Although pensions were available to Depression-era public employees, legal protections for these benefits are a more recent phenomenon. It may be appropriate to conclude that pension

benefits were junior to debt service in a government's priority of payments during the 1930s, while today these two obligations are *pari passu*, that is, on equal footing.

Geographic Distribution of Depression Era Defaults

The post-1913 boom in issuance and subsequent bust (in terms of defaults) were not spread uniformly across the nation. Seven of the then48 states accounted for 59% of the municipal defaults over the 1920-1939 period. Several states recorded ten or fewer defaults; while Maryland, Delaware, Connecticut, Vermont, and Rhode Island had no reported defaults during this period. The states with the most defaults were not necessarily the largest. Indeed, the nation's most populous state at the time, New York, experienced only eight municipal defaults.

Given the great disparity in debt accumulation and default frequencies across states, analysis of the Depression-era municipal default crisis should focus on those states that had the worst outcomes. In general, it is worth emphasizing that the relationship between a state and its local governments is not analogous to that of the national government and states. Under the US federal system, states have a substantial degree of sovereignty. Although the Civil War established clear limits to state sovereignty and the federal government has grown relatively more powerful since then, states continue to exercise substantial autonomy under the Tenth Amendment. This is not true of local government units which may be created or abolished by their states, and whose finances are subject to comprehensive state regulation. Prior to the Great Depression as well as today, states

exercised varying degrees of control over local government borrowing. Those states that were especially lax – due to lack of legislative authority or insufficient exercise of the authority provided – appear to have suffered some of the worst outcomes. The following sections discuss credit conditions in a number of the states that suffered high default rates.

Florida

Prior to and during the Great Depression, Florida suffered the most defaults and had the highest default rate of any state. Its unique experience in the late 1920s and 1930s was the result of a busted land boom and unusual state debt policies.

During the 19th century, the territory and then state of Florida was a serial defaulter. In 1841 and again in 1873, Florida repudiated its debt. By the early 20th century, Florida's constitution had been amended to forbid the issuance of state bonds – unless the state faced wartime hostilities. In the late 1920s, Florida was one of just two states that had no bonded debt, the other being Nebraska.

The lack of borrowing capacity at the state level shifted the burden of financing infrastructure onto counties, cities, school districts and other local authorities. In the early and mid-1920s, Florida witnessed a spectacular real estate boom, as the state became a popular tourist destination and an attractive place to relocate. Miami – the epicenter of the boom – saw its population rise from less than 30,000 in 1920 to over 130,000 in 1926. Local governments responded to aggressive projections of further population growth by building roads, schools and other facilities with borrowed funds.

According to a 1939 Work Projects Administration (WPA) report, Florida city bonds outstanding rose from $9 million in 1914, to $21 million in 1920 and to a peak of $256 million in 1929. County indebtedness also soared, while special tax districts created to finance schools, roads, bridges, drainage facilities and other infrastructure borrowed over $160 million. New bonding far outpaced population increases. According to Census figures, Florida's Gross Debt Less Sinking Fund Assets per capita rose from $22.72 in 1912 to $337.64 in 1931.

In 1925, real estate prices reached a speculative peak. In 1926, a hurricane hit southern Florida, killing 113 people, destroying several thousand homes and highlighting that area's vulnerability to deadly weather. In 1927, a fruit fly infestation devastated local agriculture.

Slowing population growth, reduced tourism and over-bonding created substantial stress for municipal issuers in the late 1920s. According to the WPA report, 23 Florida cities defaulted in 1927 and 1928. By early 1929, municipal credit quality had become of sufficient concern to warrant the first of several responses by the state legislature.

It is worth noting that the Florida municipal bond problem started well before the Great Depression. While the national economic downturn worsened the situation, the state would have experienced dozens or even hundreds of defaults even in the absence of the ensuing economic distress.

North Carolina

Fiscal stress also appeared in North Carolina prior to the depths of the Great Depression. As in Florida, the crisis was preceded by a rapid increase in bonded indebtedness. Census figures show that North Carolina County bonds outstanding rose from $7 million in 1912 to $159 million in 1931. This issuance was symptomatic of poor fiscal management practices. As a 1930 Brookings Institution report, prepared at the Governor's request, observed:

> *In few respects are county affairs in a more unsatisfactory shape than as regards their indebtedness. Resort has been had to borrowing to an unjustifiable extent with the result that many counties are now burdened with an indebtedness out of proportion to their financial resources. Statutory debt limitation provisions have been widely disregarded. In many cases expenditures have been financed through borrowing that should have been met from current income. In not a few cases the money realized from the sale of bonds has been applied to purposes other than those for which the sale of bonds was authorized. And in other cases the requirements in respect to the setting up of sinking funds for the retirement of debt has not been met.*

Brookings found that counties often raided sinking funds to cover operating deficits, and that sinking fund investment options were much too broad. Specifically,

sinking funds could be invested in real estate securities or "placed in banks without indemnification against loss or impairment."

Reliance on uninsured bank deposits appears to have played a role in at least one prominent set of North Carolina defaults. A May 6, 1931, Daily Bond Buyer article attributed the simultaneous defaults of Asheville, the Asheville Board of Education and Buncombe County to the failure of banks holding $8 million in public funds in late 1930. These three issuers accounted for $33 million of North Carolina's $368 million in local government debt at the time.

The Governor and State Legislature responded to the Brookings Report by creating a Local Government Commission. This body – which exerted substantial control over county, city and district borrowing – was later credited with the substantial improvement in North Carolina municipal finance that started in the mid-1930s.

New Jersey

Like North Carolina, the State of New Jersey exerted minimal control over local issuers who, in turn, greatly increased their debt loads during the 1920s. A Commission to Investigate County and Municipal Taxation and Expenditures, reporting to the Legislature in 1931, found that per capita local debt less sinking fund assets almost doubled between 1922 and 1929 – rising from $109.76 to $216.51.

A 1933 legislative committee report found that 72 local governments had defaulted by March 1933 with the number rising to 120 by July. The report went on to show how the

combination of high debt loads and rising tax delinquencies had essentially crowded out New Jersey local governments' ability to provide core services:

> *[O]nly 65 per cent of the 1932 tax levy was collected. The cost of debt service for 1933 represents 44.92 per cent of the total tax levy, thus leaving a possible balance of 20.08 per cent for carrying on all activities of local governments. These figures do not take into account the amount of over-due taxes from municipalities to the counties and from the counties to the State nor does it include the millions of dollars of bonds and notes with interest thereon already in default.*

Although New Jersey imposed limits on municipal and county debt, these restrictions had numerous loopholes. For example, the state limited municipal debt to 7% of assessed valuation. But special assessment debt and school debt were not subject to this limit. Communities on the Jersey Shore were assigned substantially higher limits in anticipation of rapid growth in these tourist areas – as was the case in Florida. Finally, the limit did not apply to revenue anticipation notes which could even be issued against delinquent real estate taxes.

The state legislature reacted to New Jersey's municipal credit crisis by implementing numerous reforms. It created a Municipal Finance Commission which took over the financial operations of a dozen cities in the greatest distress. It also created a

temporary Funding Commission that created and enforced certain prudential standards for municipal issuers planning to refund their bonded indebtedness.

Arkansas

Arkansas experienced hundreds of municipal defaults as well as a major default at the state level during the Great Depression. Most of the state's credit problems arose from road bonds.

During the 1920s, Arkansas counties created numerous road districts that incurred substantial debt. By 1927, many of these districts appeared to be in financial distress. The state legislature reacted by passing the Martineau Act, under which the state assumed county road district debt and authorized additional bonds to speed completion of the highway system. Overall, the Martineau Act increased the state's bond indebtedness by a factor of forty – from $1.6 million to over $65 million. Further legislation authorized more highway bonds as well as a smaller volume of pension bonds, raising the state's debt to $160 million by 1932.

Meanwhile, according to figures published by the Arkansas State Planning Board (1936), tax revenues peaked in 1930 and then fell over each of the following three fiscal years. Rural property tax delinquency rates increased from 5.0% in fiscal year 1930 to 19.8% in fiscal year 1933. Gasoline tax and toll revenues, which were intended to service the bonds, also fell during this period despite the road construction effort.

As a result, the state government's debt ratios became unmanageable. In the 1932 Census, Arkansas' ratio of Interest Costs to Revenue was 29.68%, the highest among the 48 states. The state with the second highest ratio, South Carolina, devoted 18.83% of revenue to interest payments. Similarly, Arkansas Gross Debt less Sinking Fund Assets per capita of $88.16 far exceeded that of every other state.

By late 1931, Arkansas bonds were under heavy selling pressure with secondary market prices as low as 80 being reported in November. That same month, bond dealer William R. Compton sent a telegram to Arkansas Harvey Parnell asking him to withdraw a bond issue planned for December and to not issue any bonds the following year.

Unfortunately, this advice was not heeded, as, by this point, the state needed bond proceeds to fund operating expenses. In March 1933, the State defaulted on highway bond interest payments. The following year, the legislature restructured the highway debt, rolling defaulted interest into new bonds and deferring principal maturities by ten years. In 1941, the highway debt was replaced by a Reconstruction Finance Corporation loan, lowering the state's interest rate by 120 basis points. Ultimately, bondholders recovered all principal and interest albeit on a delayed basis.

Given its own insolvency, the state had little ability to assist local issuers who defaulted in large numbers. Defaults were especially common among the state's many small paving districts, school districts and drainage districts.

Louisiana

Like Arkansas, Louisiana also experienced a substantial number of defaults by small districts. Also, like Arkansas, it experienced a default at the state level. But, in Louisiana's case, the default was brief and largely technical in nature. According to reports in The Daily Bond Buyer, the State failed to make timely principal and interest payments on a number of highway and levee bonds in March 1933. According to the State Treasurer, the payment delay resulted from the freezing of deposits at the Hibernia Bank & Trust Company in New Orleans. In February, a run on Hibernia had been narrowly averted when Governor Owen declared a one day bank holiday and Huey Long arranged for a substantial federal loan to the troubled institution. Hibernia was reorganized as a national bank in April. By late May 1933, all overdue interest and principal on state obligations was paid in full.

South Carolina[2]

Although Hempel (1964) mentions a possible default by the State of South Carolina during the Great Depression, we found no definitive evidence that the state missed any payments of interest or principal. However, the state did face an enormous deficit in the early 1930s, which it was only able to control by implementing drastic cuts in expenditures. By June of 1932, the State Finance Committee announced that expenditures would have to

[2] This section and the next were originally written by Charlie Deist, a research assistant working with the author on the 2011 Kroll Bond Rating Agency Municipal Default study from which this chapter is taken. The author has edited these two sections.

be cut by 15% in order to have enough cash on hand to finance more than $13,000,000 in obligations coming due in the first four months of 1933. It achieved this partly by failing to paying state employees' salaries in the last two months of 1932, and partly by slashing general appropriations by 30% in 1933. Justifying the decision not to pay salaries, State Treasurer Julian H. Scarborough argued that doing otherwise would "seriously impair and jeopardize the State's credit." The state also halted construction on a $65,000,000 highway program initiated before the start of the depression.

Unlike the state government, however, dozens of municipalities within South Carolina were unable to cut expenditures by enough to avoid default. Farming counties, such as Orangeburg, Abbeville and Chesterfield, all defaulted in the wake of poor property tax collections from farmers who were overwhelmed by their mortgage payments. South Carolina farms producing tobacco, wheat, and cotton were among the hardest hit by the onset of the depression—the U.S. Department of Commerce estimated that crop prices fell by roughly 57% from 1929 to 1932. The combination of decreased farm values and fixed mortgage payments overwhelmed these farmers, who had borrowed heavily to expand their operations after the surge in prices after World War I. Several other districts, including the City of Spartanburg, defaulted due to bank failures, which were also largely caused by high failure rate on farm mortgages.

