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Three Essays on Clean Water State Revolving Funds: Determinants of State Leveraging and Measurement of Debt Affordability

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THREE ESSAYS ON CLEAN WATER STATE REVOLVING FUNDS: DETERMINANTS OF STATE LEVERAGING AND MEASUREMENT OF DEBT AFFORDABILITY

by

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ABSTRACT

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Leveraging is a popular option among Clean Water State Revolving Funds (CWSRFs). Most states choose to issue bonds to meet the requirement of the state match contribution, and to provide additional funding into the pool of funds available for community loan assistance. Leveraging offers short-term remedies to fill a financial resources gap; however, this raises concern about any costs associated with leveraging that might negatively influence the sustainability of CWSRFs in the long run. This dissertation comprises three essays that examine the different factors that motivate CWSRFs to leverage, and it offers a look at how they measure their affordability leveraging. Chapter Two borrows the assumptions of pecking order theory to build CWSRF's leverage model. It focuses on the internal set of factors, and it analyses how the entity's size, profitability, growth, reserve, and risk affect its leveraging. Chapter Three examines the relationship between leveraging and an external set of indicators, including socioeconomic, demographic, political, and institutional factors. The findings suggest that, in leveraging, internal factors appear to be more influential than external ones. The entity's size and growth (entity-based factors) are found to be significant with both total and annual leveraging, while state wealth, state politics, and environmental needs also indicate some connection to debt share or debt per capita. Chapter Four particularly scrutinizes how leveraged states measure their debt affordability; it replicates the regression method and predicts the future debt service for New

York state. The findings suggest that the regression method can be a good tool for predicting the debt affordability level for CWSRFs. The predicted values from that method can also serve as a supplemental reference source for states before they consider additional leveraging.

This dissertation is dedicated to my husband and my children who have always supported me throughout this Ph.D. journey.

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CHAPTER 1

GENERAL INTRODUCTION

The purpose of this study is to explore different sets of factors that influence Clean Water State Revolving Funds (CWSRF)'s decisions to borrow money through issuing bonds and to consider how much debt should be incurred to finance investments in wastewater infrastructure. The research also explores the debt affordability of the CWSRF, as well as its measurement and projection. The study begins with a general introduction chapter that provides a background of state capital financing; this is followed by a brief consideration of CWSRF administration and financial management as an illustration of a financing mechanism for water infrastructure investment. The chapter also includes the statement of problems and the research purpose, accompanied by a research outline of the three essays that follow. Model specification, data description, and proposed analysis are discussed in the following chapters. The chapter concludes with the overall significance of the research.

State Infrastructure Financing

The United States public infrastructure system faces severe challenges, including insufficient capacity, deteriorating physical conditions, delayed maintenance, and declining fiscal resources (Chen, 2015; Chen & Bartle, 2017). Underinvestment continues in most sectors, including the nation's highways, bridges, electrical systems, and water infrastructure (Morris, 2017; Mullin & Daley, 2017). According to the American Society of Civil Engineers, the accumulative estimated funding gap for the nation's water infrastructure is $105 billion for 2016-2025 (American Society of Civil Engineers, 2016); on average, the annual shortfall amounts to tens of billions of dollars (American Society of Civil Engineers, 2016; Copeland & Tiemann, 2008). For CWSRFs, the total loan assistance provided by CWSRFs during the four years from 2012 to 2015 ($43.4 billion) accounts for only 16 percent of the corresponding estimated environmental needs collected in 2012 (for four years since then) by the Environmental Protection Agency ($270.9 billion). Choate and Walter (1983) warned of an impending infrastructure crisis due to underinvestment. Water infrastructure is particularly vulnerable to neglect; much of the infrastructure is buried underground or is removed from the public view and is, thus, easily ignored.

In the United States, infrastructure financing is a shared responsibility across different levels of government, within which state and local governments are the primary providers and operators of the core economic infrastructure. This infrastructure covers the vast majority of the nation's roads, highways, transit systems, drinking water, and wastewater systems (Chen & Bartle, 2017). Traditional methods of capital financing fall into three broad categories: pay-as-you-go financing, debt financing, and hybrid system financing. "Pay-as-you-go sources are comparable to equity financing of capital needs in the private sector" (Ermasova, 2013, p. 100). While private corporations raise equity financing through issuing stocks, pay-as-you-go financing for state government comes from taxes and other revenues or capital to which the taxpayers or citizens have directly contributed. Under this method, federal and state grants represent the primary funding sources for local infrastructure financing (Chen & Bartle, 2017). A clean water state revolving fund is a case in point. In contrast to pay-as-you-go or equity financing, debt financing or pay-as-you-use occurs when the state government or a private firm borrows capital and incurs debt to finance capital projects and acquisitions. State agencies can acquire debt financing through different resources, such as through the use of treasury loans, revenue bonds, general obligation, bond anticipation notes, inter-fund borrowing, revenue notes, and tax-exempt commercial paper (Ermasova, 2013). The municipal bond market, in which more than one million bonds are backed by specific revenue streams and are issued by more than 50,000 units of governments (Marlowe, 2015), plays a crucial role in state and local capital financing (Chen & Bartle, 2017).

The conventional wisdom of state public finance suggests that current expenditure should be financed by current revenues, while capital expenditures may be financed by borrowing funds. The use of debt financing for capital infrastructure is theoretically justified by the "benefits received" principle, sometimes called the matching principle, or by inter-period equity. That is, capital expenditures such as roads, highways, public buildings, water infrastructure, and other infrastructure (typically exceeding 20 to 30 years) will benefit both current and future taxpayers. Therefore, the cost of such public investments should be borne by both groups (Denison, Hackbart, & Moody, 2006; Hackbart, Sapp, & Hur, 2004). Marlowe (2015) reports that about 90% of state and local capital spending is financed by debt. Also, benefit matching has the added advantages of smoothing tax revenues and reducing volatility in the tax rates (Denison, 2002).

Given the fiscal constraints, in addition to traditional funding sources and financing methods, several alternative mechanisms of financing innovations have been proposed in order to try to bridge public infrastructure financing gaps. Chen and Bartle (2017) classify them into three main categories: (1) new funding sources through new taxes and value capture; (2) new financing mechanisms such as new credit assistance tools (including state revolving funds), alternative bonds, and debt financing tools (green bonds, social impact bonds); and (3) new financial arrangements such as public-private partnerships, infrastructure investment funds, and crowdfunding (p.14). Among these innovations, this research will focus on state revolving funds (SRFs), one of the new credit assistance tools in the second category.

Clean Water State Revolving Fund

State revolving funds (SRFs) are state-run entities capitalized by federal funds and state matching funds that offer various forms of financing, typically direct loans at low-interest rates, to local governments and other public and private entities for infrastructure projects. In other words, SRFs function as environmental infrastructure banks; they provide low-interest loans to eligible recipients for water infrastructure projects (EPA, 2021). Loan repayments revolve back into the pool of funds to fund other new local eligible projects; thus, they are aptly named "revolving funds" (Chen, 2016). Currently, there are two groups of SRFs: environmental and transportation. The environmental SRFs include Clean Water State Revolving Funds (CWSRFs) and Drinking Water State Revolving Funds (DWSRFs), both of which are capitalized by the Environmental Protection Agency (EPA)'s capitalization grants and require a minimum 20 percent match from state funds. Congress authorizes states to transfer funds between the DWSRF and CWSRF in order to maximize the efficiency of their infrastructure funding program, such as increasing fund availability where they need the most, enhancing bond rating, and lowering borrowing costs. Environmental Protection Agency (EPA) administers the transfer and cross-collateralization of these two programs similarly (Government Publishing Office, 2000).

The transportation SRF is a state infrastructure bank (SIB). Like the environmental SRFs, SIBs also receive federal transportation aid and state-matching funds as seed capitalization funds to start; then, they offer low-interest loans and non-grant forms of credit enhancement for state and local transportation projects. Among these two groups, environmental SRFs are currently utilized by all of the states and by Puerto Rico, while many SIBs are inactive and underutilized (Chen & Bartle, 2017).

The CWSRF was created in 1987 when the Water Quality Act (WQA) of 1987 was passed, and it authorized the State Water Pollution Control Revolving Funds. The WQA was to give states more control and discretion in water quality funding – to reduce the role of the national government (Morris, 2022). These 1987 amendments altered federal funding arrangements from direct grants made to municipalities to capitalized state loans; the intent was to provide long-term funding for water quality and wastewater construction activities. The federal government provides funds through annual appropriations under a state-by-state allocation formula contained in the Act itself (Copeland, 2014). Despite the formal authorization's expiration in FY1994, the pressure to extend federal funding has continued, partly since the funding needs have remained high, as estimated by EPA. Congress has continued to appropriate funds and has delayed the anticipated shift to full state funding responsibility. Appropriations for the CWSRF program through fiscal year 2019 have totaled nearly $45.2 billion; this represents the largest nonmilitary public works program since the Interstate Highway System (Copeland, 2012).

States are responsible for the operation of CWSRFs. The program offers states significant flexibility in setting priorities and in administering CWSRF dollars. States may use their CWSRF resources to provide several types of loans for treatment plants and sewer systems, stormwater, energy conservation, water conservation, nonpoint sources, and federally designated estuaries, among other related uses. States may customize their loan terms (interest rates, repayment periods). And states can decide to leverage their funds (raising additional funds by issuing bonds using program funds as security), including matching funds (Copeland, 2014, p. 3). States can also contribute additional capitalized funding and additional non-capitalized funding beyond the required 20 percent match. In addition to offering such flexibility, CWSRF is subjected to many requirements. States can use the money for different loans, but they must agree to use SRF monies first to ensure that wastewater treatment facilities comply with the CWA's deadlines, goals, and requirements. States can adopt certain financial policies, such as leveraging; principal forgiveness, however, is required to maintain the Fund balances available in perpetuity (CWSRF Regulations Section 35.3115) (EPA, 2018).

States often define their CWRSF programs as ongoing enterprise funds under the Governmental Accounting Standards Board (GASB) definition of funds (EPA, 2019). "Enterprise funds are established to account for operations that are financed and operated in a manner similar to private business enterprise" (EPA, 2018, p.52). CWSRFs must comply with financial reporting standards established by GASB Statement No. 34 (Basic Financial Statements – and Management's Discussion and Analysis – for State and Local Governments) (EPA, 2018). CWSRFs are also subjected to the Single Audit Act and Generally Accepted Accounting Principles (GAAP) and undergo independent financial audits of their CWSRF's financial statements (Government Accountability Office, 2006).

Concerning leveraging, states primarily use one of two basic approaches: the reserve method or the cash-flow method (or blended rate) (Bunch, 2008; EPA, 2018). Under the reserve fund option, states set aside and deposit federal capital grants and state matching funds into a reserve fund which is pledged to secure the bonds. These reserve funds usually account for 40 to 60 percent of the outstanding bonds. They act as security for the bond, and they are invested to produce interest earnings to pay off bond debt service later. Under cash-flow leveraging, the reserve fund is often about 10 percent of bonds outstanding, since the states recognize that a high reserve is no longer needed in their case, due to the program's high cash flow, and perfect credit history of bond repayment, and loan repayment (EPA, 2018, p.38). There are two separate pools of funds in cash-flow leveraging: the federal and state capitalization and the leveraged bond proceeds; accordingly, there are direct loans and leveraged loans. The net interest cost to the locality is a blend of the interest rates on two loans (Bunch, 2008). Recently, states have also used direct loans or a combination of both reserve funds and direct loans as collateral for borrowing in the public bond market (Copeland, 2014).

Leveraging serves two purposes: leveraging for state matches and leveraging for additional funding. There are two types of bonds used: general obligation (GO) bonds and revenue bonds. The GO bond is supported by the state's full faith and credit and taxing authority; however, its debt service (bond principal and bond interest) can be sourced either from the state government, using the general fund, or from the CWSRF, using interest earnings. The revenue bond is issued and retired by the CWSRF (EPA, 2018). Most of CWSRF bonds issued are revenue bonds; their debt services are thus backed by CWSRF's own revenues. Debt services are paid from the following combined sources: from loan principal and interest repayments, from interest earnings on the debt service reserve funds, and from other sources (e.g., subsidy payments provided by states). There is a total of about $50.6 billion (including the state match bonds) in leveraged bonds issued during the study period, of which $22.3 billion remained outstanding at the end of the 2019 reporting period, compared to about a cumulative federal and state appropriation of $54.2 billion during the same period[1].

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[1] Calculated from NIMS data

To fulfill the 20 percent matching requirement, states may contribute through appropriation, local match, non-program income, or state match bonds. States are required to describe their source of matching funds in their federal grant application. The matching funds must be deposited on or before the cash withdrawal date. Most wastewater and drinking water SRF programs have used bonds at some time to obtain state matches. For the CWSRF program, 24 states (out of 51) have issued bonds for-state matches. There are two types of state match bonds used: general obligation (GO) bonds and revenue bonds (EPA, 2018). Until 2019, the state match totaled up to $8.5 billion (nominal value). Cash and appropriation account for 29 percent, GO bond for 39 percent, revenue bond for 20 percent, and the remaining 12 percent belong to other sources[2]. Since the states borrow to meet the state match requirement, the dollars used to repay for matching bond interests and principal reduce the financial resources of CWSRF. Several states, such as Hawaii, Pennsylvania, Massachusetts, and Montana, have contributed more than the required 20 percent match in some years.

Loan terms and loan interests are two critical factors of the program, since they both need to make the program appealing and low-cost, but they also ensure the maximization of the rate of return on their funds. In other words, they need to ensure financial objectives, but they also need to meet the program objectives. States rely on several criteria to set loan terms. They also offer different loan terms for different types of projects such as green infrastructure, nonpoint source pollution control, or loans to financially disadvantaged communities. The loan terms are usually between 20 to 30 years. Prior to 2014, the loan term was capped at 20 years. However, following the adoption of a provision in the Water Resources Re-investment and Development Act

[2] Calculated from NIMS data

(WRRDA) of 2014, CWSRF loans may be issued for up to 30 years or the project's useful life (Morris, 2022). The interest earnings are the largest source of cash inflow into the program, and the CWSRF interest rate subsidy (interest from investment fund) is a factor that influences the state's entity to decide the loan interest rate. The CWSRF section 35.3120 requires that "CWSRF loan interest rates be between zero percent and the market rate, as determined by the states. EPA does not define market rate, although many states use the 20-year General Obligation Bond Buyer Index. Historically, CWSRF interest rates have averaged approximately half the market rate" (EPA, 2018, p.16).

Besides loan interest, interest earnings from cash and investments held by the CWSRF are the next most important area of cash inflows. EPA reports that the investment funds are managed by the state Treasurer or the Investment Board (in 60 percent of the states). In the remaining 40 percent of the states, the CWSRF Administrators are responsible for managing investment funds, following the incorporated statutory investment policies and procedures. CWSRF funds are usually invested in conservative investments, such as US Treasuries, and on a short-term basis. The yield on investment return is the market rate; leveraged states appear to generate higher earnings than direct loan states (EPA, 2018).

In addition to low loan interest, CWSRFs can also provide additional subsidies to borrowers in the form of principal forgiveness, negative interest, and grants, starting from 2010. Since 2014, the CWSRF statute has allowed states to use a portion of their capitalization amount for additional subsidiaries for states with an appropriation greater than $1 billion. States decide which and how projects will be selected for additional subsidy. Some states base their decisions on affordability metrics to distribute subsidies, while others allocate subsidies for high-priority water quality or public health projects (EPA, 2018).

The EPA collects data annually from the states' CWSRF programs to document program progress and to account for the use of federal funds from 1988 to the present; this information is stored in the CWSRF National Information Management System (NIMS). NIMS data is, thus, comprehensive and consistently comparable among states. The NIMS database offers both annual and cumulative data – a variety of indicators and metrics that help tell a story about an CWSRF's financial performance. The EPA contends that the cumulative figures are typically more informative and recommends utilizing them in the analysis because of the year-to-year variations (annual data) in program cash flows. The EPA SRF Fund Management Handbook also provides comprehensive information about the CWSRF and DWSRF programs.

Statement of Problem and Significance of the Study

Over thirty years of CWSRF implementation, states, at their discretion, have reported different preferences over financing decisions for the state contribution as well as for additional contributions. Many states use a mix of cash and bonds for funding; some states only use cash or appropriations, while others consistently choose bonds. In particular, leveraging has been reported as fluctuating since the inception of the WQA; some states engage in aggressive leveraging, while others consider a safer level of leveraging (Bunch, 2008; Travis, Morris, & Morris, 2004). On the one hand, leveraging increases the pool of available funds for project lending, but, in the long run, it can deplete a CWSRF, since the state borrows at market rates but makes loans at below-market rates (Holcombe, 1992). Thus, when using leveraging, states are accepting a trade-off between providing more benefits sooner and possibly damaging the long-run viability of the program (Holcombe, 1992). States that issue leverage bonds confront the challenge of structuring the CWSRF so that it allows the state to pay debt service on the bonds while maintaining reasonable interest rates on the CWSRF loans (Bunch, 2008). Leveraged states also offer higher mean loan interest (2.9 percent) compared to non-leveraged states (2.3%) in 2001 (Bunch, 2008). In addition, borrowing for the state match may impact the program in the long-term because loan interest earnings, which would have otherwise remained with the CWSRF, are lost in order to repay the match bond principal and interest. There is actually no matching fund at the end of the bond repayment, since the leveraged state match has already been repaid. The CWSRF program is left with the original federal grant plus accumulated net earnings at the end (EPA, 2018). However, due to the significant cash flow in the CWSRFs, the impact of the state match bond likely outweighs the impact of the state's not receiving the capital grant.

This research seeks to broaden the understanding of CWSRF leveraging among states. The study is structured into three essays, and it attempts to find answers to the following questions: what factors affect a state's choice to leverage; the level of leveraging; and how do states measure their leveraging or debt affordability? While the first two essays examine different sets of factors that explain a state's choice of using debt versus equity and its debt level, the third essay investigates states with leveraging, in order to discover their ability for debt repayment as well as to consider factors that influence such CWSRFs' debt affordability.

The first essay is entitled "Pecking Order Theory: Does it Explain the Capital Structure of the Clean Water State Revolving Fund?" By borrowing the pecking order theory for infrastructure investment from the private sector, this essay attempts to test whether the pecking order theory applies to the public sector by using the example of the CWSRF and then by investigating its potential explanatory power. In particular, the essay analyzes internal or entity-based factors, including profitability, size, growth, tangibility, and risks, in order to determine their relationship with a CWSRF's debt decision and the debt level.

The second essay, entitled "Leveraging in Clean Water State Revolving Fund, Evidence from External Factors", examines the set of external factors that include economic and demographic factors, environmental needs, state politics, institutional factors, and their relationship to a state's choice of debt financing and its debt level.

The final essay, entitled "An Exploratory Study of CWSRF's Debt Affordability and its Measurement," scrutinizes the CWSRF's debt capacity or affordability. The essay provides an analysis of debt affordability measurement that uses the debt service-to-revenue ratio (annual debt service as a percentage of total revenue) among leveraging states. The paper then examines the relationship between revenue-raising factors (federal capitalization, state match, other state grants, earning on investment, loan interests), loan principal repayment, weighted loan interest rate, and other factors (state personal income, population) with the annual debt service level, respectively. Then, it uses historical data about these independent variables to predict the future value of the debt service level.