Michigan and Ohio

Banking conditions contributed significantly to municipal defaults in Michigan and Ohio. Aside from individual bank failures, statewide bank holidays also triggered defaults – many of them brief. The federal bank holiday declared by President Roosevelt upon his inauguration on March 4, 1933 is a well-known event in financial history. Less recalled is the fact that several states had already initiated their own bank holidays prior to Roosevelt taking office. Municipal issuers that had coupon or principal payments due during a bank holiday were often unable to pay bondholders.

Michigan Governor Michael Comstock was the first in the country to declare a statewide banking holiday, bringing about numerous municipal defaults, including by the City of Detroit. Banks were closed from February 14 until February 22, 1933, just weeks before Roosevelt declared the nationwide holiday. Although Governor Comstock's act was technically the cause of Detroit's default, the temporary inability of the city government to access its funds most likely only delayed an inevitable default.

Detroit was then the economic engine of Michigan as well as the automotive center of the United States and the world. Beginning in 1929, declining automobile sales led to large increases in unemployment in Detroit and the surrounding regions. Laid-off workers struggled to meet mortgage payments, leading to bank failures throughout the state. By 1933, several major banks located in Detroit were on the verge of failure, threatening to worsen economic conditions in Michigan's industrial and financial hub. This led to the

sweeping decision to close banks not just in Detroit, but all across the state. Although the City of Detroit probably would have defaulted regardless of Governor Comstock's decision (due to high rates of tax delinquency as described below), the act initiated what might have otherwise been avoidable defaults in other parts of the state.

In the neighboring state of Ohio, homeowners were hit especially hard by collapsing real estate prices in the wake of the depression. Assessed valuations in Cuyahoga County (home of Cleveland, another large industrial city to default during the depression) fell by 50% between 1929 and 1934 after rising by 200% in the previous 15 years. Meanwhile, welfare rolls expanded dramatically, largely due to rising industrial unemployment in Cleveland. During the Great Depression, programs that had traditionally assisted small numbers of the mentally and physically handicapped were expanded to the unemployed. Welfare expenditures in Cuyahoga County rose 6200%, to $20,000,000 between 1912 and 1934, leaving little money to cover the county's other services and debt obligations.

California

California experienced a large number of municipal improvement district defaults and was especially hard hit by irrigation and reclamation district defaults, which started in the 1920s. Infrastructure projects designed to increase the amount of arable land suffered from a number of vulnerabilities from the bondholder's perspective. First, there was the possibility that the infrastructure would not work or would not produce the desired results,

leaving farmers with insufficient income to pay taxes necessary to service the bonds. Second, declines in commodity prices, like those experienced during the late 1920s, compromised farmers' taxpaying ability. Finally, many districts had very few taxpayers – sometimes as few as one. Thus, a single tax delinquency in a special purpose district would be enough to trigger a default.

As with Florida, the California defaults started well ahead of the Great Depression's onset. Records indicate that 25 California irrigation and reclamation districts defaulted between 1925 and 1928. An article in The Stockton Record attributed defaults on bonds of seven Northern California reclamation districts totaling $4.4 million to the failure of three farming corporations to pay assessments. Default occurred on July 1, 1928 when the first of ten annual principal repayments were due. A spokesperson for one of the agribusinesses blamed the default on poor agricultural conditions and recently imposed restrictions on the use of "Oriental" tenant farmers, which increased the company's costs. Pre-Depression defaults of agricultural districts were not limited to California: John McFerrin (1939) reports that all drainage bonds underwritten by Caldwell and Company had defaulted by 1929.

Many agricultural district defaults in California and elsewhere were resolved by the Reconstruction Finance Corporation. The RFC typically lent the district money to pay off existing bondholders. This lending program reduced financing costs through lower interest rates and extended maturity schedules. Also, as discussed in the Recoveries section, the

RFC loans were much smaller than the bonded indebtedness they replaced forcing incumbent creditors to take a significant haircut.

Summary

This survey suggests that Depression-era municipal bond defaults were largely attributable to the following factors:

(1) Bank closings and bank failures;

(2) Lack of revenue source diversification;

(3) High rates of property tax delinquency;

(4) Dependence on a small number of taxpayers;

(5) Overdevelopment in response to expected economic growth that does not ultimately materialize; and

(6) Lack of state control over municipal borrowing.

While the creation of the FDIC in the mid-1930s would seem to eliminate the first factor as a cause of future defaults, the other drivers could affect municipal issuers now and in the future.

Chapter Three: Literature Review

This chapter considers a range of issues related to municipal credit analysis and default forecasting. Social science research methods were not well developed in the 1930s, so most of the contemporaneous analysis is anecdotal in nature. In the decades since, quantitative methods have been applied to the municipal bonds, but researchers were challenged by the lack of post-Depression default occurrences. Consequently, the literature review also considers work done in the area of corporate bond default prediction, in the hope of adapting some of that work to the research question at hand.

Previous Depression-Era Municipal Default Research

Dr. George Hempel's contribution to our understanding of Depression-era municipal defaults is widely regarded in the municipal bond industry. Aside from his most commonly cited study, *The Post War Quality of State and Local Debt* (1971), some of Hempel's other work is relevant. Particularly noteworthy was his contribution to a 1973 study published by the now-defunct US Advisory Commission on Intergovernmental Relations (ACIR). This work contains a wealth of statistics as well as detailed case studies of eight high profile defaults from the Depression era.

Hempel's 1964 dissertation, *The Postwar Quality of Municipal Bonds*, available from ProQuest's Dissertation Publishing Service contains statistical material not published in the later NBER study. Portions of the dissertation along with some original material appear in a 1967 University of Michigan Bureau of Business Research report entitled

Measures of Municipal Bond Quality. Finally, Hempel researched municipal bankruptcy filings, publishing his findings in a December 1973 *Journal of Finance* article entitled "An Evaluation of Municipal "Bankruptcy" Laws and Procedures" and later updating his research in written 1975 testimony to the U.S. House of Representatives' Judiciary Committee.

Prior to Hempel, the seminal work in this area was published by A.M. Hillhouse, Director of Research of the Municipal Finance Officers Association (now known as the Government Finance Officers Association). His 1936 book, *Municipal Bonds: A Century of Experience* contains substantial commentary and data about Depression-era defaults as well as earlier default episodes. In 1935, Hillhouse published a bibliography listing news accounts of municipal defaults prior to 1930 under the title *Defaulted Municipal Bonds (1830-1930),* although this listing does not fully reflect pre-1930 Florida defaults.

Both authors derived most of their default data from *The Bond Buyer*, which published daily and weekly editions at the time. Hillhouse and Hempel published default counts by state and/or issuer type that they attributed to this publication. Their tables show the number of active defaults peaking at around 3250 in late 1935. Hempel also reports that there were a total of 4770 defaults during the period 1929-1937 in the ACIR study and elsewhere. In his review of *Bond Buyer* back issues from the period, the author was unable to find originals of the tables republished by Hillhouse and Hempel, but similar tables were furnished by *Bond Buyer* Managing Editor Sanders Shanks to *Municipal Finance*, *National*

Municipal Review and to a Congressional committee. To the best of this author's knowledge, there is no known record of which issuers are included in the default tables or in Hempel's cumulative estimate.

In a review of original sources, the author was able to identify roughly the number of defaults Hempel cites; however this would not have been possible simply from an intensive reading of reports in *The Bond Buyer's* columns of "Bond Calls, Redemptions, Debt Adjustments and Refunding Plans". The bulk of the defaults reported here came from a review of annual *Moody's Municipal and Government Bond Manuals*. The author also obtained several hundred of the defaults from sources other than Moody's or *The Bond Buyer* by visiting archives at a number of state capitols.

Econometric Default Modeling

In addition to default counts and descriptive material, Hempel also presented an econometric default model in his 1971 NBER study. Unfortunately, the model was based on data from only 24 municipal issuers in the State of Michigan, 17 of which defaulted. This sample has three shortcomings: small overall size, geographic distribution not representative of the nation as a whole and an in-sample default rate inconsistent with population default rates. Contemporaneous estimates published in *The Bond Buyer* (1938) indicate that there were about 30,000 municipal issuers in the 1930s. The approximate default count of 4800 issuers implies a population default rate of 16%. This contrasts to a rate of 71% in Hempel's sample.

Hempel collected 11 independent variables for the sample issuers. These were:

- Population
- Dollar Amount of Notes Outstanding
- Dollar Amount of Debt Outstanding
- Per Capita Debt
- Total Assessed Property Values
- Dollar Amount of Taxes Levied
- Tax Levy Per $1,000 Assessed Value
- Debt / Assessed Property Values
- Percentage of Current Taxes Delinquent
- Tax Levy Per Capita
- Assessed Property Values Per Capita

This set of variables captures many of the factors theorized to cause municipal bond defaults including size of the issuer, debt burden as well as the willingness and ability of local government and the citizenry to generate required tax revenue. No variables capture other costs that municipal leaders might choose to pay instead of debt service – such as municipal employee salaries or pensions. Also, some of Hempel's variables are derived from others, introducing a risk of multicollinearity. For example, Per Capita Debt is the quotient of Dollar Amount of Debt Outstanding and Population.

After collecting the data, Hempel subjected it to factor analysis, multiple discriminant analysis and multiple regression analysis. He reported a multiple regression equation that contained 8 of the 11 variables, which were significant at $p < .1$. While the overall regression had an r^2 of 64%, a number of the variables had signs inconsistent with theory, perhaps due to multicollinearity. Hempel addressed multicollinearity by further reducing the set of independent variables to the following four (shown here with their coefficients and standard errors):

Table 2 - Hempel's (1971) Municipal Default Model

Variable	Coefficient	Standard Error
Tax Levy per $1,000 Assessed Value	-0.00310	0.00247
Tax Levy per Capita	-0.00115	0.00108
Debt / Assessed Property Values	+0.3521	0.17000
Percentage of Current Taxes Delinquent	+0.07209	0.07277

Hempel does not report any goodness of fit measures for the overall equation, but notes that it had a higher r^2 than other alternatives he evaluated, and that all variables have the expected sign. On the other hand, two of the four variables are not significant at $p < .05$, while the two best predictors are theoretically related.

In the interest of using Depression-era data to predict future defaults, it is fortunate that certain variables fell out of Hempel's specification. Given the substantial change in prices and wealth since the 1930s, it would be difficult to use the Dollar Value of Notes Outstanding, the Dollar Value of Debt Outstanding or Per Capita Debt to model current issuers. Tax Levy per Capita, which remained in Hempel's specification, has a similar

challenge. Variables that take the form of ratios, such as Debt/Assessed Property Values or Tax Levy per $1000 Assessed Value are more appropriate for analysis and forecasting independent of time period.

Hempel (1973) later expanded the sample to 45 Michigan cities – 28 of which defaulted – and 23 independent variables. Many of the added variables were 1922 values most likely obtained from that year's Census of State and Local Governments. He identified a regression equation with nine exogenous variables significant at $p < .05$.

Table 3 - Hempel's (1973) Municipal Default Model

Variable	Coefficient	Standard Error
Log of 1932 Population	-0.07678	0.0321
Assessed Property Value Per Capita in 1932	+0.0001585	0.0000523
Growth of Population from 1922 to 1932	-0.02146	0.0113
Growth of Debt Relative to Population Growth	-0.007912	0.00213
Debt/Assessed Property Values in 1932	+0.4885	0.258
Tax Levy Per $1000 Assessed Value in 1932	+0.00919	0.00242
Tax Levy Per Capita in 1932	-0.007197	0.00322
Percentage of Current Taxes Delinquent in 1932	+0.2095	0.0962
Notes Outstanding Per Capita in 1932	+0.009159	0.00246

Hempel noted the presence of multicollinearity but did not present an alternative equation that addressed it. Two of the nine variables presented above – Growth of Debt Relative to Population Growth and Tax Levy Per Capita in 1932 – have coefficient signs that are inconsistent with intuition. Hempel reported that the nine variable regression had an adjusted r^2 of 51%, while alternatives that remedied multicollinearity had adjusted r^2 of between 39% and 45%.

In his discussion of Hempel's findings, Forbes (1973) questions the use of Depression-era data for modeling purposes, while admitting that the paucity of more recent defaults forces this choice. In particular he noted that local governments received more state aid – at the time of his writing – that they did in the 1930s. This institutional change could reduce the relevance of the historic default data.

Predicting Credit Ratings as a Proxy for Estimating Default Risk

Rubinfeld (1973) proposed a multiple regression model for predicting credit ratings. Since credit ratings are intended to convey information about the likelihood of default, exogenous variables that explain credit ratings could also be used as predictors of default. Using a sample of 128 New England municipal bond issuers, he found that the following independent variables were predictive of the credit rating at the 10% significance level:

- Percentage of Taxes Uncollected in the Previous Year
- Ratio of Direct Net Debt to Assessed Valuation
- Median Family Income
- Full Valuation of the Property Tax Base
- Overlapping Debt

The first two of these exogenous variables are consistent with those in Hempel's reduced set. Overlapping Debt refers to the indebtedness of other issuers who rely on the same tax base. For example, if property owners pay taxes to both their city and county and if both governmental entities carry debt, the county's debt would be considered overlapping

debt *viz.-a-viz.* the city and *vice versa*. This variable, along with Median Family Income and Full Valuation of the Property Tax Base, would have to be restated as a ratio to be useful in a default prediction model.

Carelton & Lerner (1969) attempted to use statistical techniques to match Moody's bond ratings using a random sampling of issuers extracted from Moody's 1967 Municipal and Government Bond manual. They tested six variables – all of which they found to be significant. These were:

- Whether the issuer was a School District
- Ratio of Debt to Assessed Valuation
- Ratio of Debt to Population
- Log of Population
- Log of Debt
- Average Collection Rate

Using a large sample of 976 cities, Farnham & Cluff (1984) tested 23 variables to determine whether they were predictive of Moody's bond ratings. They found 12 of the variables to be significant $\alpha = .05$. The method used was an "N-chotomous" probit analysis. The authors chose this method because the four possible ratings in the dependent variable were thought to be of unequal lengths, i.e. many more cities fell into the A rating category than into the Aaa category. Their analysis included several variables not considered by other authors – including housing stock attributes, form of government and geographical

location. Four of the housing stock attributes proved to be significant. Farnham & Cluff's variables are listed in the following table.

Table 4 - Farnham & Cluff's (1984) Independent Variables

Variable	**Significant at 5% Level?**
Gross Debt / 1000 Population	*
Total General Revenue	*
Percent Change in Total Revenue	*
Assessed Valuation	*
Population	
Percent Change in Population	
Percent Nonwhite	*
Percent Eighteen Years and Under	
Population Density	*
Income Per Capita	
Ratio of Non-Workers to Workers	*
Number of Manufacturing Establishments	
Percent One-Unit Housing Structures	*
Percent Housing Units Occupied	
Percent Housing Units Owner Occupied	*
Percent Housing Units Built Before 1940 (as of 1970)	*
Median Value of Owner Occupied Housing Units	*
Median Years of Education	*
Local Documents Available	
Council-Manager Form of Government	
City Located in Northeast Region	
City Located in Northcentral Region	
City Located in South	

The papers reviewed above are part of a large literature that attempts to estimate municipal bond ratings. Loviscek & Crowley (1990) compare the studies described here with eleven others that had the same objective.

Since Loviscek & Crowley published their review, at least two additional papers modeling municipal bond ratings have appeared. Moon & Stotsky (1993) analyzed data for 892 US cities with population over 25,000, of which 727 were rated. They first modeled the decision by city officials to seek a rating and then factors determining the ratings actually assigned. This methodology highlights the fact that by choosing to be rated, cities self-select into the samples used in previous studies. This suggests that studies which use ratings as a proxy for default probability suffer from selection bias.

Moon & Stotsky (1993) found that cities choosing to remain unrated were likely to achieve a lower rating. They tested twenty variables potentially affecting rating levels, and found 15 to be significant. The variables they evaluated were as follows:

Table 5 - Moon & Stotsky's (1993) Independent Variables

Variable	**Significant at 5% Level?**
Median Housing Value	*
Proportion of Housing Units that were Built Before 1940	*
Proportion of Housing Units that were Built After 1970	
Proportion of Housing Units that are Owner-Occupied	*
Per Capita income	*
Percentage Change in Population from 1970 to 1980	*
Proportion of the Population that is Non-White	*
Population Density	*
Total Debt	
Per Capita Debt	*
Ratio of Debt to Income	*
Ratio of Surplus Revenues to General Revenues	
Ratio of Intergovernmental revenues to General revenues	
Council-Manager form of government	*
Commission Form of Government	
City Located in Midwest	*
City Located in South	*

City Located in West	*
Population Between 100,000 and 500,000	*
Population Greater Than 500,000	*

Most recently, Palumbo & Zaporowski (2012) analyzed ratings for 965 county and city governments rated by Moody's in 2002. This population encompassed all such units that issued rated full faith and credit debt and that could be matched against Census, Bureau of Economic Analysis (BEA) and Bureau of Labor Statistics (BLS) data sets. Of the 15 variables they examined, 13 proved to be significant at the 5% level as shown below.

Table 6 - Palumbo & Zaporowski's (2012) Variables

Variable	**Significant at 5% Level?**
Per Capita Income	*
Percentage Change in Population 1990-2000	*
Unemployment Rate	*
Percentage Change in Earnings Per Worker 1986-2001	*
Economic Diversity Index from BEA	*
State Aid Per Capita	*
State General Obligation Bond Rating	*
Debt to Market Value (Ratio of Full Faith and Credit Debt to Population Weighted Median Value of Housing)	*
Non-Guaranteed Debt Per Capita	
Per Capita Interest Payments for Nonutility Debt	
Per Capita General Revenues	*
State Imposed Taxation Limit	*
State Imposed Expenditure Limit	*

Objections to Rating Based Analysis

Researchers who model ratings rather than defaults, implicitly assume that the former predict the latter.[3] However, if ratings do not change in response to underlying credit conditions experienced by municipal bond issuers, they may not be an effective proxy for default risk. Under SEC rules, rating agencies are required to publish transition matrices showing the distribution of rating changes over a given period. A review of the transition matrices published by Moody's Corporation (2012), Standard & Poors Corporation (2012a) and Fitch, Inc. (2012) suggests that about 90% of municipal bond ratings remain unchanged within a given year.

For example, an S&P transition matrix (for non-housing municipal issuers) shows that 89.11% of AA rated issuers remained AA the following year, while 0.18% were upgraded to AAA, 1.62% were upgraded to AA+ and a total of 9.09% were downgraded to various rating categories ranging from AA- down to BB+.

The S&P matrix represents all rating change activity that occurred between 1986 and 2011. During most of this period, a substantial proportion of municipal bond ratings reflected insurance "enhancements". So-called monoline insurers like Ambac, FGIC and MBIA – which were rated AAA – sold bond insurance policies to municipalities guaranteeing that any missed bond payments would be covered by the insurer.

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[3] In fairness to the authors of these studies, it is worth pointing out that most do not make the claim that ratings proxy default probability. When modeling credit ratings, researchers may have goals other than estimating default probability. For example, they may be interested in modeling rating agency behavior.

Consequently, the ratings assigned to these insured issuers were AAA – reflecting the estimated credit quality of the insurer. During the 2007-2008 financial crisis, all monoline bond insurers went out of business or suffered ratings downgrades (Palumbo & Zaporowski, 2012).

While the insurance was in place, ratings might have appeared to remain stable despite changes in municipal credit conditions, simply due to the stability of the insurer's credit rating. However, Fitch's NRSRO ratings transition exhibit states that the ratings analyzed are "unenhanced" which means they reflect the underlying credit quality of the issuer excluding any insurance benefit.

Insurance coverage aside, municipal ratings stability could be explained by some combination of three factors. First, underlying credit conditions for most issuers do not materially change from year to year. Second, ratings grades are too coarse to capture many credit quality changes. And, third, rating agencies do not perform sufficient surveillance activities to detect and respond to many changes in issuer credit quality. To the extent that the second and third causes are explanatory, they pose challenges to the use of ratings as a proxy for default probability.

Little evidence is available to determine the relative weight of each of these three factors. One item that may be relevant is the criticism rating agencies received for their inadequate monitoring of Residential Mortgage Backed Securities (RMBS) and

Collateralized Debt Obligations (CDO) prior to the financial crisis of 2007 and 2008. The United States Senate Permanent Subcommittee on Investigations (2011) found that:

> *Resource shortages impacted the ability of the credit rating agencies to conduct surveillance on outstanding rated RMBS and CDO securities to evaluate their credit risk. The credit rating agencies were contractually obligated to monitor the accuracy of the ratings they issued over the life of the rated transactions. CRA surveillance analysts were supposed to evaluate each rating on an ongoing basis to determine whether the rating should be affirmed, upgraded, or downgraded. To support this analysis, both companies collected substantial annual surveillance fees from the issuers of the financial instruments they rated, and set up surveillance groups to review the ratings. In the case of RMBS and CDO securities, the Subcommittee investigation found evidence that these surveillance groups may have lacked the resources to properly monitor the thousands of rated products. At Moody's, for example, a 2007 email message disclosed that about 26 surveillance analysts were responsible for tracking over 13,000 rated CDO securities. (p. 314).*

Since these findings relate to structured securities rather than municipal bonds, it is possible that they are not relevant. On the other hand, it is reasonable to think that if rating companies under-invested in surveillance for their most profitable asset class – structured finance - (Cornaggia, Cornaggia & Hund, 2011), they probably made similar under-investments in the surveillance of other asset classes. It is this author's contention, - based

on his experiences at a major rating agency - that surveillance procedures for structured assets were actually superior to those undertaken for municipal bonds.

Estimating Default Probability from Market Prices

A number of researchers have attempted to derive default probabilities from bond yields or Credit Default Swap (CDS) spreads (Longstaff, Mithal & Neis, 2004). In theory, bond yields should be a function of their credit risk. More specifically, yields should compensate investors for expected loss arising from a potential default. In the literature, expected loss is defined as the product of default probability and loss given default (LGD). LGD is simply the complement of a bond's rate of recovery, and is also called "loss severity".

Theoretical bond yields contain a number of components aside from expected loss. Bohn, Arora and Agarwal (2004) propose an equation for corporate bond yields that includes the risk free rate of interest, the level of investor aversion to risk, the bond's maturity date, issuer size (as a proxy for liquidity) and the correlation of the bond's default risk with that of other instruments. Yields may also be affected by call provisions that give issuers the option to redeem their bonds prior to maturity.