To conclude the study, the findings from each essay are reviewed and discussed in the context of CWSRF leveraging. The policy implications of the findings are also discussed, and suggestions for possible future research on the overarching topic of CWSRF leveraging and financial sustainability in CWSRFs are offered.

CHAPTER 2

PECKING ORDER THEORY: DOES IT EXPLAIN THE CAPITAL STRUCTURE OF THE CLEAN WATER STATE REVOLVING FUND?

Introduction

"Leveraging is a valuable option for states with substantially more demand than they have funds available" (EPA, 2018, p. 37). However, effective use of leveraging requires careful planning and financial management. Whether states should use debt or equity to contribute to a 20 percent state match and additional funding to the Clean Water State Revolving Fund (CWSRF), as well as the way in which leveraging influences the development and sustainability of the program, should be considered. While leveraging would bring more financial resources to the pools of funding that provide greater project assistance, it also incurs risks since the CWSRF borrows at the market interest rate but provides loans to communities at a low-interest rate (often half of that market rate). No leveraging, or insufficient leveraging, would reduce the state's opportunity to have more funds available for loans. At the same time, overleveraging would expose CWSRF to the risk of unsustainability and depletion.

The capital structure and the financing decisions of a private firm have been widely researched; however, research on not-for-profits (nonprofits and the public sector) is less prevalent, and the current literature draws extensively (theoretically and empirically) on the for-profit literature. Pecking order theory, a critical theory in the field, offers explanations for financing decisions in private organizations. It suggests that managers prefer internal funds to external borrowing; debt is a superior choice to equity if external borrowing is needed. In other words, there is a financing hierarchy: retained earnings, debt, and then equity (Frank & Goyal, 2009). Despite the differences between the for-profit and the not-for-profit sectors, the pecking order theory is found to be applicable to nonprofit organizations (Calabrese, 2011) and to quasi-government entities (Sonola, 2018).

CWSRF, a state-run entity – and "an enterprise fund" – is a self-supporting government fund that has its operations financed and operated like a private business enterprise (EPA, 2018, p.52). Like private and nonprofit organizations, a CWSRF can finance its operation and capital investment through internal funds (accumulated profit and federal capitalization grants), external funds (debt), or some combination of the two. While, in nonprofits, private capital structure theories have been tested, there is a lack of scholarly research pertaining to the public authorities. The purpose of this essay is to expand the application of the pecking order theory to the public sector by studying the capital structure and the debt use of CWSRFs. The essay analyzes the factors that determine the leveraging decisions, as well as leveraging scale, of CWSRF. The following research questions are answered in this study: What are the leverage profiles of CWSRF from 1990 to 2019, and how do leverage profiles vary by year? What is the relationship of the determinants identified in the private sector to the capital structure of CWSRF? Do the study's findings provide empirical support for the pecking order theory? And what are other determinants of the capital structure of CWSRF?

The remainder of the study is organized as follows: the next section presents a review of the literature and then a model for CWSRF's leverage, as well as the research hypothesis, design, and methodology. The final section presents the results and the findings, as well as a summary of the study, the implications and contributions, and the directions for future research.

Literature Review

This section reviews the determinants of capital structure and financing decisions in corporate finance. It then offers a more in-depth investigation of its relevance to the nonprofit and public sectors.

The capital structure can be referred to as the liability side of a balance sheet – the side where capital structure decisions involve setting the mix of equity and debt financing (Gapenski, 1994). The term “leverage” is used to operationalize between debt and equity. Sonola (2018) summarizes leverage definitions that have been commonly used in the not-for-profit and for-profit sectors. Leverage can be a ratio of total debt to total assets, total liabilities to total assets, or long-term debt to total assets. Accordingly, “a highly leveraged profile is that of a firm with a high concentration of debt in its capital structure, while an unleveraged firm has no debt in its capital structure” (Sonola, 2018, p. 10).

Despite such similar measurement of the leverage ratio, there is a fundamental legal distinction between a for-profit and a not-for-profit enterprise: nonprofit firms have no owners, have restrictions on how they can use donated assets, “are not subjected to involuntary bankruptcy”, and can issue tax-exempt bonds (Bowman, 2002, p. 294). These differences lead to the distinctive characteristics of equity components. While a private firm’s equity comprises stocks and paid-in capital, the equity of a nonprofit organization consists of contributions, subsidies, and profits/losses, which are to be retained to the non-distribution constraint (Jegers & Verschueren, 2006, p. 294). In addition, for-profit organizations, taxable entities can take advantage of the tax-exempt feature (such as the interest expense on outstanding debt being tax-deductible) and thus have more incentives to use debt. In contrast, not-for-profit organizations, which are non-taxable entities, have relatively lower borrowing rates because of their tax-exempt bond issuance (Sonola, 2018, p. 10).

Capital Structure Theories - Pecking Order Theory and its Relevance to the Not-for-Profit

Modigliani and Miller (1958)'s irrelevance proposition theorem is the initial position for all modern treatments of capital structure theories (Frydenberg, 2011). In a world of perfect market assumptions, "with no taxes, no brokerage costs, no bankruptcy costs, and riskless debt, the value of a firm is independent of its capital structure" (Modigliani & Miller, 1958 as cited by Sonola, 2018, p.13); a firm's value does not depend on how much equity and debt the firm uses. However, in the real world, the absence of these assumptions gives reasons why capital structure is relevant to a firm's value. Successively, the trade-off and pecking order theories have emerged as dominant theories in the for-profit and nonprofit literature (Sonola, 2018). While the trade-off theory's focus is the optimal capital structure or a target ratio (set by balancing the benefits and costs associated with debts) which firms gradually move toward, the pecking order theory offers a distinction between internal and external capital. Despite empirical evidence of these theories in not-for-profit firms, "there is minimal consensus on how other not-for-profit firms choose their capital structure" (Sonola, 2018, p. 3)

Pecking order theory posits that firms prefer internal to external financing and debt-to-equity if external funds are needed (Myers, 1984). The reasoning behind such ordering originates from the information asymmetry between managers and new capital (debt or equity) providers and the transactional costs from external sources of financing (Myers & Majluf, 1984). Compared to outsider investors, firm managers are assumed to possess better information about the actual value of a firm's assets and growth opportunities. Thus, managers are only willing to sell equity when the firm is overvalued, while undervalued managers seek to capture all value by not selling equity. An announcement about raising new equity sends a signal to outsiders that the firm is overvalued, and this may trigger an adverse reaction from new investors to discount the value of the shares as compensation for the assumption of an overvalued firm (Myers & Majluf, 1984; Sonola, 2018) or to discourage new investors from buying the shares (Sawant, 2010). Firms, therefore, prefer internal financing to external financing. If internal funding is not available, firms prefer to issue debt instead of equity because debt issuance is interpreted as a positive signal – that the firm is confident about future growth opportunities. A new equity option is only utilized when the firm is highly leveraged and or “additional debt is likely to cause the risk of financial distress to the firm” (Sawant, 2010, p. 75).

To apply the pecking order theory to the not-for-profit sector, the definition of internal and external funds should also be identified in the relevant not-for-profit setting. For a national capital structure, taxes, debts, and seigniorage (printing money) are three different sources of financing for government expenditures. They are, respectively, similar to the internal funds, debts, and equity of corporate financing (Miglo, 2018). For instance, internal funds and taxes depend on the firm’s efficiency or that of the government. There are many similarities between the shares issued by the corporations and the money printed by the government (Bolton & Huang, 2017), among them that both are residual claims, that their amount of circulation depends on the issuers’ decisions, and that their real value depends on the firm’s success as well as on the efficiency of the economy. Despite such similarities between the government and corporations’ financing sources, formal differences exist (e.g., money printed does not provide any dividends or votes while shares do). For a firm capital structure, nonprofit firms do not issue common stock; hence, their external financing is limited to borrowing, and their internal financing is generated from an accumulation of operating earnings (Sonola, 2018).

This essay focuses on the pecking order theory only for several reasons. Contrary to the trade-off theory, which targets an optimal capital structure, the pecking order theory contends that more profitable firms have more internal funds available; thus, they likely borrow less, whereas less profitable firms need external funding and subsequently accumulate debt (Myers, 1984; Sonola, 2018). Also, as pointed out by Shyam-Sunder and Myers (1999), the pecking order explains much more of the time-series variance in actual debt ratios than the target adjustment model based on the static trade-off theory. This is relevant to the purposes of this essay; instead of targeting an optimal structure, this essay aims to investigate the variance in CWSRF's leveraging among states. In addition, scholars have documented empirical evidence of the pecking order theory relevant to the capital structure of nonprofits (Jegers & Verschueren, 2006). Specifically, Calabrese (2011) tested the application of both the pecking order theory and the trade-off theory to nonprofits and concluded that the use of the pecking order theory was more applicable to nonprofit organizations.

Determinants of Capital Structure in the Corporate Sector

Scholars conduct reviews of corporations' capital structure and summarize various determinants of leveraging in private firms. They assess each determinant's reliability and recommend the most reliable essential factors. For the most part, this essay is based on Sonola (2018)'s and Frank and Goyal (2009)'s reviews. Following assumptions of the pecking order theory and the trade-off theory, these authors identify a model of leveraging and include seven firm attributes as the critical determinants of leverage. These include profitability, size, the tangibility of assets, the age of the plant and property, growth, liquidity, and risks. For CWSRFs, the age and liquidity factors are excluded since all CWSRFs started at the same time, and given the high cashflow nature of CWSRFs, they are likely exposed to the minimal risk of liquidity. Following is a brief consideration of the five firm attributes relevant to this essay.

Profitability. Profitability is measured as the ratio of operating earnings to total assets. The preference for internal funds to external funds in the pecking order theory suggests a negative relationship between leverage and profitability. It means that more profitable firms become less leveraged over time (Frank & Goyal, 2009). Most empirical studies find a negative relationship between leverage and profitability, a relationship that is consistent with the pecking order theory (Bessler, Drobetz, & Kazemieh, 2011; Sonola, 2018).

Tangibility (Leverage and Nature of Assets). Tangibility refers to the availability of collateral to secure debt obligations; this is typically measured by considering the ratio of fixed assets to total assets (Sonola, 2018). Under the pecking order theory, tangibility is ambiguous, and it can be negative or positive with leverage. On the one hand, “low information asymmetry associated with tangible assets makes equity issuances less costly; thus, leverage ratios should be lower for firms with higher tangibility” (Frank & Goyal, 2009, p. 9). On the other hand, tangibility increases adverse selection (sellers have more information than buyers) when information asymmetry associated with assets occurs. It results in higher debt (Frank & Goyal, 2009). Tangibility can also be a proxy for different economic forces, explaining its ambiguity under the pecking order theory (Frank & Goyal, 2009). Most studies have found a positive relationship between tangibility and leverage, not supporting the pecking order theory (Sonola, 2018).

Firm Size. The pecking order theory predicts an inverse relationship between leverage and firm size and between leverage and firm age. Large firms are better known, usually build more internal funds over time, and resort to a relatively lower use of debt as external financing (Frank & Goyal, 2009; Sonola, 2018; Titman & Wessels, 1988). A log of assets or a log of revenues is used to measure firm size. Titman and Wessels (1988) found a negative relationship; however, many others did not find supporting evidence for the pecking order theory. Instead, they found an opposite relation in that firm size was positively associated with leverage.

Growth. Under the pecking order theory's prediction, firms with more growth or investment accumulate more debt over time since internal resources will not be enough to finance their growth (Myers & Majluf, 1984). Therefore, growth opportunities and leveraging are positively related under the pecking order theory (Frank & Goyal, 2009).

Volatility/Risk. The pecking order theory predicts a negative relationship between business risk and leveraging because firms with more volatile cash flows try to accumulate cash or pay off debt during very profitable years to prevent under-investment in the future (Frank & Goyal, 2009; Sonola, 2018).

Capital Structure on the Nonprofit

The empirical research on capital structure of nonprofit organizations has been limited to the health care industry, such as hospitals (Trussel, 2012), and education such as universities (Denison, Fowles, & Moody, 2014). Recently, studies have focused on the nonprofit sector as a whole (Smith, 2012). According to Sonola (2018), the findings are mixed, with some supporting the use of the pecking order theory in nonprofits (such as profitability, growth, and risk), while the size variable provides a mixed result. Tangibility does not support the prediction of the pecking order theory. Below is a brief consideration of each factor.

The profitability factor, which is predicted to negatively affect leverage, primarily follows the pecking order theory (Calabrese, 2011; Jegers & Verschueren, 2006; Smith, 2010; Smith, 2012; Szymańska, Van Puyvelde, & Jegers, 2015), as the findings in the nonprofit literature suggest that more profitable organizations "will retain funds and resort less to the use of debt to fund investments" (Sonola, 2018, p. 51). Nonprofits likely do not want to use up all of their internal funds despite the preference for internal financing over external financing. Still, they seek to maintain some amount of internal capital to lower the cost of not having the capital for future expansion, which Calabrese (2011) considers a modified pecking order theory for the nonprofit.

"The size of an organization is the most common factor identified across all of the nonprofit studies reviewed" (Sonola, 2018, p.50). Size is mainly defined as the log of total assets and, in some cases, as the log of revenue (Smith, 2012; Trussel, 2012). Some studies have found a significant negative relationship between size and leveraging, supporting the pecking order theory (Calabrese, 2011; Jegers, 2011; Jegers & Verschueren, 2006; Szymańska et al., 2015). However, there is also evidence of a statistically significant positive relationship between organization size and leveraging, which aligns with the for-profit literature (Smith, 2012).

The nonprofit literature defines tangibility as the ratio of net fixed assets to total assets. The findings consistently indicate a positive statistical relationship with leveraging; this is consistent with most empirical studies in the for-profit literature, but it is inconsistent with pecking order theory. The growth variable is commonly defined as the growth rate in revenue or assets. Scholars found a statistically significant positive relationship between growth and leverage, which is in line with both the pecking order theory and the empirical evidence in the for-profit sector (Bowman, 2002; Smith, 2012).

A risk factor is often defined as the volatility (standard deviation) of return on assets, and empirical evidence shows a statistically significant negative relationship between leverage and risk (Bowman, 2002). Earning volatility is believed to reduce access to tax-exempt debt. This risk factor follows the pecking order theory's prediction.

Sonola (2018) also noted other industry-specific capital structure determining factors that have been identified in the literature, including the payer mix (the ratio of Medicaid and Medicare revenues to total revenues) as an essential variable for hospitals, enrollment growth as a measure of growth for universities (Denison et al., 2014), and endowment, a source of revenue which has been found to have a negative relationship with leverage (Bowman, 2002; Calabrese, 2011; Smith, 2012).

Review of Empirical Studies in the Public Sector

There is limited research on capital structure and the factors affecting borrowing for public authorities, special entities, and government agencies. Sonola (2018) was the first to examine the capital structure of water, power, or transportation enterprises, which are quasi-government entities that provide discrete services to millions of people annually. The author tests both the trade-off theory and the pecking order theory by using four debt ratios as dependent variables and seven independent variables, including profitability, size, asset tangibility, organization age, growth, liquidity, and risk. The secondary data is from the CreditScope database, covering 2000-2015; qualitative data were obtained from interviews of key financial decision-makers from these enterprises. The findings show mixed support for the pecking order and for trade-off theories. While the negative relationship between leverage and profitability supports the pecking order theory, the positive relationship between size and leverage supports the trade-off theory. The current study extends Sonola (2018)'s analysis to CWSRFs, state-run entities.

The pecking order theory has been tested in a few studies that research the capital structure of a national government. However, these articles only examine whether or not the federal government should use internal or external financing; they do not investigate the factors that might affect such a decision. Miglo (2018)'s model predicts that issuing money is more sensitive to information asymmetry (when the government has more information about the economy than potential providers of funds) than to borrowing; so, debt is preferred to seigniorage. Also, since taxes are not subject to asymmetric information, they should be preferred to debt. The implication of the pecking order theory for government finance suggests that countries with high expected GDP values should use taxes as much as possible for financing. This inference is also consistent with the observation that taxes usually account for 70 percent to 90 percent of the government spending, followed by debt and seigniorage (Miglo, 2018).

Model Specification, Research Hypothesis, and Data

CWSRF Leverage Model

The model is designed to test a set of factors (including private sector identified determinants and specific CWSRF determinants) and their relationship with the capital structure of CWSRFs. Though CWSRFs are state-run entities, they are classified under enterprise funds that are used to report activity for which a fee is charged to external users for goods and services.

For instance, CWSRFs offer direct loans (financial services) for communities to build municipal wastewater treatment plants; the communities then pay back the interests as a fee for a loan. CWSRFs are expected to be self-sustaining even when federal appropriation ends. Since CWSRFs operate like private business enterprises, private sector theory, such as pecking order theory, would be applicable to CWSRFs. However, CWSRFs also have to meet specific requirements and have to achieve other targets mandated by the federal government, such as providing loans with low interest for specifically targeted communities and offering principal forgiveness. Thus, besides the five factors borrowed and adapted from the private sector, this essay also includes several variables from CWSRF itself, which may also influence state leveraging decisions.

The model for leveraging of CWSRFs is presented below:

$$Leverage_{it}=\phi Leverage_{it-1}+\beta_1 Profitability_{it}+\beta_2 Size_{it}+\beta_3 Growth_{it}+\beta_4 Tangibility_{it}+\beta_5 Risk_{it}$$
$$+\beta_6 WAIRL_{it}+\beta_7 FROI_{it}+\mu_i+d_t+\varepsilon_{it}$$

Where ε is the error term, represents unobserved state-specific effects, and stands for time fixed effects. Leverage of state *i* at year *t* is measured in two ways: the outstanding debt (measured as a stock concept) and new debt issued (measured as a flow concept). The lagged leverage is included as a regressor. Among the predictors, Profitability, Size, Growth, Tangibility, and Risk are five independent factors drawn from pecking order theory literature. Loan Interest and Federal Return on Investment (FROI) are internal CWSRF factors. (Age determinants are not included in the model because these funds have a similar starting date; liquidity is also not included because of the assumption that CWSRF is high cash flow). The dependent and the independent variables are all financial ratios calculated or available from the CWSRF National Information Management System (NIMS).

Different from private corporations (stocks and paid-in capital) and nonprofit organizations (contributions), the equity component of CWSRFs (presented as net assets on the balance sheet) mainly comprises federal capitalization, state match contributions, transfers from other SRFs, retained earnings, and other net assets. This essay uses cumulative Contributed Capital and cumulative Retained Earnings for the equity component, including cumulative federal grants and state match, transfer from other SRF (the Drinking Water SRF), and Retained Earnings, the significant parts of the equity component, instead. Total leveraged bonds outstanding are used for the total liabilities component because the total leverage (match bond outstanding and leveraged bond outstanding) accounts for the majority of CWSRF's total liabilities. Thus, this essay treats total cumulative Contributed Capital, Retained Earnings plus Total Bond Leveraged Outstanding as the Total Assets of CWSRFs.