With respect to municipal bonds, a further complexity arises as a result of their tax status. Since interest on most municipal bonds is exempt from federal, state and local income taxation, their yields are not comparable to those on taxable securities. Some adjustment to the municipal bond yield must be made in order to make it "taxable

equivalent". One approach is to convert the tax free yield to a taxable yield based on the highest prevailing marginal tax rate, on the assumption that municipal investors are predominantly high income individuals. However, given the complexities of the tax code, the heterogeneity of individual investors and the participation of institutional investors (with different tax considerations), the use of the top marginal rate is a relatively strong assumption. Chalmers (1998) finds that interest rate differentials between long term US Treasuries and federally insured municipals (which are assumed to have no default risk) is not consistent with the tax benefits available to individuals in the top tax bracket.

The literature includes a number of efforts to decompose municipal bond yields into default risk and other components. Wu (1991) found that the risk aversion factor was not significant, but his functional form excluded recovery rates. Wu, Wang & Zhang (2006) offered a more comprehensive model that included a static recovery rate assumption. The authors attributed a substantial portion of municipal bond yields to liquidity factors.

In corporate credit markets, analysts often derive default probabilities from CDS spreads rather than bond yields. Credit Default Swaps are insurance contracts against default. If the issuer defaults, the CDS seller (or insurer) pays the protection buyer the face value of the bond and takes the bond in exchange. Deriving default probabilities from CDS spreads is easier than using bond yields because CDS have fewer complexities, such as call provisions. The applicability of CDS implied default probabilities to the municipal market is greatly limited, however, by the fact that CDS trades against a relatively small number of

municipal issuers, and trading volume is low even for those issuers for which CDS are available.

A final concern regarding market implied default probabilities pertains to how efficiently markets price credit risk. Decomposing yields into default probabilities and other components implicitly assumes that bond prices are efficient, i.e. that they accurately reflect all available information. This assumption is consistent with the strong form of the Efficient Markets Hypothesis (EMH) markets advanced by Fama (1970). More recently EMH generally, and the strong form of the hypothesis in particular, have come under attack (Summers, 1986; Crotty, 2011). Most tests of EMH have involved equities rather than bonds. In a 2003 survey of EMH literature, Malkiel (2003) identified only one study addressing bond market efficiency, and that paper found inefficiency in the pricing of corporate bonds (Keim & Stambaugh, 1986). Since large capitalization stocks experience much higher trading volumes than municipal bonds, it is not clear that EMH applies at all to the latter asset class. Indeed, there is a substantial literature documenting the lack of liquidity and transparency in the municipal bond market – suggesting the existence of substantial inefficiencies (Ang & Greene. 2011).

In summary, the task of deriving default probabilities from municipal bond yields is impeded by both the complexities of decomposing yields into their components and the likelihood that observed yields do not efficiently incorporate credit risk insight.

Default Probability Modeling Using Logit and Probit Techniques

More recent efforts to model default probabilities have used logit and probit techniques. An obvious advantage of logit and probit over Ordinary Least Squares (OLS) for default probability modeling is that the dependent variable is restricted to a range of 0 to 1. In addition, the use of a binary endogenous variable, like default/non-default, violates a number of assumptions of the OLS model. For example, OLS models of binary dependent variables are necessarily heteroscedastic, since all errors for independent variables that produce an estimated value of the dependent variable in excess of 1 must be in a single direction (Menard, 2002).

Because corporate bankruptcy has been much more common than municipal default, the academic literature contains many more efforts to model the former. Ohlson (1980) was first to apply a logit model to corporate bankruptcy modeling.

Shumway (2001) built upon previous logit models by using panel rather than cross sectional data. This approach addresses the fact that most bankrupt firms were solvent for many years before going into distress, and that it is thus useful to analyze a time series of data for each firm. Campbell, Hilscher & Szilagyi (2008) extended Shumway's model by considering more exogenous variables and more firms. The latter authors obtained their data from Kamakura Corporation, a firm that has released a commercial corporate default probability model using logistic (logit) techniques.

The literature also contains applications of probit models to corporate bankruptcy starting with Zmijewski (1984). Moody's RiskCalc is a commercial private firm default probability model that uses probit. The RiskCalc methodology document written by Falkenstein, Boral & Carty (2000) suggests that the choice of probit over logit was not a significant one, as the two models usually produce similar results. On the other hand, Altman & Sabato (2007) assert that logit models have outperformed probit models in the corporate bankruptcy field.

Probit and logit models are functionally similar, with the key difference being the fact that probit is based on a cumulative normal probability density function, whereas logit uses a logarithmic distribution. This latter distribution has more observations in its left and right tails and fewer observations at its center. Ameniya (1980), in his extensive survey of binary choice and other discrete choice models concludes that "it does not matter much whether one uses a probit model or a logit model, except in cases where data are heavily concentrated in the tails due to the characteristics of the problem being studied (p. 1487)."

Although the published literature does not appear to include general obligation municipal bond default probability models that employ logit and probit techniques, probit has been applied to the prediction of municipal bond ratings. Loviscek & Crowley (1990) proposed a probit model to determine the probability of a municipality receiving the highest Moody's rating (Aaa). Using a geographically representative sample of 121 rated

counties – of which 15 had Aaa ratings – they found that measures of revenue diversification and per capita income were both significant at $p < .01$, whereas accounting measures were not. Since the independent variable differentiates between a rating associated with minimum analyst-assumed default probabilities from other grades, these findings are less relevant to the current research issue.

Finally, Bialaszewski (1985) applied a logit model to a set of municipal revenue bonds – issues which are supported by user fees and other operating revenues collected by the issuing agency rather than with tax revenues. Bialaszewski collected financial, economic and demographic data for 36 defaulted revenue bonds and for 36 comparable bonds that did not default. She then created models using data at issuance, two years prior to default, one year prior to default and at the time of default. Different variables were significant in each model. She reported that her one year prior to default model accurately classified 87% of the observations into defaulting and non-defaulting categories, where these categories were defined in terms of a "cut point" in the calculated probabilities. Her cut point of 65.8% was set to produce the highest degree of accurate classification. It may be more appropriate to use a fixed cut point of 50%, since probability estimates over that level could be reasonably characterized as default predictions, while probabilities under this level could be seen as predictions of non-default. The significant variables in Bialaszewski's regression were:

- Total Population

- Percentage of Population that is Non-White
- Debt Service as a Percentage of Total Revenue
- Welfare Payments as a Percentage of Total Revenue
- Short Term Debt as a Percentage of Cash and Security Holdings

Since the observations involved revenue bonds, the theoretical case for some of the variables in this specification is not immediately apparent. For example, welfare payments are financed by a municipality's general fund, and should thus not be expected to compete with revenue bondholders for priority. On the other hand, non-white population and welfare dependency levels may be indicators of poverty. Impoverished residents may be less able to pay fees required to service debt incurred by the facilities that defaulted.

Finally, the use of race-based criteria for evaluating municipal bonds has been subject to criticism. Yinger (2010) finds that general obligation municipal bond ratings penalize communities with relatively high non-white populations despite the lack of evidence that these communities are more likely to default. He characterizes this result as a form of redlining and argues for municipal bond rating regulation to curtail this practice.

Review of Potential Independent Variables

The literature reviewed above contains a wide variety of independent variables that may be significant predictors of default. In addition, methodologies published by rating agencies list factors their analysts consider when assigning ratings, which (despite the objections described earlier) are intended to proxy for default probability. The following

table offers a comprehensive list of predictive variables found in the review of previous studies that have attempted to predict default or ratings. To ensure that this list is clear and concise, very specific variable descriptions have been converted to more general concepts and duplicates have been removed. For example, Hempel used "Growth of Population from 1922 to 1932"; this list just shows the more general concept of "Population Growth". Also, variables not found to be significant in previous studies are excluded.

Table 7 - List of Variables in Previous Studies

Assessed Valuation
Assessed Valuation Per Capita
Council-Manager Form of Government
Debt as a Percentage of Assessed Value
Debt Per Capita
Debt Service as a Percentage of Total Revenue
Economic Diversity Index from BEA
Full Valuation of the Property Tax Base
Geographic Location (By Region)
Growth of Debt Relative to Population Growth
Issuer Geography (State or Region)
Issuer Type (School District, City, County, etc.)
Median Family Income
Median Housing Value
Median Value of Owner Occupied Housing Units
Median Years of Education
Overlapping Debt
Per Capita Debt
Per Capita General Revenues
Per Capita Income
Percentage Change in Earnings Per Worker

Percentage Change in Total Revenue
Percentage of Current Taxes Delinquent
Percentage of Housing Units Not Built Recently
Percentage of Housing Units Owner Occupied
Percentage of One-Unit Housing Structures
Percentage of Population that is Non-White
Percentage of Taxes Uncollected in the Previous Year
Population
Population Density
Population Growth
Proportion of Housing Units that are Older
Proportion of Housing Units that are Owner-Occupied
Proportion of the Population that is Non-White
Ratio of Debt to Income
Ratio of Debt to Market Value
Ratio of Non-Workers to Workers
Short Term Debt as a Percentage of Cash and Security Holdings
State Aid Per Capita
State General Obligation Bond Rating
State Imposed Expenditure Limit
State Imposed Taxation Limit
Tax Levy per $1,000 Assessed Value
Tax Levy per Capita
Total General Revenue
Unemployment Rate
Welfare Payments as a Percentage of Total Revenue

Substantially longer lists of prospective independent variables have also been published. For example, KPMG Peat Marwick Policy Economic Group (1990) identified 153 fiscal health metrics in its study for the California Debt Advisory Commission (now

known as the California Debt and Investment Advisory Commission). That list – grouped by category - is as follows:

Table 8 - KPMG Peat Marwick Policy Economic Group (1990) Fiscal Health Indicators

Debt Position Indicators	Net Tax-Supported Debt Per Capita
	Average Debt Service Costs as a Percent of Total Revenue (Trend)
	Average Short-Term Debt as a Percent of Total Revenues (Trend)
	Composition of Debt
	Debt Capacity Index (1)
	Debt Outstanding (+Trend)
	Debt Per Capita
	Debt as a Percent of Assessed Value
	Debt Per $1,000 of Personal Income
	Debt as a Percent of Property Tax Base
	Debt as a Percent of True Property Value
	Debt Service as a Percent of Revenue
	Debt Service as a Percent of Revenue Capacity
	Debt Service as a Percent of Total Taxes Collected
	Debt Service Reserves as a Percent of Annual Debt Service
	Debt/Wealth Index
	Default History
	Federal and State Aid as a Percent of Debt Service
	Liquid Assets as a Percent of Short-Term Debt
	Maturity Term of Outstanding Debt
	Overlapping Debt as a Percent of Assessed Value of Property
	Overlapping Debt as a Percent of Full Value of Property
	Overlapping Debt as a Percent of Personal Income
	Overlapping Debt Per Capita
	Past Credit Ratings
	Ratio of Change in Long-Term Debt Outstanding to Change in Per Capita Income
	Ratio of Debt Outstanding to Be Paid in 5 Years to

		Total Debt
		Ratio of Debt Outstanding to Be Paid in 10 Years to Total Debt
		Ratio of Debt Per Capita to Income Per Capita
		Ratio of Debt to Assessed Value
		Ratio of Debt to True Property Value
		Ratio of Long-Term Debt Retired Plus Annual Interest Payments to Own-Source Revenue (Trend)
		Ratio of Long-Term Debt Retired Plus Short-Term Debt Outstanding Plus Annual Interest Payments to Own-Source Revenue (Trend)
		Ratio of Long-Term Debt Retired Plus Annual Interest Payments to State Personal Income (Trend)
		Ratio of Long-Term Debt Retired Plus Short-Term Debt Outstanding Plus Annual Interest Payments to State Personal Income (Trend)
		Ratio of Long-Term Debt Retired Plus Annual Interest Payments to Total Revenue (Trend)
		Ratio of Long-Term Debt Retired Plus Short-Term Debt Outstanding Plus Annual Interest Payments to Total Revenue (Trend)
		Average Maturity Date of Debt
		Ratio of Debt Service Payments to General Revenue
		Ratio of Debt Service Payments to Own-Source Revenues
		Short-Term Debt as a Percent of Total General Revenue
		Short-Term Debt Per Capita
		Tax-Supported Debt Per Capita
		Trend in Appropriation-Supported Debt Outstanding
		Trend in Per Capita Debt
		Ratio of Growth in Debt to Growth in General Revenues
Economic Base Indicators	Employment	Employment in Durable Goods Manufacturing (Trend)
		Employment Growth Trend
		Industrial Diversification (2)
		Manufacturing Employment as a Percent of Total Employment

		Ratio of Full-Time Equivalent Government Employment to Total Employment
		Unemployment Rate
	Income	Change in Income (Trend)
		Farm Income
		Median Family Income
		Personal Income
		Total Per Capita Personal Income
		Per Capita Income Growth Trend
		Real (Inflation-Adjusted) Per Capita Income
	Population	Median Age
		Percent Change in Black Population
		Percent of Population College Students
		Percent of Population Non-White
		Percent of Population Below Poverty Level
		Percent of Population Under 21 and/or Over 65 Years of Age (Dependency
		Percent of Population with Less Than Five Years of Schooling
		Population
		Population Growth Trend
		Population Density
	Economic Performance/ Infrastructure	Assessed Value of Property Per Capita
		Business License Trends (Number and Value)
		Housing Permit Trends (Number and Value)
		Market Value New Residential Development/Total New Development
		Percent of Residences that Are Owner- Occupied
		Percent of Substandard Housing
		Retail Sales Per Capita
		Age of Housing Stock
	Other Factors	"Better" or "Poorer" State
		Climate
		Land Area
		Median Years of Education
		Political Party in Power
		Political Fragmentation
		State of Origin

		Tourist Orientation of Economy
		Vacancy Rates
		Value of Mineral Production
Fiscal Base Indicators	Revenue Resources and Reserves	Average Current Tax Collection Rate (Tax Collections/Tax Levy)
		Change in Intergovernmental Revenue as a Percent of Total Revenue
		Change in Property Value from Value in Prior Period
		Change in Property Values Per Capita
		Elasticity of Revenue Base
		Fiscal (Revenue) Capacity
		Fiscal (Revenue) Effort
		Largest Taxpayers as a Percent of Tax Base
		Own-Source Revenues Per Capita
		Property Taxes as a Percent of Local Government Revenues
		Ratio of Assessed Value to True Market Value
		Ratio of Legal Tax Rates to Current Tax Rates
		Ratio of One-Time Revenues to Total Revenues
		Ratio of Property Taxes to Total Own-Source Revenues
		Ratio of Restricted Revenues to Net Operating Revenues
		Ratio of State Shared Revenue to Total Revenue
		Ratio of Tax Revenues to Index of Resources
		Revenue Growth Trends
		Revenue as a Percent of Personal Income
		Revenues Per Capita
		Revenue Raising Capacity
		Tax Capacity
		Tax Effort
		Tax Income Per Capita
		General Revenue Per $1,000 of Income
		Tax Rates
		Ten Largest Taxpayers as a Percent of Total Tax Base
		Total Tax Levy
		Trend in Own-Source Revenues Used to Meet Matching Requirements

	Current and Capital Expenditure Pressures	Capital Expenditures Per Capita
		Capital Expenditures Per Capita (Trend)
		Current Operating Expenditures Per Capita
		Education Expenditures Per Capita
		Expenditures for Personal Services as a Percent of Total Revenues
		Expenditures by Type
		Expenditure Growth Trends
		Total General Expenditures Per Capita
		Fire Expenditures Per Capita
		Health Expenditures Per Capita
		Growth in Government Enterprises Incurring Operating Losses
		General Expenditures Per $1,000 of Income
		Percent of Current Expenditures on Interest
		Percent of Local Schools Expenditures by the State Government
		Percent of Welfare Payments by State Government
		Police Expenditures Per Capita
		Ratio of Actual Expenditures to Index of Service Responsibilities
		Ratio of Fixed Expenditures to Total Expenditures
		Ratio of Government Expenditures to True Property Values
		Ratio of Mandated Expenditures to Total Expenditures (Trend)
		Ratio of Real Expenditures Per Capita to Index of Community Needs
		Ratio of Year-End Expenditures to Original Budget (Trend)
		Real Expenditures Per Capita (Growth)
		Revenue from User Fees as a Percent of Expenditures for Related Services
		Total Expenditures
		Trend in Capital Outlay Expenditures
		Welfare Payments as a Percent of Total Expenditures
	Pension Funds/Unfunded Liabilities	Pension Fund Obligations as a Percent of Total Assets
		Pension Fund Obligations as a Percent of Total Revenue

		Unfunded Pension Liabilities (Trend)
		Unfunded Pension Liabilities Per Capita
	Overall Operating Position	Current Assets Less Current Liabilities
		General Fund Balance Per Capita
		Ratio of Current Assets to Current Liabilities
		Ratio of General Fund Balance to Reserves
		Ratio of Surplus to Current Operating Expenses
		Operating Position (Surplus/Deficit) (Trend)

Rating agencies publish methodology or criteria documents describing the factors they evaluate when assigning ratings to municipal bonds. Each agency identifies several dozen factors. There is substantial degree of overlap between the rating agency lists, but each agency's list is distinct. The author reviewed the methodologies for rating tax supported local government bonds issued by four US agencies: Fitch Ratings (2012), Kroll Bond Rating Agency (2012), Moody's Investors Service (2009) and Standard & Poors Corporation (2012b). After removing duplicates, a list of over 170 factors evaluated by at least one of these agencies remains:

Table 9 - Credit Drivers Listed by Rating Agencies

Access to external liquidity
Accuracy and Conservatism of Budget Estimates
Actual vs. Budgeted Collections
Actuarial and other assumptions influencing the pension burden
Additional bonds test (ratio of Revenue to MADS - Maximum Annual Debt Service)
Aggressive use of investments.
Amount of the entity's budget needed to make pension contributions
Annual Change in Full Market Value of Property
Auditor has delivered a going concern opinion with the most recent review of the government's financial position
Availability of Internal Borrowable Cash Balances (i.e.. Money in Funds aside from the general and bond funds)

Available fund balance / rainy day fund as a percentage of general fund expenditures
Available general fund balance as a percentage of general fund expenditures
Balance Sheet/Liquidity
Bond Amortization Rate (10 years)
Borrowing across fiscal years
Budget Process
Budgetary operations
Cash and Investments Divided By Total Liabilities Net of Deferred Revenue
Cash On Hand
Commuting Trends
Compliance with Governmental Accounting Standards Board policies
Consistency of State Funding
Constructive relationship with elected officials
Current year balance or surplus in general fund
Debt affordability guidelines
Debt and Additional Continuing Obligations
Debt Burden
Debt Management and Capital Planning
Debt service as % of total operating expenditures
Debt service as a percentage of general and debt service fund spending
Debt Service on Bonds Originally Intended to be Repaid from a Funding Source that is no Longer Sufficient to cover the debt
Debt Service plus Pension ARC plus Annual OPEB Payment as a Percentage of Spending
Debt Structure and Composition
Deferred payments on a cash basis: in cases where good ratios hide significant under spending due to deferred payments.
Demographic Structure
Demonstrated ability and willingness to raise taxes when needed (and voter support is usually obtained when such approval is required).
Demonstrated capacity and willingness to cut operating spending (by more than 2%), resulting from a flexible cost structure, flexible legislation, and/or widespread political support
Dependence on External Borrowing for Satisfactory Liquidity Throughout the Year
Direct debt amortization
Direct debt service as a percentage of government expenditures
Disclosure
Diverse revenue stream
Economic Forecasting and Monitoring
Educational Attainment

Employment Trends
Entity's historical commitment (or lack thereof) to system funding
Existence of an oversight board
Existence of and adherence to policies and procedures
Existing state tax caps do not apply to the government, or the government retains substantial flexibility under the caps
Expected Stability of Major Spending Item
Expected structural improvement or deterioration in the current and next two years
Expenditure Growth
Exposure to interest-rate risk or instrument provisions that could increase annual payment requirements by at least 20%.
Exposure to non-remote contingent liability risk that could come due within 12 months.
Exposure to state aid reductions
Financial Management Assessment
Financial Performance
Financial planning and budgeting
Financial Reporting
Flexibility of labor environment
Forecasting
Fund balance minimums or ranges
Fund Balance Trends
Future growth potential
Future infrastructure needs
General Fund balance as a % of General Fund revenues
General fund fiscal balance
Governance and Management Structure
Government shows an unwillingness to support a debt or capital lease obligation
High levels of questionable receivables or amounts due from other funds with deficit balances
High levels of short-term debt, variable-rate debt, debt with put features, and the use of derivative products such as swaps and swaptions
High rates of voter approval for tax increases
High refinancing risk over the next 24 months.
Historic growth trend: annual increases in assessed and full valuation
History of accurate revenue and expenditure projections
History of balanced or surplus general fund results
History of cooperation between legislative and executive branches
Industry concentration
Industry Diversity

Interim financial reporting
Issuer Ability to Adjust Spending
Issuer Control over Tax Rates Without Voter Approval
Late release of audited financial statements
Limited capacity to cut expenditures due to infrastructure or operational needs or political resistance
Limited capacity to raise revenues due to consistent and ongoing political resistance.
Liquidity and budgetary risk related to variable rate debt or derivatives
Liquidity trend
Local control over expenditures
Magnitude of pension liability, the funded ratio, the size of the resource base from which
Maintenance of a general fund balance exceeding 30% of general fund expenditures for three or more consecutive years
Management may excel in consistently balancing operations despite the absence of formal policies
Management of risk related to variable rate debt and derivatives
Management team lacks the relevant skills to adequately plan, monitor, and manage the government's finances
Market Value Per Capita
Median Family/Household Income
Monitoring of economic performance
Moral obligations and other contingent liabilities
Multi-year budgeting practices
Multi-year capital planning practices
Net direct debt as % of full value
Net Direct Debt As % Of Total Governmental Funds Revenue
Operating Flexibility
Operating Revenues Less Operating Expenditures (i.e., whether one time revenues or reserve depletion are being used to achieve budget balance)
Other Long Term Commitments and Liabilities
Outstanding Litigation
Overall debt as a percentage of the taxable market value
Overall direct and indirect debt as a percentage of full market valuation
Overall net debt as % of full value (including overlapping entities)
Overlapping debt
Pension plan funded ratio
Per Capita Income
Per Capita Market Value of Property