Following capital structure literature, this essay defines the Total Leverage as the Total Bond Issued Outstanding as a percentage of Total Assets and the New (Annual) Leverage as the Annual Bond Issued as a percentage of Total Assets. These ratios will provide insight into the CWSRF's capital structure in both aspects: the stock/level of debt at the reporting date and annual flows of new debt. These measurement proxies of debt ratio also follow the practice of state debt financing, which analyzes both outstanding debts – stock of debt and new debt issued – and the flow of debt over time (Greer & Denison, 2016). Table A.1 in Appendix A provides a list of NIMS data codes for each data item used in this essay. The details of two dependent variables total leverage and new leverage presented in Table 2.1 below.

Table 2.1

Dependent Variables

Dependent Variables	Definition/Measurement and Data Source (NIMS)
Total Leverage (TL)	Bond Leveraged Outstanding as a percentage of Total Assets: $$\frac{\text{Leveraged Bond Outstanding+Match Bond Oustanding}}{\text{Total Assets}}$$
New Leverage (NL)	Annual Bond Leveraged as a percentage of Total Assets: $$\frac{\text{Annual Gross Leveraged Bonds Issued+Annual Match Bond Issued}}{\text{Total Assets}}$$

Table 2.2 below summarizes all the study's independent variables and the expected direction of the variable's relationship with leverage. A detailed description of the formula for each independent variable follows.

Table 2.2

Independent Variables Used in Analysis

Variable Name	Definition/measurement	Expected Sign
Profitability	This is the ratio of Annual Operating Net as a percent of Total Assets, in which "Operating Net" is a measure of the growth of the fund from operating activities prior to the addition of capitalization grants, match, and leveraged bonds. It is computed in this way: Loan Interest plus Investment Interest minus Match Bond Repaid minus Bond Interest Expense (EPA, 2018, p.62).	CWSRFs that have more profits tend to have lower leverage. Negative (-)

Table 2.2 Continued

Variable Name	Definition/measurement	Expected Sign
Profitability	In the context of CWSRF (with tax-exempt and subsidy or sharing of administrative costs), the annual operating net is exactly the same as the annual retaining earnings in line NIMS 318. $\frac{\text{Annual Operating Net (Retained Earnings)}}{\text{Total Assets}}$	
Weighted Average Interest Rate on Loans (WAIRL-CWSRF profitability factor)	This is the weighted average of the interest rate charged on CWSRF assistance provided during the reporting period. (NIMS 240)	The higher loan interest rate charged would result in a higher operating net leading to higher profitability. Similar to the profitability variable, it is assumed that the higher WAIRL being set, the lower the debt level will be. Negative (-)
Size	Log of Total Assets Log of (Leveraged Bond Outstanding + Match Bond Outstanding + Cumulative Federal Contribution + Cumulative State Contribution + Cumulative Retained Earnings)	States with larger total assets usually have an opportunity to retain earnings. Thus, a larger CWSRF uses less debt. Negative (-)
Growth	Annual Percent Change in Total Assets $\frac{\text{Total Asset}_t\text{-Total Asset}_{t-1}}{\text{Total Asset}_{t-1}}$	CWSRFs with more investments should accumulate more debt over time, since an internal resource will not be enough to finance the growth. Thus, the pecking order theory positively relates growth opportunities and leverage. Positive (+)

Table 2.2 Continued

Variable Name	Definition/measurement	Expected Sign
Federal return on investment (FROI) (CWSRF growth factor)	The federal return on investment (NIMS 307) reflects how successful SRF programs have been at turning capitalization grants into loans that revolve and earn interest (EPA, 2018, p.62). This is calculated as the Cumulative Project (Loan) Assistance Disbursed as a percentage of Cumulative Outlay (Contributed Capitalization). Nationally, the Federal Return on Investment was 272 percent for the CWSRF in 2017, indicating that $1 of federal funds invested in the program resulted in $2.72 in projects in the CWSRF.	FROI is an important growth indicator of CWSRFs measuring the revolving perspective of each federal dollar invested. The higher utilization or expansion of federal contributions may reduce the need for more debts. FROI and leveraging would be negatively related. Negative (-)
Debt Service Reserve Ratio (DSRR)	Tangibility is often a ratio of fixed assets to total assets. Since CWSRFs have no relevant fixed assets as private enterprises do, a reserve fund is set aside to secure the debt obligation. The debt service reserve, as a percent of the bond outstanding, is used to measure the asset tangibility variable in this essay. "This is an indicator of the size of the debt service reserve fund. A reserve fund leveraged state will have a high percentage for this measure. A cash flow leveraged program will have closer to 10 percent of outstanding debt in reserves. An increasing number of states have no debt service reserve due to high cash flows" (EPA, 2018, p.63). $\frac{\text{Cumulative Debt Service for Leveraged Bond}}{\text{Total Bond Oustanding}}$	Since the reserve information and other financial information of CWSRF are fully public or it is likely to have low information asymmetry, in line with pecking order theory, the debt service reserve ratio is hypothesized to be negative with leveraging. Negative (-)
Risk	The literature defines risk as the volatility (standard deviation) of the volatility of percentage change in operating income (Titman and Wessels, 1988). In this study, the risk is measured as a five-year standard deviation of changes in net operating income (Operating Net).	The pecking order theory predicts a negative relationship between business risk and leverage (Sonola, 2018). Negative (-)

Data

This study relies on secondary data from the CWSRF National Information Management System (NIMS) database, which contains the detailed fund information and fund analysis (CWSRF financial indicators) of the 50 states, Puerto Rico, the District of Columbia, and the U.S. territories from 1988 to 2019. This essay only focuses on the panel data of 50 states over 30 years from 1990 to 2019. The first two years (1988 and 1989) were eliminated, since the program was not yet fully implemented. There are outliers identified among several variables – for instance, the total assets of New York, and some of the largest profitability ratios belong to South Carolina. The essay then winsorizes all of the variables at the first and ninety-ninth percentiles to reduce any bias of extreme values.

Research Method

Unit root tests in Table A.2 in Appendix A suggest that the total debt variable is stationary at first. At the same time, the debt service reserve ratio (DSRR) is nonstationary, and other predictors are stationary at the level term. Due to the nature of dynamic panel data, the application of standard regression estimators such as OLS, random effects, or the fixed-effects model may be biased. Instead, this essay describes the use of the two-step system Generalized Method of Moment (GMM-Sys) model to estimate the dynamic panel data for this essay. GMM-Sys is designed for a dynamic panel model with specific conditions for application, such as the panel data with the number of cross-sections (N) larger than the time span (T). It requires the inclusion of a lagged dependent variable in the equation, using instrumental variables; the number of instrumental variables should be smaller than the number of groups (N). According to Roodman (2009), System GMM is widely recommended because it allows for more instruments that dramatically improve efficiency. This two-step system GMM model also does not require distributional assumptions like normality, it helps control the endogeneity of lagged dependent variables and control for serial correlation and heteroscedasticity (Roodman, 2009).

GMM-Sys is also popular in the capital structure literature due to its ability to cure the problem of endogeneity. Following Roodman (2009) and references in previous research, this essay builds the GMM-Sys model for total debt and annual/new debt. GMM-Sys allows the explanatory variables to be treated as potentially endogenous, predetermined, or strictly exogenous. The actual choice made is based on theoretical considerations (from the literature) and on the diagnostic test outcomes (which are available and built-in with the xtabond2 command and its results). Diagnostic test results indicate the validity of instruments collectively; it is the same for the subsets of instruments (regressors being treated as endogenous or exogenous and those generated by the lagged dependent variable). A high number of regressors treated as being endogenous means that more instruments are employed (Piper, 2014). As suggested by previous studies, determinants such as profitability, organizational size, the growth rate of total assets, and so on could also be influenced by the capital structure, or there may be a possible inverse causality between them (Forte, Barros, & Nakamura, 2013). Thus, these predictors can be considered potentially endogenous variables. There are also options and sub-options available so that researchers can employ them to adjust the fit of the GMM-Sys model.

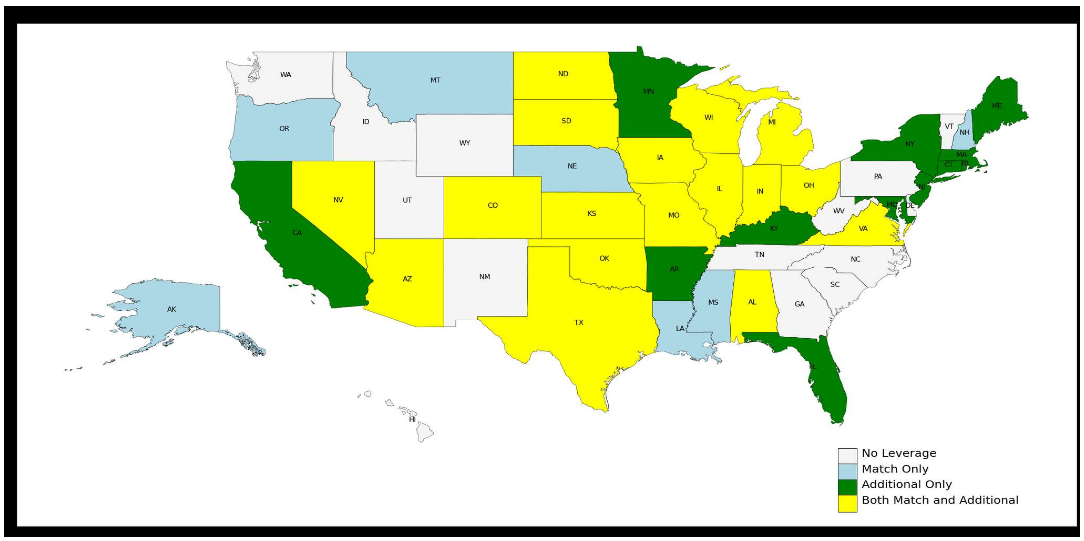
Results and Discussions

Descriptive and Trend Analysis

This section concentrates on states that leveraged and their average debt ratios to answer the first question of state leverage profiles and how they change over time. Fourteen states reported no leveraging at all; the leveraged state group is divided into three subgroups: state-match leveraging only (7), additional (excluding state-match) leveraging only (12), and leveraging for both state-match and additional purposes (17), as presented in Figure 2.1.

Figure 2.1

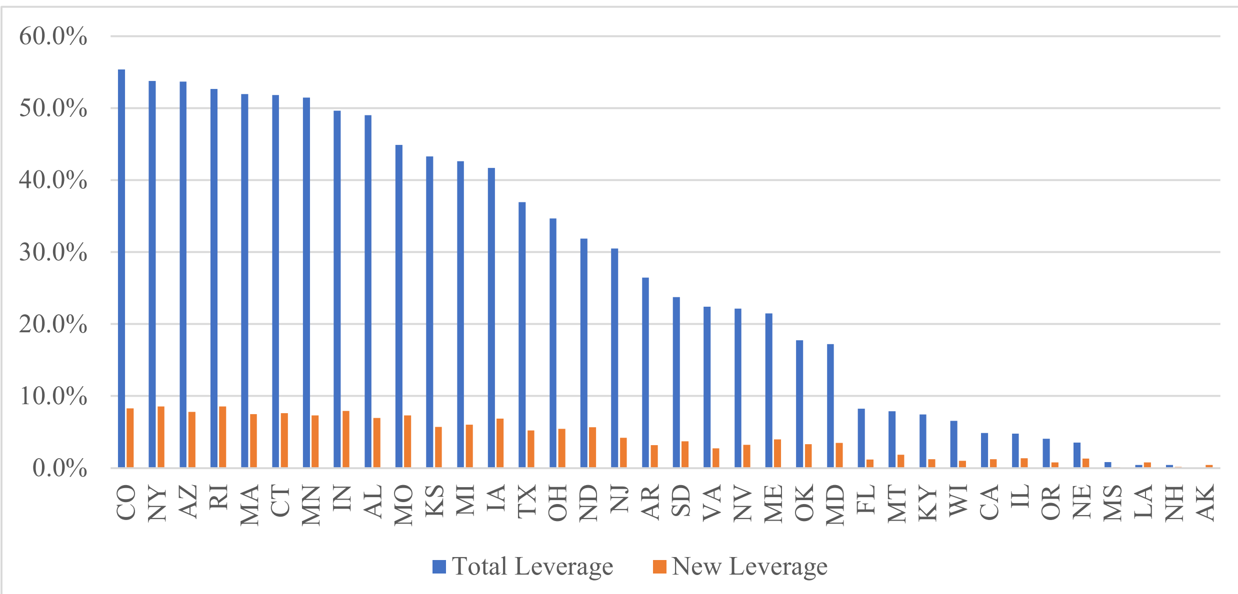
Overview of Leveraging



Within the leveraging group, there was significant variation in leveraging. Massachusetts, Rhode Island, Arizona, Colorado, Minnesota, New York, and Connecticut appear to leverage more aggressively than other states; their average total leverages ranged above 50 percent, as shown in Figure 2.2. This is consistent with documented findings in the literature. Connecticut and Massachusetts were identified as outliers among the New England states and had relatively higher debt burdens than the national average (Weiner, 2013). Their high debt levels are explained by two arguments: the greater state government responsibility and old infrastructures (Weiner, 2013, p. 17). These states also reported a consistently high average new debt issued (around 8 percent). At the other end, states that only leverage for match purposes showed minimal reliance on debt. Their total leverage ratios were lower than 10 percent. For instance, Arkansas, New Hampshire, and Louisiana showed almost zero outstanding debt. This is supported by the fact that some states only leverage for the state-match requirement (20 percent of federal capitalization), which must be available so that states are eligible for federal appropriation. The leveraging for state match is then repaid within the fiscal year; thus, there is zero outstanding debt balance at the end of the reporting period.

Figure 2.2

Average State Leverage Ratios



Both the mean annual total and the new leverage ratios were fairly stable and showed a slightly declining trend over the years, as shown in Figure 2.3. For total leverage, the mean annual maintained the peak period in the second decade at around 30 percent, and then it gradually declined in recent years since 2013 and went down to 24 percent in 2019. New leverage reached a peak of 12 percent in 1991, and then decreased to the lowest 1 percent in 2014 and increased to 2 percent in 2019. In short, there are many factors that could influence such a downtrend; CWSRF's accumulation of contributed capital (which adds to the increase of total assets over time) might be one reason associated with it.

Figure 2.3

Mean Annual Leverage Ratios (Leveraged States Only)

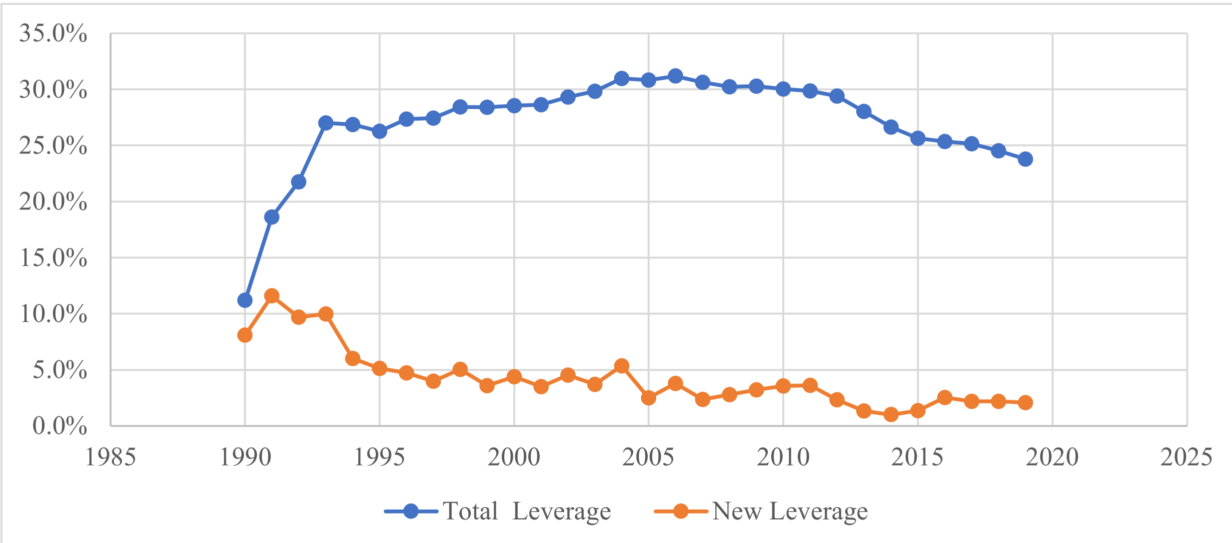


Table 2.3 presents the descriptive statistics of the entire sample. Financial variables are inflation-adjusted to 2016 dollars, using the Consumer Price Index. On average, for all states and all years, CWSRF's total leverage ratio showed a mean of 20 percent of total assets, and the new leverage ratio was smaller at the mean of 3 percent. These two proxies for leverage appear to be smaller than the average long-term debt ratio (39 percent) and the short-term debt (4 percent) of quasi-public water enterprises, as reported by Sonola (2018). The overall standard deviation for total debt was 24 percent, implying a scattered range of total leverage ratios.

The average profitability in the data was 1 percent, reflecting the not-for-profit nature of CWSRF, where loans are offered under the market rate. However, CWSRFs are still profitable and imply the possibility of supporting debt service and the continued operations of the funds.

The mean annual profitability ratio remained at a higher rate during the second decade, reaching the peak of 1.8 percent in 2001 and then descending significantly to 0.7 in 2010, the Recession year, reaching the lowest of 0.4 - 0.5 percent in the following years (2013 to 2016); the annual rate increased back to 0.8 percent in 2019. The unleveraged states, South Carolina, Tennessee, and Georgia reported the highest average profitability scores (2.2 to 2.6 percent), while Kansas, Indiana, and Arizona showed negative profitability. The mean weighted loan interest (WAIRL) was 2.3 percent for the whole sample, ranging from zero to 5 percent. The mean annual interest reported was relatively high during the first decade, with a peak in 1992 (3.2 percent), and then it gradually decreased over the last two decades, reaching 1.4 percent in 2019. Vermont offered a zero-interest rate, Connecticut consistently maintained a 2 percent rate throughout the study period, and Ohio, Texas, South Carolina, Arkansas, New Hampshire, Iowa, and Alabama charged more than 3 percent, on average, during the 30 years.

Table 2.3

Descriptive Statistics

Variables	**Mean**	**Std. Dev.**	**Min**	**Max**
Total Leverage	0.20	0.23	0.00	0.68
New Leverage	0.03	0.07	0.00	0.39
Profitability	0.01	0.01	-0.01	0.04
WAIRL (percent)	2.27	1.23	0.00	5.00
Size (billion)	1.09	1.46	0.02	9.21
Growth	0.16	0.31	-0.05	2.15
FROI	1.92	0.85	0.00	4.33
DSRR	0.10	0.17	0.00	0.66
Risk	8.34	41.07	0.05	320.72

Total assets or size factor showed more significant variability than other factors. The mean inflated total assets was $1.09 billion and fluctuated from $0.02 million, probably in the program's early years, to the largest at $9.21 billion. On average, by state, New York ($7.5

billion), Massachusetts ($3.5 billion), Ohio ($3.2 billion), Texas ($3.3 billion), and California ($3.1 billion) were some of the largest CWSRFs, while Vermont, Delaware, Idaho, Montana, and Nebraska were among the smallest sizes, with their average total assets ranging from $0.15-$0.19 billion. The size of CWSRF keeps expanding over time. The mean annual total assets sequentially rose from $0.12 billion at the starting year to $1.58 billion in 2019. The accumulation of federal capitalization would significantly contribute to such expansion.