Percentage of Revenue from Largest Taxpayer
Percentage of Revenue from Top 10 Taxpayers
Percentage of variable-rate obligations
Population Growth
Population trend
Poverty level (and trends)
Predictability
Presence of onerous revenue limitations
Property tax collection rates
Publication of a five year capital plan
Quality and Timing of Receivables and Payables
Reserve Policy (established rainy day reserve funds (particularly those with automatic funding sources, limits on use, and replenishment requirements)
Reserve Trends
Resource Base
Restrictions on the use of nonrecurring revenue
Revenue and expenditure balance
Revenue raising flexibility
Revenue Source Diversity
Revenue Volatility
Robust and stable internal cashflow generation capacity
Service Fund Balances
Service Scope (When the government provides limited services, operational risk declines)
Significant medium-term debt plans.
Size and Growth Trend
Size of the resource base from which funding is derived
Socioeconomic and Demographic Profile
Speculative contingent liabilities or those otherwise likely to be funded on an ongoing basis by the government representing more than 10% of revenues
Stability
Systemic support
Tax base size
Tax Burden Relative to Other Communities in a Metropolitan Area
Tax Collection Schedules
Taxpayer concentration: assessed valuation of a locality's ten largest taxpayers
Tenure and Relevant Experience of Key Officials
The need for additional borrowing to repay outstanding notes
Timely budget adoption

Timely disclosure of key documents
Timely payment of pension ARC
Timing of Disbursements
Timing of fiscal year and tax billing dates result in high cash with abnormally low fund balance levels
Total Cash as % of Governmental Fund Expenditures
Total Government Cash As % Of Total Governmental Funds Debt Service
Total Governmental Funds Debt Service As A % of Total Governmental Funds Expenditures
Total Governmental funds fiscal balance
Total of debt service, pension actuarially required contribution (ARC), and OPEB funding, as a percent of spending
Transparency and accountability
Trend of budget-to-actual performance
Trend of receivables and payables
Trend of structurally balanced operations
Type of Economy
Unaddressed exposure to large unfunded pension or OPEB obligations leading to accelerating payment obligations over the medium term that represent significant budget pressure
Unemployment rate
Unfunded Mandates from Higher Levels of Government
Use of Cash Accounting (Negative)
Use of long term debt for operating needs (negative)
Whether action is taken within a budget year to restore budget balance
Whether Issuer Conducts Interim Budget Reviews Regularly
Workforce Profile
Year End Cash as a Percentage of Operating Revenue

These lists contain a number of variables that are highly correlated with one another (such as “Per Capita Income” and “Median Family Income”) as well as some that are difficult to operationalize (“Predictability” being just one example). But, even if the lists were reduced to a set of clearly distinct, readily measurable attributes, they would still be quite long.

Since municipal bond defaults are relatively rare, a model relying on a much shorter list of variables should be both possible and desirable. The philosophy of science contains a substantial literature advocating simpler – or more parsimonious – models. This literature is often traced back to Ockham's Razor and Isaac Newton. More recently, scientists have developed two tests of model efficacy - the Akaike Information Criterion and Bayesian Information Criterion - that penalize models with extra parameters. If two models fit the data equally well, the one that contains fewer parameters is preferred by both of these tests, although they measure the tradeoff between goodness of fit and parsimony differently (see Forster and Sober, 2004 for a detailed discussion of these issues).

Budget Forecasting and Simulation

Independent fiscal variables supplied to the models described above were typically actual revenue, expenditure and debt values. Compared to US publicly traded firms, municipalities usually report actual results less frequently and with longer delays. The Governmental Accounting Standards Board (2011) reported that larger governments took an average of 171 days from the end of the fiscal year to issue annual financial reports while smaller governments took an average of 200 days. Consequently, modeled municipal default probability estimates that rely solely on actual data can be expected to produce much less timely results than modeled corporate default probability estimates.

One way to address this timeliness issue is to supplement or replace actuals with budget forecasts, but the accuracy of these projections is subject to debate. Auerbach

(1999) found large standard errors in a comparison of federal budget results to Congressional Budget Office and Office of Management and Budget forecasts, but did not find evidence of bias. Boylan (2008) found that state general fund revenue forecasts for the period FY 1982-2005 understated actuals by 3% on average. He also found that revenue forecasts were significantly more optimistic relative to actuals in election years. This election year bias at the state level may be attributed to balanced budget requirements. A more aggressive forecast during an election year enables targeted spending increases (or the avoidance of cuts) at politically crucial times.

To the extent that the magnitude and direction of budget forecast errors can be estimated, adjustments may be made to budget forecast data before loading them into a default probability model. A precedent for budget adjustments exists in the stock market. Public companies publish revenue and earnings forecasts, but these forecasts are adjusted by equity analysts who maintain their own projection models.

Crippen (2003) argues that medium term budget forecasts (those with 3-10 year time horizons) should be presented in the form of confidence intervals rather than point estimates. He applauds the Congressional Budget Office's 2000 decision to adopt the use of fan charts, which depict a widening forecast range over time.

CBO published these fan charts until 2007, but then discontinued the practice. The most recent methodology document (Congressional Budget Office, 2007) explains the procedure used to determine the forecast distribution. CBO derived the distribution by

calculating observed annual errors for its five-year forecasts published between 1981 and 2006. This procedure has the advantage of considering CBO's actual forecasting record, but it has the disadvantage of relying on a relatively tranquil period in US economic history. The timespan contained two mild recessions (1990-1991 and 2001), and the severe one at the beginning of the period is underrepresented in the sample (1981-1982). The reason that the major recession is underrepresented is that the data set does not include multiple year forecasts issued in years prior to 1981 – due to lack of data availability.

The 2007 report includes the range of potential budget forecasts shown in that year's fan chart. For FY 2009, projected outcomes ranged from a $613 billion deficit at the 5th percentile and a surplus of $318 billion at the 95th percentile. Absolute range minima and maxima are not reported. The actual 2009 budget deficit was $1.4 trillion. The fact that the actual deficit was well outside the forecast range can be explained by two factors. First, CBO baseline forecasts assume that present law will prevail. In 2007, current law would not have included the impact of the American Recovery and Reinvestment Act (ARRA). Later Congressional Budget Office (2009) estimates indicate that the FY 2009 budgetary impact of ARRA was about $200 billion of greater expenditures and reduced revenue.

The second, larger, factor appears to be actual economic performance well below the minimum of the distribution derived from the 1981-2006 period. According to data from the Bureau of Economic Analysis (2012), the 2009 fiscal year change in real GDP (-3.3%) was lower than the changes in all 25 years of the sample period. Only two fiscal

years during this period had negative real GDP growth, with the worst being -2.7% in 1982. As more recent experience has shown, effective financial models must be parameterized against long data series, so that extreme outcomes can be included in the sample distribution.

CBO's simulations rely on varying macroeconomic drivers such as GDP growth. Polski (2011) argues that macroeconomic simulations techniques "cannot handle the disruptive events, strategic behavior, or adaptive change that characterize real political economies (p. 11)." She advocates the use of "agent based models" that attempt to simulate the behavior of individual actors within the economic and political systems. A similar methodology known as microsimulation can be used to model the behavior of individual taxpayers or program beneficiaries. For example, Gokhale (2010) created a microsimulation model to forecast social security contributions and expenditures under current law and various alternative policies. The model simulates the behavior of 15,000 family units intended to act as a representative sample of American households. While agent based modeling and microsimulation have the potential to improve budget forecasting, these advanced methodologies have yet to be applied to all major line items in a large government's budget.

The logistic default probability model developed in the remainder of this paper could be used with either budget forecasts or budget simulation results. Because the model

relies solely on fiscal magnitudes, it supports a clear separation between the tasks of forecasting fiscal results and of determining whether these results will trigger a default.

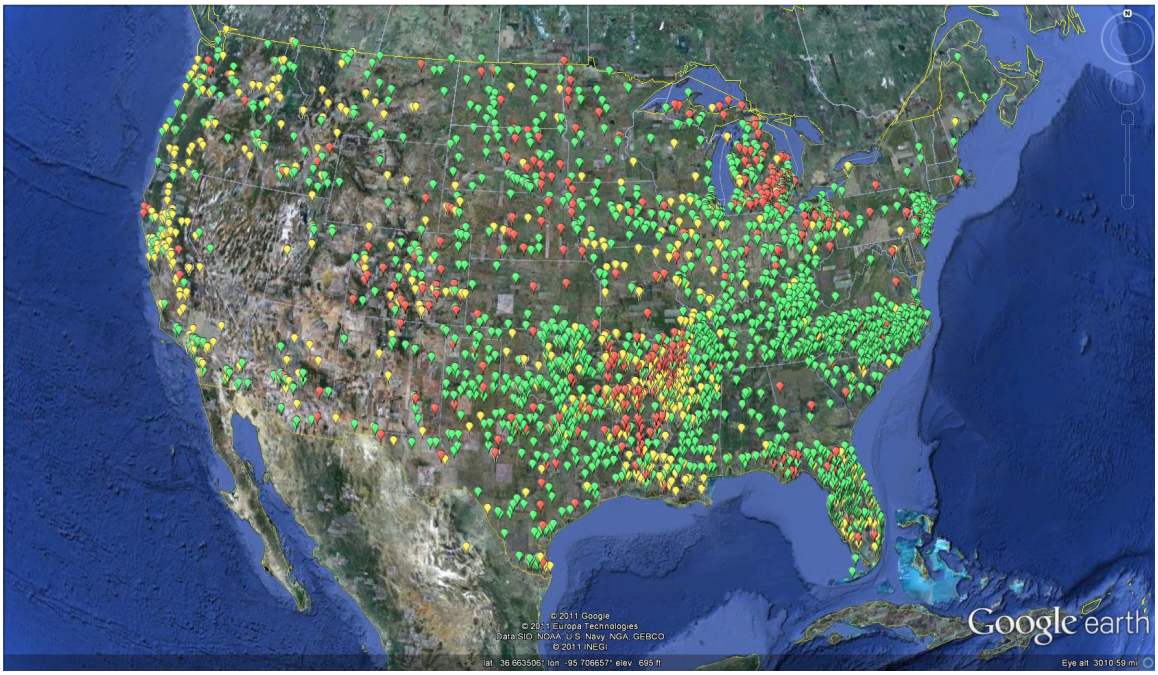
Chapter Four: Methodology

As discussed in the literature review, Hempel (1971, 1973) was the last researcher to directly model general obligation municipal credit risk – rather than use ratings as a proxy or infer default probabilities from credit spreads. His work was handicapped by lack of access to binary response regression techniques and the availability of a small, unrepresentative data set. Advances in statistical software and data retrieval technologies enable an improvement upon Hempel's analysis.

The current study applies a binary response technique to a larger number of geographically representative issuers. Since municipal bankruptcy is a rare event, it is preferable to use a model that differentiates between observations in the tail – suggesting a choice of logit over probit.

While Hempel estimated that 4770 defaults occurred during the Depression, he does not appear to have individually identified them. Using the resources mentioned in Chapter One, the author cataloged these defaults along with a couple of hundred additional payment failures that occurred prior to the Depression. Figure 3 shows the full set of defaults for the period 1920-1939 plotted on a map. This map highlights the phenomenon of state-level default clustering discussed in Chapter Two.

Figure 3 - Municipal Bond Defaults, 1920-1939



Yellow points represent special districts; red represents school districts; and green represents cities, states and counties.

In addition to enumerating the defaults themselves, exogenous variables were collected from annual Censuses of large cities available during the Depression. In some cases, this data was supplemented with content from contemporaneous Moody's bond manuals. Exogenous variables available include population, revenues and expenditures by category, assets, debt and assessed valuations. Several hundred variables were found, but many are minor categories of revenue and expenditure that are not likely to be explanatory.