In considering the growth factor, the average change rate of the total asset (growth factor) was 16 percent, widely ranged with a minimum of negative 5 percent and a maximum of 215 percent. Like the loan interest, the mean annual growth rate burst during the first decade, peaked at 81 percent, but then steadily dropped to the lowest 2.2 percent in 2014. It increased modestly back up to 3.4 percent in 2019. Missouri, Kansas, Colorado, Minnesota, Indiana, and Maryland had the largest mean growth rates, at above 20 percent. Utah, New Mexico, and Georgia had the lowest mean growth rates, at about 10 percent, and these states are non-leveraging. The CWSRF internal growth rate FROI had a mean of 192 percent, which indicates that each $1.00 in federal funds invested in the program resulted in $1.92 in (loans) projects in the CWSRF. This number ranged from zero to 433 percent. During the three decades in the study, the average annual FROI showed an uptrend, growing from 96 percent at the beginning to 271 percent in 2019. Minnesota, New York, Rhode Island, Texas, Massachusetts, and Colorado represented the leading group, with an average of 274 to 337 percent. Alaska, Delaware, Vermont, and West Virginia maintained a mean FROI of around 100 percent at the other end.

The debt service reserve as a percentage of the outstanding debt ratio, DSRR, had a mean of 10 percent, indicating very small collateral, resulting from the high cash flow character of CWSRF and its creditability of bond repayment history (EPA, 2018). The mean reserve spread from zero to 66 percent during the three decades. Over the years, all states' mean annual reserve ratio reduced gradually, reaching 5.8 percent in 2019 from the highest of 13 percent in 1997. Considering individual states, Missouri, Michigan, Colorado, New York, and Massachusetts showed the highest average reserve: over 30 percent (32.8-49.2 percent). The risk factor (the volatility of percentage change in operating income) indicated an extensive scattered distribution, with a mean of 8.34 percent and ranging from 0.05 percent to 320 percent.

To further understand the CWSRF's leveraging profile, the observations are divided into four groups based on the outstanding debt ratio, as shown in Table 4.

Table 2.4

Degree of Leverage by Medians

Variable	**No leveraging**	**Yes Leveraging**		
		Low	Medium	High
	0%	<=40%	40%-60%	>60%
Observation	619	490	300	91
New Lever.	0.00	0.00	0.06	0.07
Profitability	0.014	0.009	0.003	0.002
WAIRL	2	2.3	2.5	2.67
Size (billion)	0.31	0.60	1.31	0.88
Growth	0.08	0.05	0.07	0.07
FROI	1.3	1.98	2.39	3.19
DSRR	0.00	0.02	0.27	0.31
Risk	0.3	0.5	1.6	1.5

Table 2.4 illustrates further insight into the medians among leveraging groups. The profitability of no leveraging observations indicates the highest rate (1.4 percent). It reduced to 0.9 percent when the level of leveraging gets to a low level and down to 0.3 percent at medium and 0.2 percent at high leveraging levels. This suggests that CWSRFs with higher leveraging have lower profitability. This is explained by the fact that costs associated with leveraging (bond issuing and leveraged loans) may cause a reduction in the profitability of CWSRF. On the

contrary, weighted loan interest kept rising, inconsistent with increasing leverage, starting with 2 percent at zero leveraging to 2.6 percent at a high leveraging level. Observations with leveraging showed a larger size. However, this was not subsequently correlated within the leveraged group. The medium leveraging group indicated the highest median size ($1.31 billion). The growth rate remained relatively high, at 8 percent, but it declined to 5 percent when the leveraging increased from 0 percent to low leveraging. Within the leveraged group, growth increased steadily from 5 percent to 7 percent as the degree of leverage increased, suggesting that higher leveraging contributes to the increased growth of CWSRF. FROI and DSRR, similar to WAIRL, increased according to the degrees of leverage; FROI started from 1.3 percent with zero leveraging and reached 3.19 percent when leveraging is high. Lastly, the risk factor indicates a dichotomous pattern with the debt ratio. At a low leveraging level (below 40 percent), the risk was low (0.5); the risk was high (1.6) at a high leveraging level (above 40 percent).

Table 2.5

Correlation Matrix

	TL	NL	Profit.	WAIRL	Log size	Growth	FROI	DSRR	VIF
TL	1.000								
NL	0.52***	1.000							
Profit.	-0.47***	-0.19***	1.000						1.51
WAIRL	0.16***	0.23***	0.16***	1.000					1.09
LogSize	0.45***	0.08***	-0.09***	-0.07***	1.000				1.65
Growth	0.023	0.54***	-0.07***	0.27***	-0.30***	1.000			1.18
FROI	0.62***	0.15***	-0.36***	-0.05**	0.58***	-0.19***	1.000		1.94
DSRR	0.66***	0.31***	-0.27***	0.03	0.40***	-0.027	0.29***	1.000	1.3
Risk	-0.0398	-0.033	0.05**	0.0398	-0.0243	0.07***	-0.05*	-0.039	1.01

Note. * p<0.10 ** p<0.05 *** p<0.01

Table 2.5 presents the correlation matrix of the whole sample. As shown in Table 2.5, most cross-correlation for independent variables was relatively small. The highest correlation between independent variables was 0.58 between size (log) and FROI. The VIF score is also included in Table 2.5, indicating a small scale, giving less cause for concern about the multicollinearity problem. Later, the Arellano-Bond autocorrelation tests in the first difference GMM-Sys model would also support this.

Regression Results

Table 2.6 shows the primary results from the GMM-Sys regressions. In both system GMM models, in addition to the lagged and two-lagged dependent variables, the study used suitable lagged values of the regressors as instruments; this allowed these instruments to be correlated with past or possible current errors. In the total leverage model, the profitability variable was treated as potentially endogenous (correlated with past or possible current errors), and the lagged dependent variable and the other six regressors (WAIRL, Size(log), DSRR, Risk, FROI, and Growth) were considered as predetermined (correlated with the past but not with the current and future errors). Time dummy variables were assumed to be strictly exogenous (not correlated with error terms in all temporal periods). A similar treatment was applied in the annual leverage model, except for the size (log) variable, which was also classified as potentially endogenous as same as the profitability variable, with an additional two-lagged dependent variable as a predetermined instrument. Doing this was expected to address the potential endogeneity issues discussed earlier. The diagnostic tests reported in Table 2.6 confirm that our identifying assumptions are statistically acceptable. The AR2 test yielded a p-value of 0.092 and 0.123, respectively >0.05, which means that the null hypothesis cannot be rejected. The essay thus accepts the null that the error term of the orthogonal deviations equation is not serially correlated at the second order. The Hansen test revealed a respective p-value of 0.112 and 0.186, suggesting that the null hypothesis cannot be rejected, or the essay accepts that instruments are valid.

Table 2.6

System GMM Regression Results

Variables	Total Leverage	New Leverage
L.TL	0. 923351*** (20.28)	
L.NL		0.1877993***(2.86)
L2.NL		0.1409211 ***(3.30)
Profitability	-0.4458768 (-1.18)	0.4943621 (1.04)
WAIRL	0.0019314 (1.20)	0.0028565 (1.39)
Size (log)	**0.0444047***(3.97)**	**0.0456444**(2.17)**
Growth	**0.1639305***(5.79)**	**0.2236471***(5.80)**
FROI	**-0.0211657*(-1.96)**	-0.0057185 (-0.33)
DSRR	-0.0076475 (-0.17)	0.0250869 (0.55)
Risk	-0.0000481 (-0.96)	-0.0000423 (-0.84)
Year Dummies	Yes	Yes
F Statistic	324.74	14.45
Number of observations	1350	1350
Groups/Instruments	50/44	50/34
AR(2)	0.092	0.123
Hansen statistic	0.112	0.186

Note.
* p<0.10 ** p<0.05 *** p<0.01
t statistic in parentheses
P-value reported for AR (2) and Hansen statistic.

The first interpretation from Table 2.6 is that the total leverage variable was highly persistent; in both models, lagged total leverage and two-lagged annual leverages were the most relevant predictors. The growth of total assets stood out as a determinant of the leverage ratios. A percent change in the growth of assets was associated with a 0.16 percent increase in outstanding debt ratio and a 0.22 percent increase in new debt issued in the short run at a 1 percent significance level. This result suggests that high growth CWSRFs tend to resort to debt to finance their expansion (loan assistance expansion), at least after they have exhausted their internally generated funds – federal capitalization and retained earnings. This prediction is consistent with pecking order behavior. The growth coefficient estimates were larger for new debt than for outstanding debt, inferring that CWSRFs may issue more new debt to invest for their expansion but that they do not necessarily have equivalent high debt levels (debt outstanding).

The other robust inference is the statistically significant positive influence of the size on leverage. This finding is the opposite of the assumption of pecking order theory, but it sides with that of trade-off theory and many empirical studies in the private and nonprofit literature (McCue & Ozcan, 1992; Smith, 2012; Sonola, 2018). It implies that the larger CWSRFs have more access to the credit markets, and they are likely to use their credit reputations and leveraging experiences to attract more debt.

The revolving rate of federal capitalization FROI was shown to negatively influence the total leverage ratio; a percent change in FROI was associated with a 0.021 percent decrease in outstanding leverage. This may imply that CWSRFs that manage their federal seed money more efficiently (high utilization of federal investment) thus have more available funding for loan activities and tend to maintain a lower level of outstanding debt.

Both profitability and weighted loan interest demonstrated no association with any debt ratio. The literature on capital structure for nonprofit documents shows previous studies that found their profit regressor not to be a determinant of debt financing. Calabrese and Ely (2016) found that multisectoral American nonprofit organizations' total margin (profitability) is unrelated to tax-exempt borrowing. Yan, Denison, and Butler (2009) found that percent surplus is not supported in their leverage model of large nonprofit organizations.

The long-run GMM-Sys coefficient results, calculated by the short-run or contemporaneous coefficient, divided by one, minus the coefficient of lagged dependent variable (Piper, 2014), indicated that the effects of size on total leverage are much more significant (0.5793256). However, the growth and FROI were no longer significant, likely due to the high value of the lagged coefficient in the total leverage model. The long-run effects of size (0.0561985) and growth (0.2753594) on new leverage were higher than in the short-run.

Contribution and Conclusion

This essay provides a descriptive analysis of the CWSRF leveraging profile and explores the capital structure of CWSRF through the lens of a private sector capital structure theory: pecking order theory.

Overall, pecking order theory is somewhat applicable to CWSRF, a public entity. The empirical findings suggest a mixed result. On the one hand, consistent with the pecking order theory, this study found a strong positive significant relationship between change in total assets (growth variable) and total leverage/new leverage. On the other hand, size showed a statistically significant positive relationship with the total leverage, which is opposite to the prediction of pecking order theory (instead, consistent with the prediction of trade-off theory). This finding is not surprising, but it is in line with general empirical results in the literature, which usually find support for financing behavior from a combination of critical theories (pecking order theory and trade-off theory). In addition, the growth of federal capitalization (FROI) was also identified as a relevant determinant that influences the total leveraging of CWSRFs.

Regarding policy implications: even though the EPA encourages states to leverage to increase the pools of funds for loans, this study shows that, on average, only 20 percent of the capital structure of CWSRFs is primarily sourced from leveraging. The average for leveraged states is 27.1 percent, and this number has tended to decline in recent years (to 23.8 percent in 2019). Within this range, the leveraging is at a relatively low level, lower than general nonprofit or water enterprises (40%). Therefore, there is still "safe" room for CWSRFs to get extra funding from this source of bonds.

Associated factors that explain the capital structure choices of CWSRFs identified here can be a good reference source for CWSRF managers at CWSRFs. In general, the growth rate, the federal return on investment (FROI), and the size are among the most important financial factors that consistently influence the decisions to use leveraging, as well as the level of leveraging by states. The empirical evidence implies that CWSRFs that are larger, or that grow faster, tend to issue more new debt and to maintain larger amounts of outstanding debts, or they are more reliant on bonds. On the contrary, CWSRFs that are either smaller or less growing choose to leverage less new debt and maintain lower outstanding debt levels. These empirical findings add more evidence from the public sector to the raised concern in the literature on nonprofit capital structure with regard to "how to make smaller capital-starved nonprofits better able to take advantage of the tax-exempt bond markets in a responsible manner" (Calabrese & Ely, 2016, p. 473). The EPA should direct more attention to enabling small states with capital needs to access the bond market.

It is noted that, whereas profitability (or sustainability) is not a determinant of CWSRF capital structure, the federal return on investment – the revolving rate of federal capitalization – is. This makes more sense in the context of CWSRF. CWSRFs generally do not seek to maximize profits while subjected to specific mandates as state entities. However, they do need to sustain and to target other purposes, such as expanding the use of capitalization grants to meet the needs of wastewater loans. Therefore, they are likely to sacrifice profitability but to prioritize other growth purposes in their financing decision-making. This also raises concerns about the program's sustainability when the profitability is not receiving due attention.

Leveraging plays a vital role in implementing CWSRF; its cumulative contribution is about $50.6 billion, almost the same as the cumulative federal and state capitalization of $54.2 billion; this accounts for a significant portion of CWSRF funding available for projects which help to finance water infrastructure needs. Debt enables the leveraging of fiscal resources (federal capitalization grant) to expand the resources (FROI) for current operations. However, debt issuance may also pose a threat to the sustainability of CWSRFs. This research is essential in understanding the organizational causes that motivate preferences for leveraging. Additional research is needed to further examine the other external perspectives (economic, federalist, citizen preferences) that encourage CWSRFs to issue and hold debts.

Limitations

Despite the contribution and the implications noted above, a few limitations to this study should be noted. First, the study only covers the CWSRF. Further application to its twin, the Drinking Water State Revolving Funds (DWSRFs), would provide a base for an interesting comparison. Second, this study did not use the data from audited financial statements that were separately prepared or incorporated by various state agencies (environmental, health, economic, and others). Still, NIMS data is officially consolidated and managed by the EPA. Financial statements might provide more detailed information, such as short-term liabilities or grants, which would add more insight into leveraging CWSRF. Finally, a qualitative study to understand the viewpoint of crucial finance decision-makers in the CWSRF administration would supplement further findings regarding their leveraging decisions. Both of the dependent variables showed a high percentage of observations equal to zero (41 percent), which is similar to a case on the study of financing for highways performed by Wang et al. (2007), who used random-effects TOBIT model to treat the zero entries as censored.

CHAPTER 3

LEVERAGING IN CWSRF: EVIDENCE FROM EXTERNAL FACTORS

Introduction

Debt financing is the most significant financial source for public infrastructure; as Marlowe (2015) noted, about 90% of state and local capital spending is financed by debt. The literature has documented a tremendous diversity in debt practices among states (Bahl & Duncombe, 1993). Previous studies explain state debt financing using a variety of factors, including voters' preferences, political and institutional factors, borrowing costs, intergovernmental revenue, and many other factors (Shi, Hendrick, & Park, 2018). Wastewater infrastructure is no exception. In most states, Clean Water State Revolving Fund (CWSRF) represents the largest source of federal assistance to states and local communities for funding wastewater infrastructure (Gómez, 2013); however, the initial seed funding from Congress would not be sufficient to meet the current environmental needs (Travis, Morris, & Morris, 2004). States are thus encouraged to contribute more than the minimum required 20 percent state match and leverage to increase available funding. "Leveraging is a process through which a state places its annual federal appropriation (and perhaps its state match funds) in a reserve pool to guarantee the sale of revenue or general obligation bonds" (Travis et al., 2004, p. 464). Bond proceedings are then placed in the CWSRF fund pool and are available for loans. The leveraging practice among states is varied; some states do not leverage at all. Some engage in aggressive leveraging, generating upwards of five dollars for every initial investment dollar. On the other hand, states may choose a safer level of leveraging, with a trade-off of fewer dollars (about two-to-one) available (Travis et al., 2004).

Leveraging can help increase available funds; however, it can also create challenges and implications for the CWSRF program. Previous studies have pointed out several issues associated with leveraging, such as financial capacity issues, borrowing costs, and consequences for the program's long-term sustainability (Holcombe, 1992). Since leveraging mechanisms often involve incredibly complex financial transactions that require highly trained financial expertise sourced from other agencies or from the private sector (Heilman & Johnson, 1991), states must consider these factors before leveraging. In addition, Heilman and Johnson (1991) and Morris (1994) also emphasize that the decision to leverage is often a complex process on the part of the states; it may involve a calculation of risk, perceived long-term and short-term benefits, demand from communities for loan assistance, the water quality needs in the state, and myriad other factors.

The purpose of this article is to explore the potential determinants of CWSRF’s decision to leverage or to use debt financing. Following the median voter theory’s assumptions and borrowing from previous studies on state debt financing determinants, this essay builds a model of leverage CWSRF that emphasizes the demographics, socioeconomics, demand for service, political factors, institutional factors, and the state management capacities that influence the financial decisions of elected officials. Are these determinants relevant to CWSRF, and, if so, how do they associate? This study contributes to the literature on debt financing in some crucial ways. Although there is extensive research on state debt financing in general, there is a lack of scholarly research on a specific infrastructure sector: water infrastructure; and there is a further lack of research on a particular state authority: the environmental/water authority. This study on the determinants of the financing decisions of CWSRF also expands to a more extended period

(1990-2019). It includes more variables, as well as new operationalization when compared to previous studies.

The remaining essay provides a synthesis of the previous work on the determinants of state debt financing and expands the application of state debt determinants to the CWSRFs. The essay then presents a discussion of the data and the method used. Finally, the last section includes findings, as well as a discussion of contributions and practical implications.

Literature Review

There is considerable literature examining the factors that determine state debt issuance choice and the level of state debt. The most common method employed is the interest group approach, which focuses on the behavior of politicians who weigh the electoral costs and benefits of debt financing (Ellis & Schansberg, 1999). Thus, financing decisions may be influenced by political factors and by the characteristics of their constituency and may be constrained by relevant debt institutions.

In the early years, Bahl and Duncombe (1993), borrowing from the literature on the demand for local public services, considered how demand for services, government spending, the composition of debt, and historical debt influence the use of long-term debt by state and local government during the 1980s. Ellis and Schansberg (1999) focused on the way in which the demographic, political, and institutional factors, controlling for income and capital spending, impact debt accumulation at the state level. Wang, Hou, and Duncome (2007) developed a model with demographic, socioeconomic, political, and institutional variables to capture the behavioral patterns of voters and politicians when making capital financing decisions (pay-as-you-go financing). More recently, Kim and Lim (2018) employed a political market framework to explore the mediating role of political institutions in state financing decisions within different institutional settings. Particularly, Schneider (2019) examined determinants of debt financing for highway capital spending in the states by using a variety of socioeconomic measures representing the median voter model, controlling for political and institutional factors, and others. The following literature categorizes these dependent variables and determinants into relevant groups and reviews the documented empirical evidence about each one.

Dependent Variables

The literature measures the debt burden in the flow of debt (the new debt issued) and the stock of debt (outstanding balance). Debt burden can also be defined as the amount of debt or the debt ratio. Scholars often consider total outstanding debt per capita (Liu, Moldogaziev, & Mikesell, 2017), long-term debt per capita (Clingermayer & Wood, 1995; Kim & Lim, 2018), outstanding debt as a percentage of per capita income (Bahl & Duncombe, 1993), total debt held at the state level (Greer & Denison, 2016), and total annual issued debt to its expenditure/government spending (Ellis & Schansberg, 1999; Schneider, 2019; Temple, 1994) as dependent variables. More than one dependent variable is often used in a study. For instance, Ellis and Schansberg (1999) operationalized debt financing decisions as to the use of debt relative to another method of financing state budget, using the ratio of a state's change in total debt to its expenditures for a given year (Ellis & Schansberg, 1999, p.574). This measure indicates the proportion of state government spending financed by issuing debt rather than taxes or federal aid to states. Schneider (2019) also used the amount of new issue bond proceeds divided by highway capital spending as the debt share dependent variable. Following the debt share approach (Ellis & Schansberg, 1999; Schneider, 2019), this study looks into the debt flow in both aspects: new debt issue as the percentage of loan assistance (flow of debt-share) and the annual debt issue per capita (flow of debt level).

Independent Variables

This section provides a review of debt financing determinants emphasizing three main perspectives: (1) the voter factors, (2) the political factors, and (3) the institutional factors.

Voter Factors. Median voter theory proposes that government decisions are based on the preferences of decisive voters under certain conditions. Following the modified median voter model used by Wang et al. (2007), Schneider (2019), and other empirical studies, this section reviews voter demand as well as socioeconomic and demographic factors related to preferences of the median voter for debt financing. Thus, this factor category includes several subfactors such as service demand, demographics, and economic factors (voter's demand, age, and income).

Population Density. Bahl and Duncombe (1993) argued that demand for services is affected by several factors, including debts. A higher debt burden is expected to be positively associated with a growth in demand for government services that require massive capital expenditures. Service demand is captured by three sets of indicators: by population size (in millions), by population density (persons per square mile), and by the growth rate in the population. Larger populations and greater urbanization rates reflect increased demand for services, creating pressure to increase infrastructure spending. Similarly, the growth of population and urbanization increase the rate of capital spending and, therefore, the debt burden. A series of variables are used to proxy the demand for specific services such as public school and college enrollments, per capita domestic water consumption (thousands of gallons per day per person), per capita energy consumption (billions of BTU per capita), state park acres per square mile of state land (Bahl & Duncombe, 1993), and miles traveled vehicle per 1,000 residents (Schneider, 2019). Each should be positively associated with the level of the debt burden. The findings are mixed. Bahl and Duncombe (1993) concluded that population density tends to increase debt burdens. A higher population growth rate is associated with a greater debt claim on personal income; states with larger populations and higher per-capita personal incomes do not incur more significant debt burdens. However, other authors found no evidence that population density has impacted state long-term debt (Kim & Lim, 2018; Greer & Denison, 2016).

Needs. Particularly for CWSRF, Travis et al. (2004) used the environmental need data collected from the Environmental Protection Agency (EPA) Office of Wastewater Management and the demand for SRF loans as a proxy for service demand. They tested their relation, respectively, with the number of funds leveraged by states. The higher the demand from communities and the higher the need, the more pressure placed on leveraging to attract more funds to meet that demand and requirement. This is also in line with the EPA's vision of the CWSRF program. The findings indicated that environmental needs do not explain the decision to leverage, but needs size is associated with leveraging scale (Travis et al., 2004). In addition, case studies confirmed that some states with low demand for CWSRF loans have chosen not to leverage their funds (Morris, 1994).

Age. Demographic differences across states may also affect voters' preferences over debt financing for infrastructure (Wang et al., 2007), and the median voter's age also matters. To capture differences in demand, scholars have studied the percentage of the population between 18 and 65 years of age and older than 65 (Ellis & Schansberg, 1999; Kim & Lim, 2018); the percentage of the population under 18 and older than 65 (Greer & Denison, 2016); and the percentage of the people between 18 and 24 years and older than 65 (Wang et al., 2007; Schneider, 2019). The use of these age groups helps distinguish between desires for government spending that target both the elderly and the non-elderly populations. Based on the intergenerational effects of public debt, it is hypothesized that older voters tend to prefer more debt financing than younger voters (Brennan, 2012). The empirical results are also mixed. Kim & Lim (2018) found a positive relationship between the population over 65 and the level of long-term debt. They contended that the older population expects more services from the government, which can increase the level of state debt. Similarly, Wang et al. (2007) found that the share of the population over 65 was negatively related to pay-as-you-go financing (equity financing), suggesting that, as the population ages, they tend to prefer debt. To the contrary, other findings showed a negative relationship between the older 65 age group and respective state debt financing (Ellis & Schansberg, 1999) and the debt share of highway spending or new highway bonding (Schneider, 2019). Greer & Denison (2016) found that a percentage of the population under 18 was negatively associated with a lower rate of total debt outstanding at the state level.

Income. From an income perspective, there are different approaches to hypothesizing the impact of income on debt choice; debt preference can be tied to income expectation (itemized returns) or to debt affordability. For the former, lower-income individuals are assumed to be constrained and are expected to prefer debt financing; states with relatively lower per capita incomes will have a larger share of debt financing. The wealthier individuals who are bequest maximizers (who itemize their tax returns) will favor tax financing because of taxes-paid deductions (Wang et al., 2007). For the latter, the individual income per capita has frequently been adopted as a proxy for state wealth (Bahl & Duncombe, 1993). Higher-income states are more likely to generate debt because of their capacity to handle new debt (Ellis & Schansberg, 1999; Fisher & Wassmer, 2014). Alternatively, state debt might decrease with an increased ability to pay (Ellis & Schansberg, 1999). The findings are not conclusive. Greer and Denison (2016), Liu, Moldogaziev, and Mikesell (2017), and Kim and Lim (2018) found a positive relationship between income and debt, while Bahl and Duncombe (1993) and Ellis and Schansberg (1999) found a negative relationship showing a decrease in debt when incomes are increasing. Wang et al. (2007) found that the preference for financing from current taxation (equity financing) increases as income increases (negative relationship). Notably, income is found to be negatively related to new debt issued and positively related to debt level (debt per capita) (Ellis & Schansberg, 1999).

Political Factors. It is said that debt issues are inherently political, as seen in political debates by federal, state, and local governments over the issuance of new debt and debt levels (Greer & Denison, 2016). Given that politicians have their self-interests and their own opportunistic and ideological motives in their decisions to use financing mechanisms in addition to weighing their constituencies' perceived interests, they will also consider maximizing their electoral votes. Based on the assumptions of the political business cycle theory and the partisan cycle theory, Wang et al. (2007) used the gubernatorial election year and party majority in the Senate and House as determinants of a state's use of pay-as-you-go financing (equity financing). Notably, Kim and Lim (2018) applied the political market framework. They used three main political variables for the state level, including political competition (consisting of an election year and interparty competition), divided government, split legislature, and political turnover, with the political institution as a mediating variable. Many other political factors, such as political ideology (Greer & Denison, 2016), have been hypothesized and tested in the literature.

Election Year. According to Nordhaus (1975), policymakers will make decisions favoring the current generation over future generations. This is extended to debt-financed state spending literature; Baber and Sen (1986) found empirical evidence to support the hypothesis that state debt increases in anticipation of a gubernatorial election. Similarly, the debt illusion hypothesis implies that the costs of public programs that are financed through current taxes are more visible to voters, as compared to those financed through borrowing debt; thus, close to an election year, state debt financing is likely to increase (Greer & Denison, 2016; Kim & Lim, 2018). However, Liu et al. (2017) asserted that "the election effect on debt issuance may be contradictory. When facing elections, politicians may be less likely to issue debt to avoid being blamed for too much debt accumulation; on the contrary, they may be more likely to issue debt and invest in infrastructure to garner more votes" (Liu et al., 2017, p. 685). Some scholars tested the relation between leveraging and the year before a gubernatorial election year (Clingermayer & Wood, 1995; Kim & Lim, 2018). Others considered the gubernatorial election year. Nevertheless, scholars found no evidence supporting the hypothesis that debt financing is likely to increase closer to the election year (Wang et al., 2007; Liu et al., 2017; Kim & Lim, 2018; Schneider, 2019).

Ideology. Political ideology is also considered a factor in the median voter's preference for using debt (Schneider, 2019). Researchers often use the political ideology index (which is structured such that more liberal states have higher scores) and they find that states leaning more liberal are more likely to issue debt at the state level. For instance, when liberalism increased from the neutral to the most liberal position, the state debt per capita rose $50 (Clingermayer & Wood, 1995). From the median voter's approach, Wang et al. (2007) and Schneider (2019) argued that majority parties in the legislature should represent the ideology of the median voter and thus tested two variables: (1) the Democratic majority in the state Senate and (2) the Democratic majority in the state House of representatives to see whether Democratic control of either or both chambers positively affects debt issuance for the highway. While Wang et al. (2007) found no support for the assumptions, Schneider (2019) suggested that a Democratic majority in the upper chamber is statistically and negatively related to the debt share of state highway capital. This essay proposes that Democratic control of either or both chambers will positively impact the decision to issue debt for CWSRF loan assistance.

Divided Government. It is assumed that there is less cooperation between parties in a divided government, one in which no single party controls both legislative chambers and the governorship. As a result, the parties tend to reach compromises in the budgeting process by increasing spending without increasing taxation (Alt & Lowry, 1994). Thus, a divided government is expected to lead to more reliance on debt financing. While some authors found empirical evidence to support the assumption, others found the opposite result. Ellis and Schansberg (1999) indicated that Democrats usually favor spending programs that require more revenues or that imply a positive correlation with higher debt. Wang et al. (2007) found a statistically significant negative relationship between divided government and the share of pay-as-you-go financing for capital projects. This suggests that the debt share of capital financing is greater in a divided state government. Conversely, Clingermayer and Wood (1995) found evidence suggesting that states with Democratic governors and Republican legislatures have relatively less debt; this is the opposite of the divided government hypothesis. Schneider (2019) suggested that a divided government is negatively related to bond financing. Similar to divided governments, split legislature governments can affect the degree of long-term state indebtedness.

Recently, Kim and Lim (2018) also found the positive effects of a split legislature on state long-term debt (p. 7).

Institutional Factors. The purpose of these legal institutional factors is to constrain government officials' behavior. That is, limits and rules are explicitly designed to support the fiscal decision-making of government officials in favor of limits or rules, as embodied in state statutes and constitutions (Johnson & Kriz, 2005). The state debt limit and Tax and Expenditure Limits (TELs) variables are among the primary factors that influence state indebtedness, and they are directly related to the debt financing decisions addressed in this study.

Debt Limits. Debt institutions can be captured by different limits, general obligation debt limits, debt limits to a share of a defined revenue base, debt referendum, debt supermajority, or debt prohibition (Ellis & Schansberg, 1999). Some states have more than one debt limit. These limits are expected to restrict the growth of state debts, or these limits will be negatively correlated with the state debt issuance and state debt outstanding. The literature documents different ways of specifying this debt limit variable. Some studies define the variable as a single dichotomous dummy with the presence of the limit equal to one and the absence equal to zero, and others use each type of debt limit separately. As the earlier defined variable, debt limits showed little to no impact on total long-term debt (Clingermayer, 1991). Individually, debt prohibition, limited debt to a share of the revenue base, or debt referenda were shown to reduce state debt (Ellis & Schansberg, 1999; Kiewiet & Szakaly, 1996). Bahl and Duncombe (1993) constructed their own debt index and concluded that the stringency of the debt limits negatively affects the level of debt.

In addition, there is a federal-level restriction on the use of public debt known as the private activity bond (PAB) volume cap (Hildreth & Zorn 2005; Greer & Denison, 2016). State and local governments can issue tax-exempt bonds to finance specific projects considered private activities as defined in the tax code. For instance, sewage facilities are qualified private activities and are subjected to an annual state volume cap (Tax Reform Act, 1986). While the general debt limitation is more relevant to general state debt financing, this PAB volume cap is more specific to the CWSRF's leveraging. Thus, it will be used as a debt limitation for this essay. A new cap is allocated to each state based on a formula: a state per capita debt issuance allocation (Tax Reform Act, 1986). The annual cap was increased from the greater of $50 per capita or $150 million in 2000 to the greater of $105 per capita or $321.77 million in 2020 (and it is adjusted annually for inflation). The $321.77 million minimum for small states offers a more generous volume cap than the per capita allocation. The unused caps can be carried forward or converted into Mortgage Credit Certificates. Thus, a state's current volume cap or total cap can be defined as its new allocation plus what is carried forward from its last three years, minus any allocation converted into Mortgage Credit Certificates (Center of Finance Development Agency, 2021).

Tax and Expenditure Limits. TELs are intended to limit the amount of state revenues or expenditure and thus to potentially motivate the issue of debt at the same level as TELs (Greer & Denison, 2016), or they are assumed to have a positive association with state debt level (Bahl & Duncombe, 1993; Kim & Lim, 2018). TELs can be measured as the stringency index and as a dummy variable like the debt limit. The TELs index constructed by Amiel, Deller, and Stallmann (2009) is the most popular. The index ranges from 0 for states with no TELs to 30 for states with the most limiting TELs. Scores are based on following factors: the type of the TEL (revenue or expenditure, constitutional or statutory), how the TEL was adopted, the level of restriction imposed, and the override and exemptions. Bahl and Duncombe (1993), Clingermayer and Wood (1995), and Kim and Lim (2018) reported evidence that TELs are positively associated with state debt, suggesting that debt can be a tool used for circumventing the intent of the TEL (Schneider, 2019). Since the Amiel et al. (2009) index is available from 1969 through 2005 only, Greer and Denison (2016) assumed that TELs are relatively constant and extended the index through 2011, based on the 2005 TELs. Similarly, this essay also uses the Amiel et al. (2009) index and spreads it through 2019, based on the 2005 TELs.

State Capacity to Issue Debt/Debt Capacity. Historic debt is defined as debt capacity, which is expected to be an essential factor influencing the decision to issue debt. Bahl and Duncombe (1993) argued that once the state has reached a high level of debt, it takes a long time for the debt to retire. Also, once the state often carries a high debt burden, there will be less pressure from the voters to lower it. When the state debt is defined as outstanding debt (debt stock), Bahl and Duncombe (1993) used historic debt as a control variable and found support for their arguments that states with high debt levels would be more likely to rely on debt relative to other states. Kim and Lim (2018) also found that lagged debt per capita positively correlated with current long-term debt per capita. When the debt variable is proxied as debt share of spending, the prior debt level is assumed to be negatively related to debt issuance. Temple (1994) suggested that a state with lower debt outstanding would incur lower interest expenses; thus, the debt share of expenditures would be higher. However, the empirical evidence did not show the outstanding debt as significantly related to the debt share. Recently, for highway infrastructure, debt outstanding was found to be negatively correlated with the debt share of capital outlay (Schneider, 2019). Since this essay uses the debt share of loan assistance, not the share of spending as Temple's (1994) assumption, this study uses historic debt and hypothesizes that it positively affects CWSRF financing decisions.

In addition, federal funding would also affect state debt capacity. Prior studies reported that federal grants were negatively related to debt financing (Kim & Lim, 2018; Temple, 1994), suggesting that states with higher federal contributions would borrow less for capital funding. Schneider (2019) found that the federal share of highway capital outlay was negatively associated with debt share and new bond issue financing. This essay also uses federal share as a percentage of loan assistance as a proxy for federal contribution and attempts to test whether it will influence the state's debt share and debt per capita.

For CWSRF, Travis et al. (2004) also measured state commitment and state capacity and their impacts on leveraging, as suggested by Lester's model (Lester, 1994). Because leveraging requires a significantly higher institutional capacity to implement (Heilman & Johnson, 1991), it is expected that states with stronger institutional capacity will be more likely to leverage. The findings showed mixed support for Lester's commitment/capacity model. The institutional capacity was significant at both stages of the decision process: the decision to leverage and the level of leveraging.

Model Specification, Hypothesis, and Data

CWSRF Leverage Model

The model is built on the assumption of median voter theory, which hypothesizes that voters' preferences will influence government decisions under certain political and institutional conditions. The median voter preferences are determined by income, age, and specific demand factors. The electoral cycle and government composition variables capture voter ideology and the politics that influence voters' preferences. At the same time, the choices of median voters are constrained by institutional limits via state debt limits, tax and expenditure limits, and state capacity to issue debt. This essay will examine all the factors described to explore their association with the leveraging state decision.

The exploratory model to explain the CWSRF's leveraging is presented below:

$$Leverage = \phi Leverage_{it-1} + \beta_1 S_{it} + \beta_2 P_{it} + \beta_3 I_{it} + \mu_i + d_t + \varepsilon_{it}$$

Where leverage of state *i* at time *t* is the annual new debt issued for addressing loan assistance needs. The dependent variable will be measured in two ways: the choice of debt financing relative to other methods and debt scale. The first is to measure the annual new bond issued as the share of total annual loan assistance in CWSRF. This measure indicates the proportion of CWSRF's loan assistance financed by issued debt rather than by federal appropriation to states. As noted in the literature, a ratio approach makes it difficult to isolate the effects of the independent variables on debt, which may lead to problems in statical inference (Kronmal, 1993). Another dependent variable, the new bond issued per capita, will be included to address this potential issue. Clingermayer and Wood (1995) also measured debt per capita (debt level/stock of debt per person) as they argued that it controlled for differences between states due solely to disparate state population size (Clingermayer & Wood, 1995, p.110). $\text{Leverage}_{\text{it}-1}$ is a lagged dependent variable, ε_{it} is the error term, μ_i represents unobserved state-specific effects, and d_t stands for time fixed effects. S is the vector of social-economic variables, P is the vector of state politics variables, and I is the vector of institutional variables. In short, this essay will analyze the preferences of voters in making the determination, the state political environment, budgetary institutions in the state, and state capacity to issue debt. Table 3.1 provides the description and measurement of the two dependent variables. Detailed data codes for each NIMS item can be found in Table A.1 of Appendix A.

Tables 3.1

Dependent Variables

Dependent variables	Definition/measurement and Data
Debt share (Debt financing relative to other methods)	Debt per dollar of loan assistance: a ratio of annual bond issued to its dollar of loan assistance for a given year $$\frac{\text{Annual Gross Leveraged Bonds Issued+Annual Match Bond Issued}}{\text{Annual Loan Assistance}}$$
Level of leveraging (Debt per capita)	The ratio of annual bonds issued to its population in a given year $$\frac{\text{Annual Gross Leveraged Bonds Issued+Annual Match Bond Issued}}{\text{State Population}}$$

Table 3.2 below describes all independent variables used in the study, along with the expected direction of the variable's relationship with leverage. A detailed description of the formula for each independent variable follows.