Data Selection

Today, the municipal bond market covers a broad range of issuers. This diversity was also present – albeit to a lesser extent – in the years prior to World War II. The

municipal bond default list compiled for this study includes 5079 issuers who failed to make timely and complete principal or interest payments (or who obliged investors to accept refunding bonds in lieu of cash at maturity) at some time between 1920 and 1939. The defaults are classified by issuer type as follows:

Table 10 - Default Counts by Issuer Type, 1920-1939

Issuer Type	**Count**
Cities and Towns	1443
Counties	539
States	4
School Districts	1131
Road and Bridge Districts	421
Drainage, Irrigation and Levee Districts	708
Municipal Improvement Districts	743
Other	90
Total	**5079**

While many of these types are familiar to the contemporary reader, others may require some explanation. Road and Bridge Districts were created for the purpose of building and maintaining infrastructure that primarily benefited motorists. These districts usually existed at the County level and could thus include a number of cities, towns and unincorporated areas. They were financed by special assessments – an extra property tax levy imposed upon all owners within the district. Municipal Improvement Districts were also funded in this manner, but their scope was limited to a particular city and they were used to finance streets, sidewalks and sewers. While these districts are relatively uncommon today, a modern analog is the Sanitary and Improvement Districts in Nebraska

– about 30 of which have made Chapter IX bankruptcy filings since 1981. Drainage, Irrigation and Levee districts were also funded by special property tax assessments usually in agricultural areas. These infrastructure projects often benefited a very small number of farmers or farming corporations.

Financial data for these special assessment districts and for school districts is more limited than for other issuer categories. Moody's bond manuals provide some data, but it is incomplete and not in a consistent format. The best data is available for states and large cities because they reported their financial statistics to annual Censuses at the time. Comprehensive financial data for smaller cities and counties was collected by decennial Censuses in 1922 and 1932.

Since annual Census data is available for a substantial number of larger cities, and since these cities experienced a significant number of defaults, the quantitative analysis component of the current study focuses on this subset of issuers. Future work on the data set could target other issuer groups.

Contemporaneous Census Data for Large Cities

For fiscal years 1930 and 1931, the Census Bureau reported financial statistics for 311 US cities with population over 30,000 (as of April 1, 1930). After 1931, the collection effort was scaled back, perhaps due to budgetary pressures at the federal level. In fiscal years 1932 and 1933, the Bureau reported similar statistics for 94 cities with population over 100,000 (also as of April 1, 1930). In fiscal 1934, Honolulu was added to the annual

data set. Thus annual time series of fiscal data are available from the Census for 94 cities during the Depression period while more limited data is available for an additional 217 cities. In all, a total of 1000 city/year observations are available for the period FY 1930-1935. Data reported for each entity include revenues by category, expenditures by category, as well as various classifications of assets and debt.

Of the 311 cities in the sample, 46 had defaults on general obligation bonds between 1930 and 1936, implying a cumulative default rate of 15% for this sample. As noted in Chapter Three, the overall municipal default rate was about 16%. Among the non-defaulting cities, some had "forced refundings" in which investors were obliged to exchange maturing bonds for new ones with later maturities. Many others had defaults on special assessment bonds which were not general obligations of the cities. In the following analysis, none of these instances are classified as a default – but adjusting the default classifications in light of these circumstances is a reasonable task for future research.

Some defaults were attributed at the time to bank closures or bank holidays. Since FDIC insurance is now available, it would be reasonable to exclude defaults that really were the result of banking issues. However, reclassifying such defaults should only be done after an intensive reading of contemporary newspapers to confirm that they were fully attributable to banking problems. In certain cases, city officials may have used bank closures or holidays as a pretext to obscure fiscal problems that rendered the city unable or

unwilling to pay even if funds had not been temporarily frozen. Thus, these classification adjustments are also left to future research.

Once a city defaults, its data may become idiosyncratic as it suspends interest payments and possibly writes down principal. For example, Miami's interest costs fell from $2.2 million in 1929 to $0.3 million in 1933. News sources indicate that the city first defaulted in 1930. Since the purpose of the analysis is to predict default, post-default observations are dropped from the data set, resulting in the loss of 43 observations. Of the remaining 957 city/year pairs in the sample, 125 are associated with defaulting cities.

Although several hundred series are available in the Census data, most of them relate to small components of revenue and expenditure, and are thus unlikely to be predictive. This still leaves a number of aggregate revenue, expenditure, debt and asset series that may yield independent variables. Because prices and per capita income are much higher today than in the early 1930s, a model based upon raw values of the exogenous variables would not be relevant to today's context. To have predictive value, variables must be evaluated in ratio form.

Conceptual Model and Variable Selection

The ratio most commonly used in discussions of sovereign credit is the debt-to-GDP ratio. The fiscal Census data do not include any indicia of economic activity. More recently, regional income account statistics have been reported for states, metropolitan areas and counties in recent years, but most series do not extend back to the Depression era.

For example, The Bureau of Economic Analysis has estimated Gross State Product only back to 1963, but does have state-level personal income data from 1929. Data for smaller political units are not available for the pre-World War II era. If we make the very strong assumption that personal income was homogenous across a given state, state level personal income data provided by BEA could be used with the city default data set.[4]

Although reliable measures of total economic output are not available at the municipal level, other demographic and macroeconomic variables can be employed. Previous studies have used population, assessed valuation and per capita income as independent variables in default probability or rating prediction models.

If fiscal data is available the use of demographic and macroeconomic variables may not be necessary. The choice of whether to pay or default upon debt service obligations is made by the political leaders of a governing unit. The most immediately accessible data available to these officials include the size of the interest or principal payment that needs to be made, what financial resources are available to the government to make the payment and what other spending priorities are competing with the debt service obligation.

Demographic and macroeconomic factors affect the government's revenues and expenditures, and thus have an *indirect* effect on its ability and willingness to make debt service payments. But, if revenue and expenditure data can be observed directly, using

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[4] No personal income data is available for Hawaii during prior to 1950. In later analysis, Hawaii personal income for the Depression period can be inferred from the ratio of Hawaii to US per capita personal income in 1950 and annual US per capita personal income for earlier years.

these indirect measures in a default prediction model is not necessary. If a revenue driver like assessed valuation is predictive of revenue, including it along with revenue in a model will lead to multicollinearity. On the other hand, if assessed valuation is not a good predictor of revenue – perhaps because the government does not rely primarily on property taxation – it is not likely to be a good predictor of default. Consequently, the model constructed here is derived solely from fiscal measures. A comprehensive methodology for default prediction can incorporate demographic and macroeconomic factors by using them for revenue and expenditure forecasting.

Rating agencies use a number of purely fiscal metrics that can be estimated directly from the municipal Census data set. One commonly used metric is the ratio of interest costs to revenue. The intuition behind this ratio is that a default becomes likely when interest costs become so onerous that they threaten to crowd out other spending priorities. When the interest burden is low, it is not rational for a political leader to default, because he or she then loses access to capital markets. As interest expenses rise, this disincentive is increasingly likely to be outweighed by the near term political costs of cutting spending on popular programs.

This theoretical underpinning does have a couple of limitations that should be noted. First, defaults often occur when a principal payment – rather than an interest payment – becomes due. In the Depression era, cities were more vulnerable to principal repayment defaults because the concept of serialized maturities had yet to become popular.

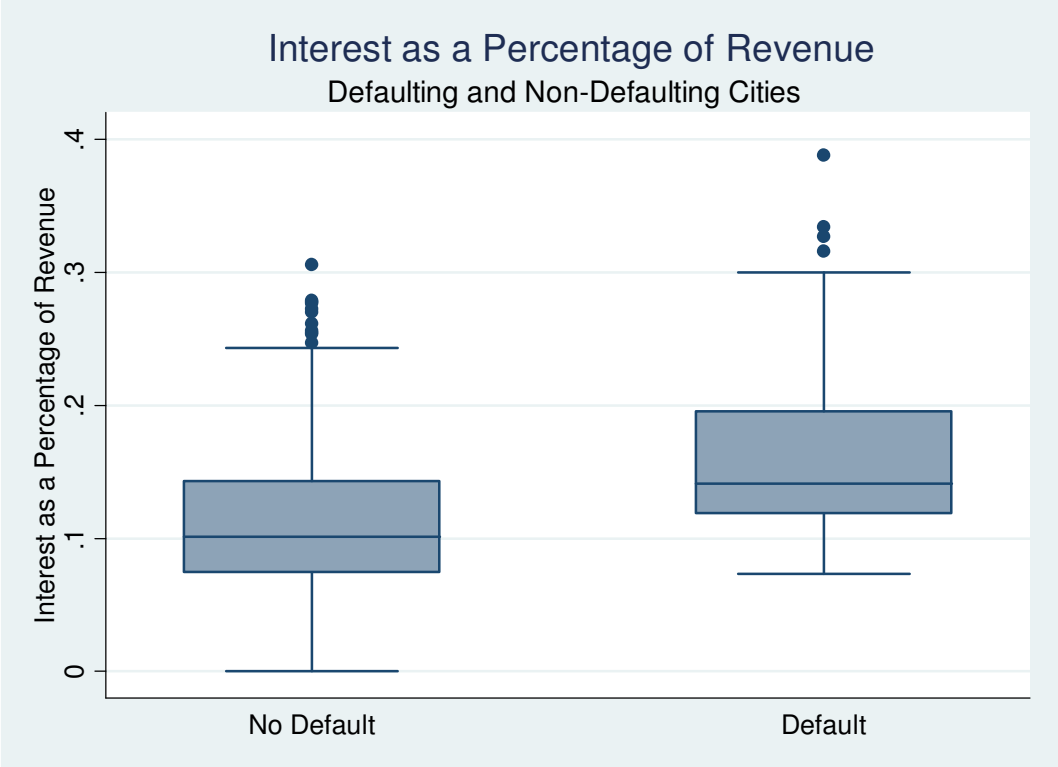
Large bond issues were typically scheduled to mature all at once. Many obligors accumulated revenues in "sinking funds" to meet these large debt repayments, while others expected to pay off the maturing bonds by issuing new ones. When sinking fund assets declined in value and the new issue market dried up, many governments were unable to redeem or roll over maturing issues. In the aftermath of the Depression experience, public finance specialists began to advocate serialized maturities, under which a large bond issue is broken down into a number of smaller tranches whose principal becomes due at varying dates – often one year apart.

Second, revenue may not be an ideal denominator, since political leaders may have the option of running surpluses or deficits. While many state and local governments are and have been subject to balanced budget requirements, these are typically prospective rather than retrospective and are often subject to evasion. On the other hand, using expenditures rather than revenues as a denominator is also an imperfect measure. Local governments cannot sustain large annual deficits indefinitely, so revenues appear to be a better indicator of their long term fiscal capacity.

A review of the 957 city/year observations shows that defaulting cities tended to have higher interest to revenue ratios than those that did not default. This is reflected in the box and whisker plot below. Further, a one sided t test of the defaulting and non-defaulting sample means fails to reject the null hypothesis that defaulting cities have higher interest to

revenue ratios than non-defaulting cities at $p < .0001$. The sample mean for defaulting cities is 16.1% versus 11.0% for cities that did not default.

Figure 4 - Interest/Revenue Ratio



Several of the Non-Defaulting observations with high Interest to Revenue Ratios were associated with two cities in Virginia: Norfolk and Portsmouth. Ackerson and Chamberlain (1935) report that Virginia implemented unique municipal default legislation in 1932. The Virginia law – which remains on the books[5] – authorizes the Governor to

[5] Section 15.2-2659 of the Virginia Statutes states: Whenever it appears to the Governor from an affidavit filed with him by or on behalf of the owner or owners of any general obligation bonds of any locality, or by any paying agent for the bonds that the locality has defaulted in the payment of the principal of or premium, if any, or interest on any of its outstanding general obligation bonds, the Governor shall immediately make a summary investigation into the facts set forth in the affidavit. If it is established to the satisfaction of the Governor that the locality is in default in the payment of its bonds or the interest on

investigate and withhold state aid to defaulting municipalities and to directly pay the withheld money to bondholders. Since gubernatorial action under this law is triggered by a petition from holders of affected bonds, the law does not appear to directly stop defaults, but does create an incentive on the part of local officials to avoid default.