Table 3.2

Independent Variable Specification, Data Sources and Hypothesized Sign

Variable Name	Definition/measurement	Data Source	Expected Sign
Socioeconomic factors/Voter's preference			
Population density (POPDEN)	Persons per square mile	Census Bureau	Positive (+)

Table 3.2 Continued

Variable Name	Definition/measurement	Data Source	Expected Sign
Old population (OLD)	Percent of the population 65 and over	Census Bureau	Positive (+)
Young population (YOUNG)	Percent of the population under 18	Census Bureau	Negative (-)
Income per capita (INCOME)	Real per capita personal income	Bureau of Economic Analysis	Negative (+)
Environmental needs (NEEDS)	The total environmental needs consist of seven categories. States report this list of needs every four years, beginning in 1988. Although the actual needs may change, the estimates of years between reports (every four years) are considered as the same amount reported. The most current needs reported in 2012 are also extended to 2016-2019.	EPA	Positive (+)
Political Variables			
Gubernatorial election year (ELECT)	Dummy variable, if it is gubernatorial election year = 1, otherwise = 0	Book of the States	Positive (+)
Divided Government (DIVIDED)	Dummy variable, if governor and majority of both chambers are of different parties = 1, unified party control = 0	Book of the States	Positive (+)
Senate Democratic Majority (SDEM)	Dummy variable, if Senate majority party is Democratic = 1, otherwise = 0	Book of the States	Positive (+)
House Democratic Majority (HDEM)	Dummy variable, if House majority party is Democratic = 1, otherwise = 0	Book of the States	Positive (+)
Institutional factors			
Tax and expenditure limit (TEL)	TEL state index	(Amiel et al., 2009)	Positive (+)

Table 3.2 Continued

Variable Name	Definition/measurement	Data Source	Expected Sign
Private activity bond (PAB) volume cap	The annual total amount of cap (new cap plus any carried over amount)	Council of Development Finance Agency (CDFA, 2021)	Negative (-)
Debt capacity (HODEBT)	Outstanding debt at the beginning of the year - lagged (Total Outstanding Debt)	NIMS	Negative (+)
Federal share (FEDSHARE)	Federal appropriation per dollar of loan assistances $\frac{\text{Annual Federal Contribution}}{\text{Annual Loan Assistance}}$	NIMS	Negative (-)

Data

The EPA has collected the NIMS database annually since 1988 from the 50 states, the District of Columbia, and the five U.S. territories. This study focuses on 50 states and does not include the District of Columbia or the five territories. The program's first two years, 1988 and 1989, are eliminated since the program was not yet fully implemented. Nebraska is dropped because of its unique unicameral legislature (Chen, 2017). As a result, the essay has balanced panel data, including 49 states observed over 30 years. The two dependent variables are the debt ratios calculated using the NIMS data and the population of 49 states. Other data of independent variables are collected from different external sources, as noted in Table 3.2. As noted, the Private Activity Bond (PAB) data only cover from 2005 to 2019; thus, this variable is excluded in the GMM-Sys analysis of both models. Instead, a separate regression will be conducted for 15 years where PAB (Private Activity Bond) information is available. Another issue noted is that there is extreme value detected in the sample, such as the negative value of new debt issues (five observations), negative loan assistance (one observation), and debt share of loan assistance (11255%). To reduce the potential bias of outliers, this essay winsorizes all variables except for the dummy variables and the TEL index at the first and ninety-ninth percentiles. Four variables with absolute amounts, including income, needs, PAB, and outstanding debt, are transformed using the log. Financial variables are inflation-adjusted to 2016 dollars using the Consumer Price Index.

Research Method

The previous literature on state debt choice indicates that the two-way fixed-effects model for panel data is the predominantly used approach to estimating the results. Driscoll-Kraay (DK) standard errors are also recommended, instead of White and Newey-West standard errors, because they are more robust to general spatial and temporal dependence forms (Hoechle, 2007). However, the two-step system Generalized Method of Moment (GMM-Sys) is considered more advanced to random-effect and fixed-effect models. GMM-Sys allows us to model for any unobserved fixed effects represented by μ explicitly and includes lagged dependent variables among regressors to address potentially omitted variables (Forte et al., 2013, p.361). It also enables us to use lagged values of the regressors as instrumental variables to address the likely endogenous relationship between the regressors and dependent variables. GMM-Sys also has its limitation because it is complex and does not address cross-sectional dependence. This essay thus estimates debt share and debt per capita models using the GMM-Sys estimator and reports the two-way fixed effect estimation results for reference.

The system GMM-Sys– xtbond2 enables researchers to treat explanatory variables as potentially endogenous (correlated with past or possible current errors); predetermined (correlated with past but not current and future errors); or strictly exogenous (not correlated with error terms in all temporal periods). It also allows us to include options such as the lags option, the collapse option, and more, to facilitate the use of instruments. The diagnostic tests are embedded in the system and are subjected to certain conditions for accepting the result of GMM-Sys regression (Blundell & Bond, 1998; Forte et al., 2013; Piper, 2014). However, Roodman (2009) also offers what he calls a 'common sense' value for judging the outcome of diagnostic tests (Piper, 2014).

Finally, because many states do not issue debt for loan assistance or do not use it each year, over 60 percent of the observations for the dependent variables are zero. Wang et al. (2007) use the random effects Tobit model to treat zero entries as lower limit censored to estimate the impact on the debt ratio. This essay also runs the random effects Tobit model for references.

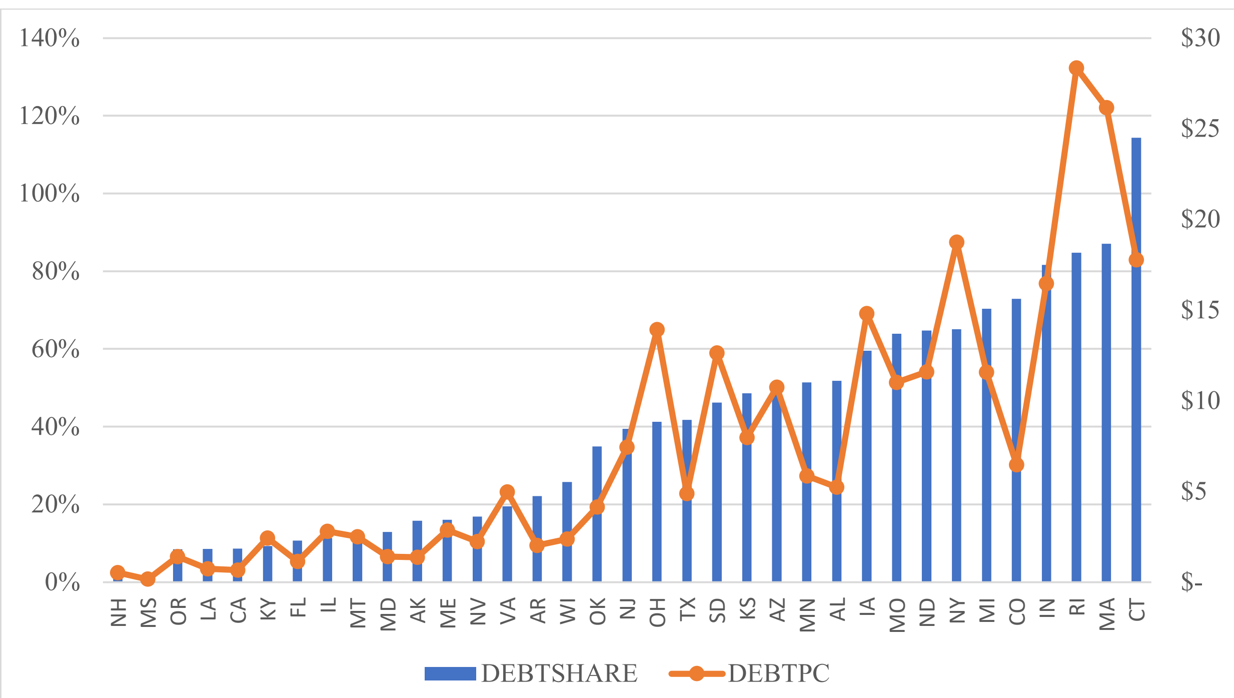
Results and Discussions

Descriptive Analysis

Among 50 states, 14 states report no leveraging throughout the 30 years; the remaining 36 states decide to issue bonds to fund their loan assistance to the communities. Total loan assistance in the states over the 1990 to 2019 period was more than $137 billion (excluding Puerto Rico). On average, for all states, bond issued accumulation (over $50 billion) accounted for 36.7 percent of total loan assistance over the same period, which indicates a significant role of bond financing in CWSRF loan assistance. In terms of individual states, Figure 3.1 below illustrates the average debt share and the average bond proceed per capita of 35 leveraged states (excluding Nebraska) and their diverse variation. On the one side, states depend significantly on bond proceedings to finance their loan activities (50 percent to 114 percent); on average, more than 80 percent of loan assistance from Connecticut, Massachusetts, Rhode Island, and Indiana were sourced from debts. The debt per capita of these states also indicated a relatively high corresponding rate with their debt share ratio; Rhode Island was peak among these ($28). Incidentally, Massachusetts ($11,059), Connecticut ($9,837), Rhode Island ($8,472), and NY ($6,893) also reported the top median general state debt per capita (Murphy, 2019). On the other side, some states showed a minimum reliance on debts to finance loan assistance. New Hampshire, Mississippi, Oregon, Louisiana, and California each had a minor average debt share ratio.

Figure 3.1

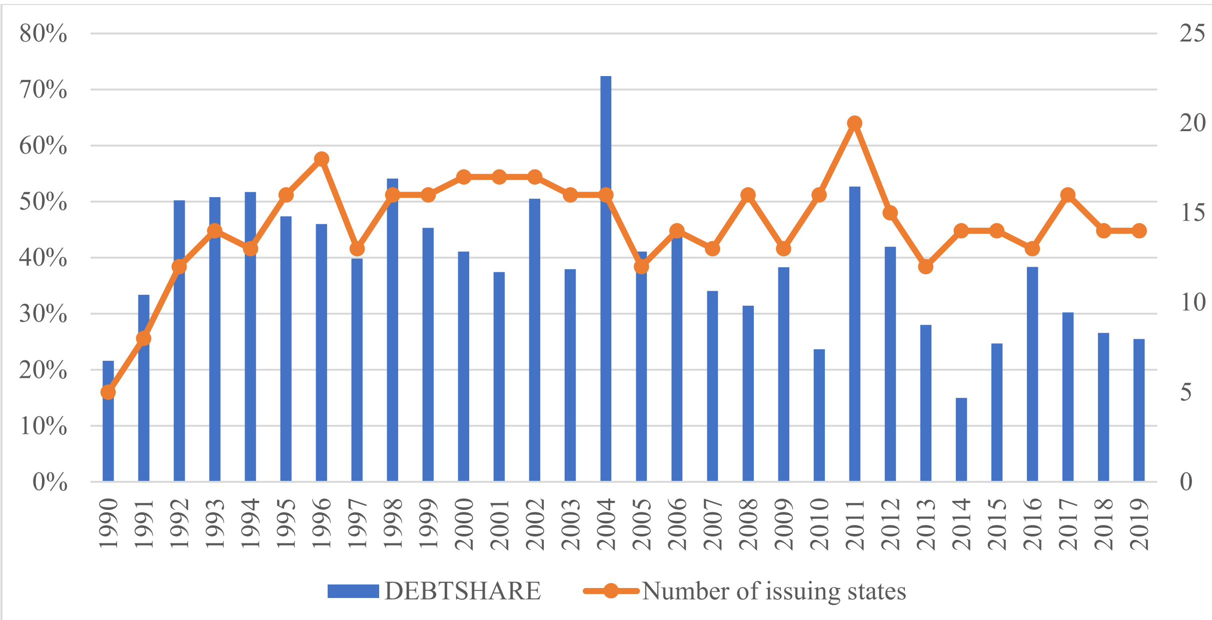
Mean Debt Ratios by Leveraged State



In terms of the period, Figure 3.2 shows the mean annual debt share, and Figure 3.3 presents the mean annual debt per capita for only those states that issued debt, as well as the number of issuing states.

Figure 3.2

Mean Annual Debt Share (DEBTSHARE) for the Issuing States



Both figures reflect a similar unstable debt trend that peaked in 2004 and bottomed in 2014. The mean annual debt share in Figure 3.2 varied between 15 percent and 72 percent of loan assistance during the study period. During the recession years, CWSRF received the largest nominal amounts of federal appropriation ($2.7 billion in 2009). In addition to that, CWSRFs also received $2 billion in supplemental funds under the American Recovery and Reinvestment Act (Copeland, 2015). This may suggest that CWSRF did not suffer insufficient revenue to support loan assistance during the Recession. However, right after the Recession, more states were issuing debt, and the level of debt increased. The average amount of debt issued by the states reached the second-highest level in 2011: 53 percent. In the same year, 2011, the number of issuing states was

20, the highest during the study period. In recent years, the mean annual debt share has decreased considerably (38 percent to 25 percent) in Figure 3.2. In contrast, the mean annual debt per capita has increased slightly ($8.3 to $8.9) in Figure 3.3. This opposite direction trend may suggest that the loan assistance grows faster than that of the population since both ratios have the same numerator (the annual debt issued).

Figure 3.3

Mean Annual Bond Proceeds Per Capita for Issuing States

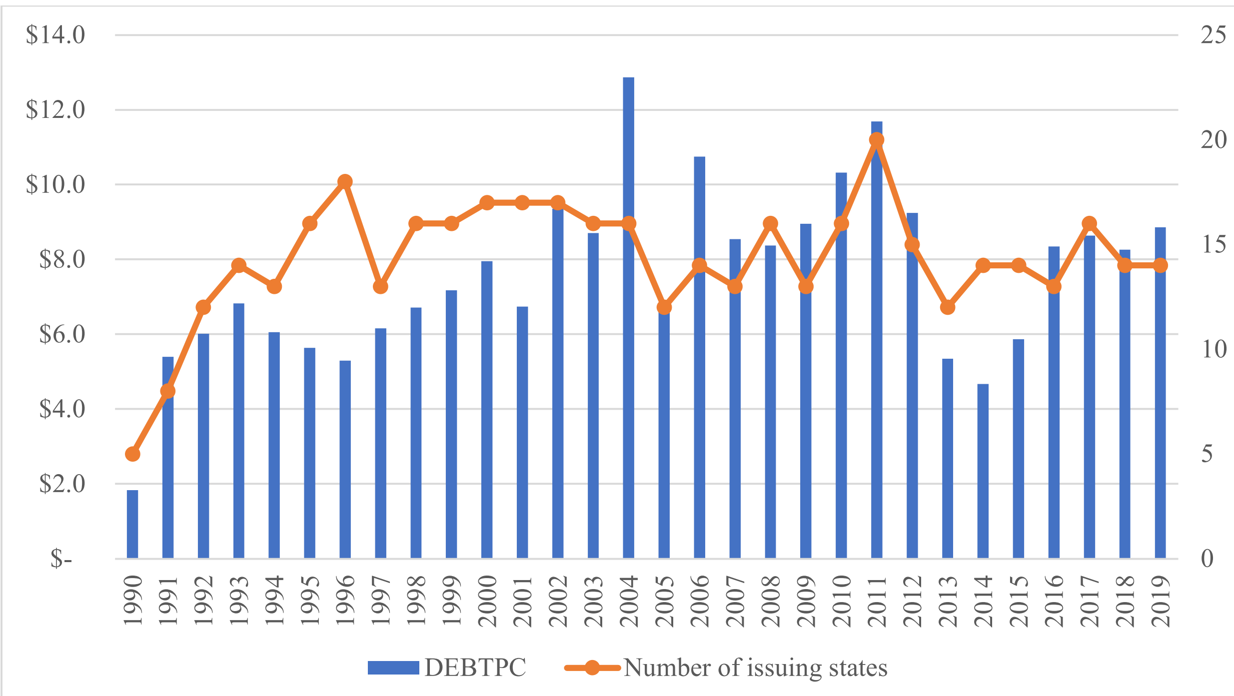


Table 3.3 reports the descriptive statistics of the entire sample for the state panel data between 1990 and 2019, including the mean, standard deviation (SD), minimum value, and maximum value for each variable. For the dummy variables, the mean reports the occurrence percentage of observation with a value of 1, whereas the standard deviation is not applicable.

Table 3.3

Descriptive Statistic

Variable	Mean	Sta. Dev.	Min	Max
DEBTSHARE	0.28	0.57	0.00	3.33
DEBTPC	5	12	0	59
POPDEN	191	254	1	1176
YOUNG	0.25	0.02	0.19	0.32
OLD	0.13	0.02	0.06	0.19
NEEDS (billion)	4.77	6.34	0	39.56
INCOME	41822	8152	24575	74342
ELECT	0.27	n/a	0	1
SDEM	0.47	n/a	0	1
HDEM	0.52	n/a	0	1
DIVIDED	0.49	n/a	0	1
TEL	9	8	0	30
PAB (billion)	1.56	1.54	0	12.05
HODEBT (billion)	0.34	0.78	0	6.44
FEDSHARE	0.65	1.03	0.00	7.02

For the entire sample, the average debt as a percentage of loan assistance was 28 percent, which is noticeably smaller than 39 percent of leveraged states. Its significant standard deviation (57 percent) indicated a considerable scattered range of the ratio. Similarly, the debt per capita was also dispersed, with a mean of 5 and a standard deviation of 12 dollars per capita. In looking at the citizen preference independent variables group, the average population density was 191 persons per square mile, fluctuating from a minimum of 1 to a maximum of 1,176. The average real per capita personal income over the study period was $41,822, ranging from a low of $24,575 to a high of $74,342. About the population's age distribution, the average share of under 18-year-olds in the population was one-fourth, and the number ranged between 19 to 32 percent. The older population represented a smaller share, averaging 13 percent and ranging from 6 percent to 19 percent. The average need for wastewater treatment was $4.77 billion per state year, and this number varied between zero to $39.56 billion.

Four political variables were all dummy variables, with 1 representing the presence of establishment and 0 indicating the absence. Gubernatorial elections take place every four years, except in Vermont and New Hampshire, where the governor is elected every two years. About 27 percent of the observations indicated (1) an election year. On average, 13.3 states per year had an election year, with a minimum of 2 to a maximum of 36 states. Democratic Party control of the Senate (SDEM) and House (HDEM) chambers was at 52 percent and 47 percent, across the sample. The mean number of states having the HDEM by year was 25.3, with a minimum of 16 and a maximum of 37 states each year. The mean number of states by year having SDEM was 23.1, with a minimum of 13 and a maximum of 32 states each year. The percentage of the divided government observation was 49 percent. There was an average of 24.2 states with divided government; the number of states ranged from 11 to 32 per year.

In considering institutional variables, the state TEL index ranged from 0 (for no limits) to 30 (for most stringent limits). The mean TEL index was 9, suggesting that states still have room for making their TEL more restrictive. The Private Activity Bond volume cap (PAB) had an average of $1.56 billion per state year, ranging from zero to $12.05 billion. Historic debt levels measure debt capacity. The average debt outstanding at the beginning of each year was $0.34 billion, far smaller than the average PAB limit. Similar to debt share and debt per capita ratios, outstanding debt observations had a broad range in which 43.2 percent of observations were zero, as the results of 14 states that did not issue debt during the study period. The maximum outstanding debt was about $6.44 billion in New York. Debt capacity can also be influenced by each state's federal share of loan assistance funding. The average federal share varied widely, ranging from less than 30 percent in Massachusetts and Minnesota to over 95 percent among these unleveraged states such as Utah, Vermont, Delaware, and Alaska. The average federal share across the states was 65 percent, ranging from zero percent to 698 percent.

Further looking into different debt issuing levels in Table 3.4, observations are categorized into two groups: no leveraging and yes leveraging, which fell into four sublevels zero, low, medium, and high leveraging, based on the value of the debt-share ratio.

Table 3.4

Medians by Leveraging Levels

	No Leverage	**Yes Leverage**		
Variables	0	Low (<0.5)	Medium (0.5-1)	High (>1)
No. of Obs.	890	276	170	134
DEBTPC	0	2	15	23
POPDEN	101	64	140	88
YOUNG	0.24	0.25	0.25	0.25
OLD	0.13	0.13	0.13	0.13
NEEDS (billion)	2.03	3.70	4.18	2.74
INCOME	39,686	42,325	42,399	41,227
ELECT	0	0	0	0
SDEM	1	0	0	1
HDEM	1	0	1	1
DIVIDED	0	1	1	1
TEL	7	13	10	10
PAB (billion)	1.10	1.40	1.15	1.02
HODEBT (billion)	0	0.10	0.52	0.37
FEDSHARE	0.38	0.31	0.25	0.32

Further looking into different debt issuing levels in Table 3.4, observations are categorized into two groups: no leveraging and yes leveraging, which fall into four sublevels zero, low, medium, and high leveraging, based on the value of the debt-share ratio. There are some noticeable differences between the two groups. The no leveraging group had a lower median percentage of young people, environmental needs, income per capita, TEL index, and outstanding debts than the leveraged group. States issuing debt at all levels had a divided government; the opposite was true for the no leveraging states. Median population density, SDEM, and HDEM showed no apparent pattern among the other variables. The median old population (13 percent) and election (not an election year) remained the same across both leveraged and not leveraged states. Income and PAB variables formed a similar pattern, reaching the highest median at the low leveraging level and the lowest median at the high leveraging level. This suggests that the less wealthy states either did not issue debt or issued debt the most while the wealthiest states issued the least debt, and the medium income group coincidently incurred the medium level of debt. Similarly, states with the lowest median PAB issued the most debt, and states with the highest PAB issued the least debt. As expected, the highest median of federal share (38 percent) belonged to the no leveraging group; the leveraged group had a lower rate, ranging from 25 percent to 32 percent. However, the states that received higher federal funding (32 percent) within the leveraged group also issued high debt.

Empirical Analysis

Table 3.5 reports the regression results of DEBTSHARE and DEBTPC using the two-step system GMM estimator. This essay included lagged dependent variables and regressors with suitable lagged values as instruments in the system GMM model. In the DEBTSHARE model, the lagged dependent variable, real per capita income, environmental needs, population density, and the young and old population rates were assumed to be predetermined; federal share and historic debt variables were considered potentially endogenous. In contrast, other variables and time dummies were treated as strictly exogenous. In the DEBTPC model, the lagged dependent variable was treated as potentially endogenous; federal share, historic debt, and population density were considered predetermined, and other variables and time dummies were assumed to be strictly exogenous.

Table 3.5

Regression Results

	DEBTSHARE		Debt per Capita	
	Two-way FE	GMM-Sys	Two-way FE	GMM-Sys
Leverage(t-1)	**-0.169*** **	**-0.182*** **	**-0.017**	**-0.167** **
	(-4.41)	*(-3.44)*	*(-0.25)*	*(-2.22)*
POPDEN	**-0.0004**	**0.0004**	**-0.033**	**-0.002**
	(-0.91)	*(1)*	*(-1.32)*	*(-0.36)*
YOUNG	**4.015**	**7.144**	**171.3** **	**50.159**
	(1.35)	*(1.08)*	*(2.22)*	*(1.22)*
OLD	**1.837**	**2.579**	**-49.1**	**17.919**
	(1.49)	*(0.7)*	*(-0.95)*	*(0.39)*
INCOME(log)	**1.240*** **	**-0.511**	**19.4*** **	**8.867* **
	(3.3)	*(-0.91)*	*(3.04)*	*(2.01)*
NEEDS(log)	**-0.033*** **	**-0.074** **	**-0.572** **	**-0.284**
	(-3.51)	*(-2.08)*	*(-2.35)*	*(-0.59)*
ELECT	**0.044**	**0.075** **	**0.378**	**-0.129**
	(1.39)	*(2.03)*	*(1.1)*	*(-0.16)*
SDEM	**-0.014**	**-0.050**	**0.352**	**-1.993**
	(-0.71)	*(0.75)*	*(0.79)*	*(-1.24)*
HDEM	**0.001**	**0.081**	**1.276** **	**3.457** **
	(0.03)	*(1.02)*	*(2.41)*	*-2.12*
DIVIDED	**0.005**	**0.036**	**-0.085**	**1.039**
	(0.24)	*(0.75)*	*(-0.22)*	*(1.39)*
TEL	**0.00006**	**-0.002**	**-0.005**	**-0.115**
	(0.01)	*(-0.36)*	*(-0.06)*	*(-1.39)*
HODEBT(log)	**0.017*** **	**0.046*** **	**0.210*** **	**0.496*** **
	(5.57)	*(4.39)*	*(3.77)*	*(2.68)*
FEDSHARE	**0.049** **	**0.057* **	**-0.46**	**-0.051**
	-(2.09)	*(1.99)*	*(-1.87)*	*(-0.3)*
Year dummies		Yes		Yes
R-squared	0.0841		0.0547	
F Statistic	183.5(<.001)	7.32(<.001)	106.31(<.001)	12.42 (<.001)
No. of obs.	1421	1421	1421	1421
Groups/Instruments		49/45		49/43
AR(2)		0.443		0.119
Hansen statistic		0.196		0.202

Note. * p<0.10 ** p<0.05 *** p<0.01

Allowing these regressor instruments to be correlated with the error terms in the future and/or contemporaneously was expected to address the potential endogeneity issues and to reduce any concern related to potentially spurious inferences. The diagnostic tests results reported in Table 3.5 confirm that our identifying assumptions were statistically acceptable. The AR2 test yielded a p-value of 0.443 and 0.119, respectively (>0.05), which means the null hypothesis cannot be rejected. The essay thus accepts the null hypothesis that the error term of the orthogonal deviations equation is not serially correlated at the second order. The Hansen test revealed a respective p-value of 0.196 and 0.202, suggesting that we cannot reject the null hypothesis that our instruments are valid.

The first finding from Table 3.5 is that only a few variables indicate the association with debt ratios. This finding can also be interpreted from the small value of R-squared, which is 0.084 for DEBTSHARE and 0.054 for DEBTPC. Regression results from two-way fixed effect and two-step GMM-Sys estimators are relatively similar, with minor differences. Looking further into the GMM-Sys estimation, the lagged DEBTSHARE and the lagged DEBTPT were the relevant predictors of current debt ratios inferring that CWSRF debt ratios are persistent. The proxy for debt capacity-outstanding debt, stood out as the consistently relevant predictor of the debt ratios. As expected, the sign of the coefficient was positive, which is compatible with the most prior empirical evidence in state debt financing, suggesting that when CWSRFs get used to the higher level of debt, they may continue to maintain such a level, and it will take time to pay back the debts. The historic outstanding debt effect was significantly larger for debt per capita than for debt share.

In the DEBTSHARE model, NEEDS, ELECT, and FEDSHARE were also identified as relevant determinants of debt share. The NEEDS was unexpectedly found to negatively correlate with debt share as a percentage of loan assistance. This suggests that a change in environmental needs leads to a decrease in the share of debt supporting loan assistance per state year. As noted earlier, as a ratio variable, it might be challenging to isolate the effects of environmental needs regressor on the numerator (new debt issued) and denominator (loan assistance); further steps should consider this. The coefficient estimates for our ELECT proxy had a positive sign, as expected, suggesting that the CWSRFs tend to increase their debt issued for loan assistance during an election year. While previous studies found no evidence of a relationship between election and debt, this finding remarks an exciting point for future reference.

The other surprising inference is the positive influence of the federal share of loan assistance on debt share. This result suggests that CWSRFs that receive a larger appropriation from the federal government to finance their loan assistances tend to issue more bonds, which is inconsistent with previous findings on debt financing. Such inconsistency may be due to the unique characteristics of CWSRF's leveraging regulations. States are motivated to issue bonds for required matching (20 percent of federal appropriation), seven states issue bonds for the matching purpose only, and 17 states issue for both matching and additional funding. Accordingly, the increase in federal funding triggers an increase in bond issuance for matching. This finding added a new perspective on the role of the federal grant on debt financing in the SRF setting.

In the DEBTPC model, the findings also support the assumption that higher-income CWSRFs are likely to have more debt per capita because they can afford to repay it. Although the income variable is not significant with debt share, it indicates a negative direction. These findings are relatively similar to those of Ellis & Schansberg (1999), who found income to be negatively related to debt share but positively related to debt per capita. States with a Democrat majority in the lower chamber also tend to maintain more new debt per capita. In some two-way fixed-effects regressions, we found a positive relationship between the younger population and leverage. Still, this result is most likely spurious because it completely disappears in all models estimated using system GMM.

Using two-way fixed effects adjusted with DK standard errors for 15 years of data from 2005 to 2019, this essay added the private activity bond cap back to the model and found that the rate of young population became significantly positive, and the TEL index became negatively significant with DEBTSHARE. The lagged DEBTSHARE remained negatively significant, other variables were no longer significant. Similar estimated results were noted in the debt per capita model for the young population rate and the TEL index. Additionally, population density became negatively significant with debt per capita. These findings suggest that PAB is not a relevant predictor of the CWSRF debt ratio.

Table 3.6 shows the results from the data random-effects Tobit model. The lagged dependent variable was also included in the model. Table 3.6 also presents Tobit coefficients and two marginal effects: (1) the probability of choosing whether or not to issue a bond; (2) the change in the expected value of debt ratio conditional upon the use of debt (debt ratio >0). Like two-way fixed effects, lagged debt per capita yielded an insignificant relationship with the current DEBTPC. The results were relatively similar to the GMM model. Historical outstanding debt and environmental needs remained the determinants of the debt ratio. Income was positively significant with both debt share and debt per capita. However, political factors became no longer significant with debt share and per capita. The federal share of loan assistance was no longer significant with debt share, but it became significant with debt per capita. While the Tobit model can address the issues of mass zero observations, it is a random effect regression, and it could not accommodate the robust option to address other issues.

Table 3.6

Tobit Regression

	DEBTSHARE				DEBTPC			
	Random Effects		Marginal effects		Random Effects		Marginal effects	
Variables	xttobit	z-stat	Probability	Conditional	xttobit	z-stat	Probability	Conditional
Lagged DEBT	-0.28	**-5.29*** **	-0.10	-0.07	-0.06	-1.12	0.00	-0.02
POPDEN	0.00	0.04	0.00	0.00	0.01	1.21	0.00	0.00
YOUNG	0.73	0.15	0.25	0.19	111.19	1.15	1.93	29.06
OLD	-0.76	-0.16	-0.26	-0.20	-28.76	-0.31	-0.50	-7.52
INCOME(log)	1.94	**3.17*** **	0.66	0.50	30.52	**2.55** **	0.53	7.97
NEEDS(log)	-0.05	**-1.94* **	-0.02	-0.01	-1.13	**-2.11** **	-0.02	-0.30
ELECT	0.10	1.2	0.04	0.03	1.14	0.68	0.02	0.30
SDEM	0.02	0.17	0.01	0.00	0.31	0.17	0.01	0.08
HDEM	-0.02	-0.16	-0.01	0.00	1.36	0.74	0.02	0.36
DIVIDED	0.03	0.49	0.01	0.01	0.00	0	0.00	0.00
TEL	0.01	1.06	0.00	0.00	0.02	0.1	0.00	0.00
HODEBT(log)	0.07	**9.37*** **	0.03	0.02	1.20	**7.65*** **	0.02	0.31
FEDSHARE	0.05	1.43	0.02	0.01	-2.30	**-3.19*** **	-0.04	-0.60
Wald chi2			155.82			119.75		
Prob > chi2			0.000			0.000		
Likelihood test of sigma_u=0			98.76			115.92		
No. of Obs.			1421			1421		
Left-censored			851			849		

Note. * p<0.10 ** p<0.05 *** p<0.01

Contribution and Conclusion

The purpose of this essay is to explore what factors are relevant for CWSRF's decision to issue debt to support loan assistance for wastewater infrastructure. Applying median voter model assumptions and incorporating other variables suggested by empirical evidence from previous research on government finance decisions, a model of external predictors of debt share and debt per capita for CWSRF in the states was constructed that includes median voter preference variables, state political variables, and institutional limits/capacity variables. The results of the GMM-Sys estimator indicate that a few relevant determinants can be identified. The previous debt ratio was consistently negatively related to the current one, which supports the assumption of the GMM-Sys model for the persistent dependent variable.

The results showed limited support for the assumption of median voter's theory since most preference factors did not show association with the CWSRF debt ratio. Only income and environmental needs were significant with debt per capita and debt share, respectively. State politics also indicated a limited association with leveraging; debt share tends to increase during the election year, and debt per capita also tends to increase when the Democrat majority controls the lower chamber. Other institutional factors, particularly debt capacity, appeared to be the most relevant predictor of CWSRF's leveraging. The more significant the historic debt level, the higher the debt ratio, especially the debt per capita. The change in federal contribution may trigger an increase in debt issuing for state matching purposes. Despite the limited association identified, this study has established initial empirical evidence for leveraging this CWSRF – innovative financing mechanism. In addition, the findings also draw attention to the distinctive feature of CWSRF. A change in the federal contribution was found to be significant with an increase in CWSRF's debt issuance for state-match (a positive relationship), which is inconsistent with previous studies (a negative relationship) of general state finance. More study focusing on specific factors of CWSRF or further study on similar revolving fund settings like Drinking Water or State Infrastructure Bank (SIB) would help build up this niche area.

Compared with highway infrastructure financing or with public state financing, CWSRFs or wastewater infrastructure appear to receive less attention from state politics and are not as much associated with other social-economic factors. Many reasons can explain such differences.

Most of the bonds issued by CWSRF are revenue bonds backed by CWSRF's own resources and not subjected to voter's approval and statutory debt limits as the general obligation (GO) bonds issued by the state government, suggesting that state politics and legal constraints will have less influence on CWSRF's leveraging. However, such underlying differences also raise another concern about the limited state financial contribution toward CWSRF. Most of the states only contribute 20 percent state match to the CWSRF program. About 70 percent of such amount is cash appropriation and GO bonds secured by taxes and 30 is percent backed by the CWSRF's revenue[3]. This means that the real contribution is only 70 percent of the 20 percent match. Such smaller financial contributions certainly make CWSRF’s role in the state appropriating process less influential than other programs. States are thus recommended to contribute to state-match entirely using the state's own revenue resources, not CWSRF resources. Additional contributions above the state match are also recommended. If that is the case, these further allocations will surely help increase the CWSRF's program visibility and role in budgeting and financing infrastructure processes.

In addition, the incoming cash flow from the recently passed infrastructure bill to CWSRFs will likely increase the federal contribution and thus the 20 percent state match to a more significant level. The bond issued for state match practice would lead to considerable loss to the program when the debt is paid off. Finally, in terms of policy implication, CWSRF is the effort of Congress to reduce the national government role and shift more control and discretion to states in their water quality funding (Morris, 2022). The loose connection between the state (state politics, state budgeting, and other factors) and CWSRF raises concern over how much the

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[3] Calculated from NIMS

states have actively approached and taken over such "transfer" of power. Notably, states appear to use other financial sources rather than their own revenue (cash or appropriation) as state match or additional contribution to the CWSRF program casting doubt on the state's ownership and stewardship of the CWSRF program.

Limitations

CWSRF has its unique characteristics: leveraging to offer loans to local governments and participants of the program, not directly using their borrowing for infrastructure investment. These differences somehow alter both their motivation for leveraging and the way in which they manage leveraging, compared to the debt management of the other state agencies. New variables that are more relevant to CWSRF should be tested. A future qualitative study that interviews CWSRF administrators on their perceptions of leveraging would reveal more specific features underlying CWSRF’s leveraging decisions.

CHAPTER 4

AN EXPLORATORY STUDY OF CWSRF'S DEBT AFFORDABILITY AND ITS MEASUREMENT

Introduction

Debt financing for infrastructure investment is widely accepted, and it has become popular among states; it expands the resources available to finance new infrastructure. However, debt is not a source of revenue; instead, it is a financial obligation that commits future taxes in order to secure financial resources in the present. The amount that a government can borrow is restricted by its ability to repay. That, in turn, depends on the property and income wealth of the citizens in that jurisdiction (Greer, 2013). States should consider their capital investment needs versus their ability to meet debt service requirements, given other priorities and obligations (Weiner, 2013). So how much debt can the state afford? What is an "acceptable and sustainable" level of debt? What is the appropriate balance between pay-as-you-go financing and debt financing? The answers to these questions remain in debate. In the literature, there is little consensus on measuring affordability (Denison, Hackbart, & Moody, 2006). There is no clear standard for making judgments about the specific amount of affordable debt for a jurisdiction (Greer, 2013).

While the literature on state debt affordability mainly addresses tax-supported bonds, there has been minimal research on non-tax-supported bonds as most Clean Water State Revolving Fund (WSRF leveraged bonds. This essay fills that gap by scrutinizing the state CWSRF's debt repayment capacity or affordability. The paper will explore the following questions: what is the current CWSRF debt affordability profile (debt service ratio); how is

CWSRF's debt service ratio, compared to general fund's debt service ratio; which factors influence CWSRF's repayment capacity; and what is the predicted amount of debt affordability?

The essay includes a literature review on state debt affordability, a proposed model of debt affordability prediction for CWSRF, expected results, and a conclusion. The essay first analyzes debt affordability using the debt service ratio (annual debt service as a percentage of total revenue) among leveraging states. The paper then examines the relationship between revenue proxy factors (federal capitalization, match revenue, other state grants, operating income) and other factors (per capita income and population) with annual debt service ratio, respectively, and interprets them. After formulating the best-fitted regression model, the predicted values of each independent variable are then used to forecast the future debt level, and then affordability or capacity is assessed.

Literature Review

This section first provides a review of the classification of state debt and discusses how debt affordability is defined. It continues with an introduction of the measurement of debt affordability, including the different models and methodologies employed by states and empirical evidence, with a focus on a regression model that is relevant for this essay. Following that is a review of debt affordability metrics and the factors that potentially influence such metrics. While the literature offers evidence on debt capacity measurement for the state level, there has been minimal documentation, particularly for infrastructure funds and CWSRF, as briefly discussed at the end of the review.