Aside from the absolute burden of debt services, changes in available resources may be expected to enter into the default decision. For example, if revenues are declining, officials may face the choice of reducing public services below baseline levels or defaulting. Thus year-on-year revenue changes should be predictive of default. This analysis is supported by the Depression-era data. A one sided t test for defaulting and non-defaulting governments rejects the null hypothesis that annual revenue changes for the former group are not less than the latter at $p < 0.001$. The mean revenue change for defaulting observations is -2.3% versus +0.1% for the non-defaulting cases. Unfortunately, the use of this variable entails the loss of some observations. Revenue change is not directly observable from the Census data; it must be calculated by comparing revenues from the current Census to the prior one. The first Census used in the data set is that of 1930, so 1929 revenues are required to make data from that year usable. While 1929 census data is available, it only included 250 of the 311 cities in the 1930 census, resulting in the loss of

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them, the Governor shall immediately make an order directing the Comptroller to withhold all further payment to the locality of all funds, or of any part of them, appropriated and payable by the Commonwealth to the locality for any and all purposes, until the default is cured. The Governor shall, while the default continues, direct in writing the payment of all sums withheld by the Comptroller, or as much of them as is necessary, to the owners of the bonds in default, or the paying agent for the bonds, so as to cure, or cure insofar as possible, the default as to the bonds or interest on them.

61 observations. Of the remaining 896 observations, 117 are associated with a defaulting city.

A city's liquid assets may be expected to act as a cushion against default. The census data contains several categories of cash. Given the great variance of city size in the sample and the need to produce a time-independent model, any cash balance must be scaled. Since cash may be used to pay interest or principal, it can be reasonably scaled by converting it to a proportion of outstanding debt.

The t test shows that Cash in Public Trust Funds as a Percentage of Gross Debt fails to reject the null hypothesis that this factor does not correctly differentiate defaulting and non-defaulting cities at p=.01 . Since data is available for all cities in 1930, the full 957 observations can be included in the test. The mean cash balance for the 832 non-default observations is 0.92% of debt, while the mean for the 125 default observations is only 0.16%. The t statistic for the Public Fund Cash to Debt Ratio was somewhat higher than two other ratios tested: All Cash Assets as a Percentage of Gross Debt and All Assets as a Percentage of Gross Debt, although both of these ratios are significant at the 5% level.

Theoretically, a city could sell fixed assets to remedy a shortfall, but it may not be feasible to do so quickly enough to avert a default. Other cash balances, such as those in pension funds, could in theory be borrowed to make debt service payments, but there may be legal barriers to accomplishing that. While these rival variables may add explanatory data to a larger data set, they do not appear to be helpful in this current analysis.

Finally, it is reasonable to argue that a cash balance three or four years prior to a default is less relevant than the amount of cash available closer to the time of the actual default. The data set contains 21 observations in which the data's as of year is coincident with the city's default date, i.e. the fiscal data is from the year in which the city actually defaulted. The other 25 defaults occurred in smaller cities after 1931, when the census stopped collecting their financial data. The average Cash in Public Trust Funds as a Percentage of Gross Debt for these 21 observations is only 0.06% versus 0.83% for the remaining 936 observations.

If data for the smaller cities post-1931 could be collected, it may be possible to implement a panel style logit regression like that described by Shumway (2001). This approach would allow the cash variable to play a stronger role in the model. In recognition of this potentiality, the cash variable (identified as the cash to debt ratio) is included in two of the models described in the next chapter, even though its coefficient is not significant at the 5% level.

Population

Population may be considered to be a revenue and expense driver and thus excluded from a purely fiscal model. However, since population appears in a number of the models found in the literature and is also considered by rating agencies, it is worth addressing directly in this study. In theory, population should be inversely related to default

on the grounds that smaller cities are likely to be less diversified (and thus more risky) and that they are also more likely to have operational problems that would trigger a default.

This theory is not confirmed by the 311-city data set. The 46 cities that defaulted had an average population of approximately 321,000 while the 265 non-defaulting cities had an average population of roughly 127,000. Population averages provide a distorted view because they overweight larger cities. At the time (much like now), New York was the nation's largest city by a considerable margin. The fact that it defaulted adds substantially to the average population of defaulting cities.

One way to address this bias is to rank the cities from 1 to 311 and then compute the average rank of defaulting and non-defaulting cities. This analysis yields an average rank of 128 for defaulting cities and 161 for non-defaulting cities, also counter to theory.

On the other hand, it is worth noting that the sample being used here is biased from the perspective of the population variable because it only includes the nation's 311 most populous cities at the time. It is possible that cities with less than 30,000 people – none of which were included in this study – had a higher default rate. This possibility could be assessed through further research, but this effort could be complicated by under-reporting of defaults which is more likely with smaller issuers. Given the findings presented in this section, population is excluded from the model presented in the next chapter.

Chapter Five: Logistic Regression Analysis

As detailed in the previous chapter, analysis of the data set identified three fiscal variables that have both empirical and theoretical support. These are: (1) interest to revenue ratio, (2) revenue percentage change and (3) cash (in public trust funds) to (gross) debt ratio. A model fitted with Stata's logit function yields the following coefficients, errors and *p* scores:

Table 11 - Preliminary Logit Model

Variable	Coefficient	Standard Error	*p*
Interest/Revenue	14.4821	1.893319	0.000
Δ Revenue	-2.210628	0.9757137	0.023
Cash / Debt	-31.44081	33.82232	0.353
Constant	-3.745874	0.3121508	0.000

Stata reports a Likelihood Ratio χ^2 statistic of 83.03 for this model, implying that the model is more predictive than a null model (where all coefficients are zero) with a high degree of certainty ($p = 0.0000$).

Another method for assessing the model's goodness of fit is to compare its default probability predictions to the default flag. This functionality is supported by Stata's "estat classification" function. This function assumes that default observations with a default probabilities of greater than 50% is correctly classified as are non-default observations with default probabilities of less than 50%. On the other hand, defaults with sub-50% default probabilities and non-defaults with 50%+ default probabilities are defined to be incorrectly classified. According to this test, 783 of the 896 observations or 87.39% are correctly

classified. Thus, it appears that the model effectively distinguishes between default and non-default cases.

Several of the incorrectly classified observations are in the state of Virginia. As discussed in the previous chapter, some Virginia cities reached high interest to revenue ratios without defaulting perhaps because of a 1932 law that required the state to offset reported defaults and investigate the defaulting entity. Given this legal difference, it may be appropriate to use a dummy variable for Virginia cities so that they receive lower default probabilities in recognition of this state level legal protection.

Since no Virginia city defaulted, the Stata logit function is unable to process the Virginia dummy. According to Zorn (2005), this is due to the separation problem, which he defines as "the presence of one or more covariates which perfectly predict the outcome of interest (p. 157)." Since standard logit analysis can lead to infinite coefficients and standard errors, Stata addresses the separation problem by dropping variables that perfectly predict the binary result. Zorn (2005) notes that this problem can be addressed by using Firth's penalized likelihood approach. A Stata package named firthlogit developed by Joseph Coveney implements the penalized likelihood approach. With the Virginia dummy included, firthlogit returns the following:

Table 12 - Penalized Likelihood Model with Virginia Dummy

Variable	Coefficient	Standard Error	*P*
Interest/Revenue	17.40586	1.999077	0.000
Virginia Dummy	-3.691617	1.47175	0.012
Δ Revenue	-1.966129	0.966753	0.042

Cash / Debt	1.499424	1.222403	0.220
Constant	-4.135864	0.3053858	0.000

The package reports a slightly higher χ^2 of 83.43. Stata's estat classification is not available for this third party package, but it is possible to generate the probabilities from the coefficients and relevant data set values, and then perform the classification analysis in a Stata do file. This analysis finds that the number of correctly classified observations increases from 783 to 785, increasing the accuracy rate marginally from 87.39% to 87.61%.

Unfortunately, this new model contains a problem. While the *p* score for the Cash / Debt ratio improved, the coefficient's sign changes to a counterintuitive direction. Under this second specification, the more cash a city has relative to its debt, the more likely it is to default. Consequently, this variable is removed in the final model presented below.

Table 13 - Final Penalized Likelihood Model with Cash/Debt Variable Excluded

Variable	Coefficient	Standard Error	*p*
Interest/Revenue	17.41951	1.99172	0.000
Virginia Dummy	-3.695301	1.471739	0.012
Δ Revenue	-1.964635	-1.964635	0.042
Constant	-4.13551	0.3037248	0.000

This last model has a slightly improved χ^2 of 83.85 and also correctly classifies 785 or 87.61% of the observations, so the elimination of the Cash/Debt variable does not cause a loss of accuracy. As noted previously, this variable should be more predictive in an analysis that distinguishes between observations coincident with default from those that are two or three years away from actually defaulting.

This final model may be used to estimate default probabilities for our sample of municipalities, including ones issuing general obligation bonds today. The default probability formula implied by the model is as follows:

$$\exp(-4.14 + 17.42IR - 3.70VA - 1.96\Delta R) / (1 + (-4.14 + 17.42IR - 3.70VA - 1.96\Delta R))$$

Where IR = Interest/Revenue, VA = Virginia Dummy and ΔR = Annual Revenue Change. Coefficients in the above were rounded to two decimal places for clarity of presentation, but the more precise coefficients provided in Table 4-3 would be preferable.

The default probability equation presented here represents an alternative to the complex rating process discussed in the literature review. This model can be used to calculate default probabilities and thus creditworthiness for today's municipal bond issuers. It offers investors, city finance officials and the general public a quick way to evaluate bonds and assess the credit implications of various fiscal alternatives. Policies that result in high debt service burdens or volatile revenues heighten default risk: the equation presented here provides a way to estimate the power of these relationships.

Limitations and Future Research

As previously noted, further data supplementation and cleansing may enable the application of a panel methodology. This would facilitate comparisons between city financials in the fiscal year of default to those one, two or three years away from defaulting. It may also permit model specifications that could incorporate a measure of the city's cash reserves.

The exogenous variables in the foregoing analysis were based on composite financials for all governmental units within the city. A better approach would involve using only data from the municipal government itself – which is identified as the "city corporation" in the Census reports.

A few dozen municipal defaults have occurred since the Great Depression. A predictive model would benefit by including data for some of these defaulters and a significant number of comparable, contemporaneous non-defaulters.

Conclusion

The empirical analysis presented here supports the common sense view that revenue declines lead to defaults when debt service costs become a substantial burden. Aside from confirming intuition, the model allows us to quantity these vulnerabilities in a way that permits reasonable estimation of default probabilities for current issuers. Although the data is many decades old, it addresses a timeless issue affecting municipal leaders in a liberal democracy: how to trade off service demands from the electorate with the need to maintain credibility among bond investors. Until we have another episode that yields a statistically significant number of municipal defaults relative to the universe of issuers, the Depression data is the best resource we have to fit a default probability model.

The specification provided here leaves many open questions, but these are best answered by those whose job is to forecast revenues, expenditures and debt issuance. Including revenue and expenditure drivers in the model specification would duplicate the

work of these experts – and would do so in an inefficient way since these drivers vary across municipalities.

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