Definition of State Debt Repayment Capacity or Affordability

Many different types of obligations may be described as state debt. In a broad approach, state debt can be bonded debt, unfunded pension liabilities, unfunded other post-employment benefits (OPEB) liabilities, budget deficits, or unemployment insurance loans. For this essay, state obligation refers to bonded debt (GO bonds and revenue bonds). Government bonds can be classified using different criteria – for instance, by revenues (general taxes, dedicated taxes, and user fees), by purpose (public purpose, private purpose), by security (GO, revenue, and hybrid), and by many other methods (Weiner, 2013). In a narrow sense, the definition of state debt focuses on general obligation (GO) debt or tax-supported debt, which is typically backed by the issuer's full faith, credit, and taxing power. For measuring affordability, state policymakers and rating agencies tend to focus on tax-supported debt, which can be sub-divided into the net or gross tax-supported debt. In contrast, gross is broader in scope and includes certain types of self-supporting debt (GO bonds with dedicated revenue and revenue bonds of state enterprises).

Denison et al. (2006) classified state debt using the source of funding for debt service, which splits it into the general fund and the special revenue fund (an earmarked or dedicated fund). Under the general fund sources, both traditional GO bonds and revenue bonds (referred to as "lease-backed bonds") are included. Under the special revenue fund, there are also both types of bonds. GO bonds, or "double-barreled" bonds, are issued by a state agency with the sovereign authority to tax and, therefore, can issue GO bonds independent of the state. Revenue bonds, such as bonds issued for transportation projects, are backed by earmarked Road Fund revenue. Most of CWSRF's issued bonds are supported by its SRF (interest-earning, loan principal, and others), while some of each state match bond is backed by the state general fund (EPA, 2018). Montana, for example, has issued GO bonds to meet its CWSRF match; the GO bonds are repaid with interest earnings on SRF loans and are further secured by the full faith and credit of the state (EPA, 2018). While GO bonds are subject to limits on total debt outstanding and often require voter approval prior to issuance, revenue bonds are neither subject to these voter approval requirements nor to debt limits/caps (Tax Policy Center, 2021). In addition, revenue bonds often offer a higher coupon rate than GO bonds; this means that the investors are willing to take some risks in exchange for a higher return (Hyun, Nishizawa & Yoshino, 2008).

In the literature, debt capacity and debt affordability both measure the ability to borrow, and they are similarly defined and often used interchangeably. However, the two concepts have a slightly different emphasis at times. Debt capacity focuses more on the total amount of outstanding debt relative to the total economic base or to relative current revenue, whereas debt affordability emphasizes the burden associated with repaying the debt (Kriz & Wang, 2012). Denison et al. (2006) contend that the term “debt capacity” has to do with a state’s ability to sustain debt in the long run or, similarly, the level of debt that can be supported without imposing undue budgetary constraints on other desired state programs and expenditures (Ramsey & Hackbart, 1996).

Alternatively seen, debt capacity is “the amount of financing that can be issued by the state within legal constraints without overextending the state’s ability to pay its obligation” (Hildreth, 2005, p. 17). The concept of debt affordability refers to a state’s ability to repay all of its obligations without negatively impacting the provision of ongoing public services or raising taxes to anticompetitive levels (Hildreth, 2005). Accordingly, in order to answer the debt affordability question, the established models should primarily consider the uncertain future of revenue and expenditure and other relevant factors related to the nature of revenue resources; political and legal factors should not be of primary concern (Bartle, Kriz, & Wang, 2008).

Furthermore, Denison et al. (2006) suggested that there is no one-size-fits-all capacity. Instead, it may be more appropriate to employ multiple debt capacities due to the varying volatility of the different types of municipal bonds. Finally, state governments consider debt affordability a key concept because of its potential implications for state borrowing costs and impacts on the government's long-term fiscal sustainability. The borrowing cost and the debt service may also rise as debt burdens rise. As the debt service requirement accounts for a significant portion, the available funding for services will likely be squeezed accordingly (Weiner, 2013).

Measurement of State Debt Affordability

Bartle, Kriz, and Wang (2008) and Kriz and Wang (2012) provided a comprehensive review of current debt affordability models accompanied by a brief description of each method, examples, states that have adopted the method, and a short discussion of the strengths and weaknesses for each method. Traditionally, debt affordability has been estimated by one or more of the following three methods: debt ceiling, benchmarking, and the regression approach. The debt ceiling, or self-comparison approach, compares a jurisdiction's debt level to a single value or multiple values of the measure itself. There are three sub-methodologies for the debt ceiling: the simple, the bond-rating-oriented, and the complex approaches. The debt ceiling is a straightforward and easy-to-implement method. However, it is known to be intuition-based and arbitrary, since it often ignores many important determinants while setting the ceiling. It is also known to be static because it does not change when the economic environment changes (Kriz & Wang, 2012).

A benchmarking approach that is highly recommended by the Government Finance Officers Association (GFOA) is used to compare a jurisdiction's own debt level to that of others.

A "bench" can be the national median or the median of a peer group. Selected debt capacity, such as debt service, is then calculated and compared to the bench. Many states have been using the debt ceiling (Connecticut, South Carolina, Tennessee, Maryland, Wisconsin, Oregon) and benchmarking (Virginia, California, New York). About 22 states use the debt-service-to-revenue ratio to measure their debt affordability. These states set a ceiling for the debt-service-to-revenue ratios; for instance, Massachusetts, Maryland, and Alaska recommend 8 percent, while it is 18.5 percent in Hawaii by the constitution and 15 percent in Delaware by statute. Weiner (2013) offered cross-comparative measures of state government debt burdens in New England by using different affordability ratios. The author presented a comparison of the debt service-to-revenues ratio and concluded that Connecticut and Massachusetts have among the highest debt burdens, 12.7 and 11.3 respectively, for net tax-supported debt (p. 22). The benchmark approach is thought to be comparable; however, it is inaccurate and static because of its inherent issues that no two jurisdictions are perfectly comparable; many factors have been left out, including the broadness of the tax base, the efficiency of management, and future economic growth (Kriz & Wang, 2012).

The regression approach is the only empirical method; it comprises two components: multivariate and time series (Bartle et al., 2008). The specific steps in this approach include selecting the appropriate estimating equation to explain debt capacity; testing the model's fitness by using historical data to estimate coefficients; using the time series technique to predict the future value of independent variables, and then substituting the predicted future values of the independent variables into the previous equation and calculating the future debt affordability (Kriz & Wang, 2012, p. 13), with the assumption that the interest rate, the credit rating, and so on are unchanged (Bartle et al., 2008). Compared to other approaches, regression is a science-based and data-supported technique. However, this regression method also has weaknesses. It relies on assumptions and the fact that some variables are nonquantifiable and some high correlation problems exist; these issues can lead to multicollinearity issues (Bartle et al., 2008).

Other new models have been introduced: the curve model (Brecher, Richwerger, & Wagner, 2003), the stochastic simulation model (Kriz, 2010), and the simultaneous equation model (Wang, 2009). Each model also has pros and cons; for instance, the curve model is not a causal statistic model. It is complex to explain the result of the stochastic simulation model; the simultaneous model is only supported by specialized statistical software (Kriz & Wang, 2012). It has been suggested that a debt analyst can easily use more than one method or can combine two or more of the three methods; this can help produce more accurate estimates of debt capacity. For example, the result predicted by the linear regression model can also be compared with benchmarks (Kriz & Wang, 2012).

To gauge affordability, states and credit rating agencies typically rely on ratios that compare a state's debt with the resources available for its repayment. These frequently used debt affordability ratios include debt service to revenue; debt per capita; debt relative to current revenues; debt-to-value of taxable property; debt-to-personal income; debt service-to-expenditures, and others (Brecher et al., 2003; Robbins & Dungan, 2001; Simonsen, Robbins, & Brown, 2003; Weiner, 2013). Simonsen et al. (2003) provided definitions of each ratio; for example, debt service consists of principal and interest payments that the state government makes every year. Weiner (2013) categorized these ratios into groups that comprise the states that employ the metric. Among these, the debt service-to-revenues metric is the one most frequently used by state governments (22 states); it is, arguably, the best indicator of the near-term affordability of state debt since this metric reflects current costs and policies. Weiner (2013) also suggested that no single ratio stands out as the best gauge of debt affordability and notes that states should consider using multiple metrics: for instance, debt service-to-revenue for the near term and debt-to-personal income for a longer-term perspective.

Empirical Evidence

Applying a regression approach**,** Ramsey, Gritz, and Hackbart (1988) further developed a state debt predicting model that is based on an existing one, using four quantifiable and important independent variables: revenue, per capita income, population, and the assessed value of the real property with surveyed data from 1977-1986. The basic estimating equation used to calculate the debt capacity for Kentucky is:

$$Y=a+ b_1X_1+ b_2X_2+ b_3X_3+ b_4X_4 \quad (1)$$

Where:
Y= Annual debt service on tax-supported debt
X1= Assessed value of real property (taxable capacity)
X2= State Revenues (Revenue raising capacity)
X3= Per Capita income
X4= Population

The authors tested whether there is a statistically significant relationship between the set of independent variables and the annual debt service, and then predicted the future value of each independent variable using an autoregressive estimating procedure. Then, they substituted these estimated values into the equation to produce a forecast of future debt service levels. The future debt levels can be estimated based on the debt service level given the existing level of interest. The regression results indicated a fit model with R^2=0.98, even though X3 was not statistically significant. The authors acknowledged that multicollinearity may exist among independent variables but argued for not respecifying the model since these variables were previously identified as both appropriate and important variables for state policy and budget decision-makers in identifying the level of debt capacity that can be afforded (Ramsey et al., 1988, p. 233). In addition, they also argued that the interrelation among independent variables that existed in the past may continue to hold in the future; since the purpose of the model is to predict the future value, the multicollinearity that exists does not harm the predictive ability of the model. The empirical results indicated that multicollinearity did exist, as noted by the negative signs for X2 and X3; X3 was not statistically significant. In addition, it is recognized that many variables that impact debt capacity are difficult to quantify and to model, such as state debt management practices, capital budgeting procedures, and divisions of state and local responsibilities.

Other empirical studies offer a variety of factors that impact debt affordability. Besides the assessed value of the taxable property, Bahl and Duncombe (1993) also included federal grants to state government, personal income, and tax capacity into the measurement of a state's ability to cover its debt service obligations. Furthermore, interest rate and borrowing cost are also essential factors in determining the overall fiscal burden. The state government borrows millions of dollars, and any variation in interest rates substantially impacts interest payment (Levine, 2011). Thus, high-interest rates discourage bond sales. Empirical evidence suggests that the interest rate has a statically significant adverse effect on the level of debt (Clinger, Feiock, McCabe, & Park, 2008; Clingermayer & Wood, 1995).

Rating agencies such as Fitch, Moody's, and Standard & Poor's usually examine four factors: economic condition, financial condition, debt position, and administrative factors, in order to determine the bond rating. States and local governments often imitate these models to estimate their debt capacity. States and local governments employ modifications to serve their own governmental perspective, which is different from that of the rating agencies (Kriz & Wang, 2012). Accordingly, the literature on state debt affordability focuses on identifying income and wealth variables that are reasonable proxy measures. For instance, among the rating criteria for Fitch's water and sewer revenue bonds for 2018, coverage and financial performance criteria include various quantitative ratios, such as pledged revenues, growth in operating revenues and expenditures, reserve funding, weather-related demand, and economic cycles (Fitch Ratings, 2017).

Concerning a Specific Infrastructure Fund

Denison et al. (2006) conducted a review of road fund (special revenue fund) debt policy and provided a comparison of the debt service ratio between a statewide general fund and a specific road fund. From 1990 to 2000, the average debt service expenditures relative to total General Fund revenues tended to remain at 3-4 percent, with the lowest calculated mean ratio value occurring in 1992 with a debt service ratio of 2.8 percent. The highest mean debt service ratio was observed in 1997 at 3.6 percent. The ratios of Road Fund debt service to total Road Fund revenues for the period exceeded the observed average of the General Fund (around 10 percent). The debt service ratio of the Road Fund is higher because Road Fund revenues are principally used for infrastructure financing, while the General Fund principally funds operating budgets. The Road Fund can also support more debt due to its relatively stable revenues (earmarked resources and the inelasticity of Road Fund revenue sources). Also, mean debt service to Road Fund revenue ratios varies greatly among states (with the highest states in the 16.7-21.6 percent range and the lowest states in the 1.6–3.2 percent range). Such stratification likely reflects a credit risk as well as different states’ preferences to use debt financing (p.34).

In their regression model, Denison et al. (2006) included the Road Fund debt limit as explanatory variables and toll revenue, federal highway trust fund transfer, road-related tax revenue, personal income, population density, and others as control variables. The result implies that states with a Road Fund debt limit tend to have a higher debt service as a portion of revenue, by 6.8 percent, as compared with states without a Road Fund debt limit. The states with Road Fund debt limits have about $17 more debt service per capita when compared to states without the debt limits. The debt service-to-Road Fund revenue ratio and the debt service-to-Road Fund per population are also statistically significant, along with state personal income, population density, and road-related tax revenue.

For wastewater capital projects, (Bartle et al., 2008) reviewed the literature and states' practices in assessing the affordability of large capital projects through the case of the Combined Sewer Systems in Nebraska, which were financed by revenue bonds. The authors developed a financial simulation model that captures the likelihood of the city of Omaha's overburdening by projecting residential indicators (expenditures as a percentage of income), which is a commonly accepted metric for wastewater treatment programs in the EPA analysis. However, this is just exploratory research, and the conclusion should be viewed as leading to hypotheses that can be tested later, using systematic methods. Particularly for CWSRF, Holcombe (1992) also developed leveraged and inflation models to predict the future balance of the revolving fund.

The SRF fund management handbook also recommends models and tools for calculating leveraging. These include cash flow modeling, the SRF financial planning model (spreadsheet or software), trend analysis, and analysis of financial metrics. The cash flow model has been developed by underwriters, financial advisors, and the EPA. It identifies all cash flows associated with CWSRF and analyzes whether program demand and cash flow needs exceed the current available fundings; if so, leveraging is necessary. Cash flow modeling can run scenarios to consider how the state capacity would change without federal capitalization, or an increased interest rate, or increased leveraging. Other financial indicators such as operating net and net interest margin, trend indicators such as executed loans as a percent of funds available, and debt indicators such as debt service coverage ratio and debt-to-net position can be used in combination with cash flow modeling. All indicators together help to inform whether a state is leveraging appropriately (EPA, 2018, p. 46). States usually utilize consultants to evaluate their leveraging decisions. For instance, Alabama, which began to leverage its CWSRF program in 1990, asked the EPA, with the help of a consultant, to evaluate whether it should continue to leverage, using the SRF financial planning model. As a result, Alabama decision-makers were recommended to discontinue leveraging in 2006 (EPA, 2018).

Model Specification

The terms "debt capacity" and "debt affordability," in the context of CWSRF, are also used interchangeably, and they refer to the state's ability to afford a greater level of leveraging without negatively impacting the funding available for loan assistance (since a debt service payment will curtail funding available for loan assistance), the SRF's sustainability, the state's water credit ratings, and any borrowing costs. Following the literature on the debt affordability of tax-supported bonds, this study aims to expand this to apply it to the bonds of CWSRF. Replicating the regression methodology employed by Ramsey et al. (1988), this essay proposes a model to estimate debt affordability for CWSRF as follows:

$$Y=a+ b_1X_1+ b_2X_2+ b_3X_3+ b_4X_4 \quad (1)$$

Where:

Y= Annual debt service payment
X1= Operating revenue (CWSRF revenues)
X2= Federal and State capitalization (non-operating revenue)
X3= Per capita income
X4= Population density

Annual debt service payment is the total of principal repayment and interest bond repayment. CWSRF revenue includes operating revenue (interest on investment and interest on loans and others) and non-operating revenue (federal and state contributions) (EPA, 2016). In this model, instead of using the assessed value of the real property as the measure of taxable capacity, the federal and state contribution is used as a measure of the tax-related component, and the operating revenue serves as the proxy for CWSRF revenue rising capacity. Per capita personal income is also used as a proxy for the availability of tax (Denison et al., 2006) and state wealth in the previous literature.

In addition to this replicated model, a similar process is performed to estimate the annual debt service levels using another set of internal CWSRF financial-based factors for comparison. As noted, most CWSRF bonds are revenue bonds that are backed not by taxes but by CWSRF itself. These bonds also do not require voter approval, and the revenues that CWSRF generates should be sufficient to pay off the debt service. Thus, per capita income and population density may not be relevant to CWSRF's debt service as much as to the general fund debt service. In the adjusted model, X1 and X2 remain the same operating revenues and federal and state capitalization. Income and population density variables are being replaced by the loan principal repayment and weighted average interest rate on loans (WAIRL). Since CWSRF's main activity is offering loans to local governments and communities, principal repayment seems to be the largest component of CWSRF's assets. The fast and efficient circulation of loan repayment would result in massive inflows of cash and more income, which would support debt service repayment. Similarly, the higher loan interest charged would also bring in more interest income for CWSRF. These two are treated as internal revenue-raising proxies for annual debt service.

Research Method and Data

Using financial historical data from NIMS (Y, X1, and X2) and data from the Census and Economic Analysis Bureaus (X4 and X5), this essay investigates whether the annual debt service has a significant relationship with the four factors listed in Equation 1. Later, it uses the Auto Regressive Integrated Moving Average (ARIMA) model in Stata for time series analysis to project the future value of each independent variable, which is then substituted into Equation (1) to forecast debt service levels. The model can then be tested for any state that uses leveraging in CWSRFs. Among the CWSRFs found to be the most aggressive in leveraging are Connecticut, Colorado, Massachusetts, New York, Michigan, and Indiana; this essay uses New York data from 1990 to 2019 and attempts to estimate the future annual debt service levels for 2020-2030.

ARIMA, the Autoregressive Integrated Moving Average, is used to predict the future value for time series independent variables of equation (1). Box and Jenkins (1976) introduced the three-step method to select the appropriate ARIMA models. The ARIMA (p, d, q), in which p is the autoregressive lags, d is the order of the integrated series or the number of nonseasonal difference needed for stationarity, and q is moving average lags. The three steps consist of identification, estimation, and diagnostic testing (Box & Jenkins, 1976). In the first stage, several tests, such as graphs, correlograms, and formal tests (the Dickey-Fuller and Phillips-Perron tests) are conducted to decide whether the variable is stationary (if the mean and covariance of the series do not depend on time) and, thus, to decide the appropriate d. Then, correlograms are employed to determine p and q. The partial autocorrelation function (PACF) test is employed to determine the p, the autoregressive lags. The autocorrelation function (ACF) test is used to determine the q the moving average lags. The outcome of these tests may indicate several possible candidate models. However, it is recommended to rely on the "parsimony"; this explains the trade-offs between adding more variables, which leads to an increase in model fit (R-squared) at the cost of decreasing the degrees of freedom to decide the most appropriate model. In other words, it is recommended that the model with smallest number of parameters to be estimated should be the one chosen (Deka & Resatoglu, 2019).

The second stage, estimation, decides which model is better, among all of the possible models, by considering the significance of ARMA components, the Akaike (AIC) and Bayesian (BIC) criterions, the maximum likelihood, and the estimate of error variance (sigma value) (Mohamed, 2020). The choice is given to the model with the higher significance of constant, AR and MA, the smaller sigma value, the greater log likelihood value and the smaller AIC and BIC. The third stage involves checking whether the selected model satisfying the requirement for a stable univariate process. The tests include the Portmanteau test with a null hypothesis that the estimated residual of the model is white noise, as well as other tests to confirm whether the estimated ARMA process is stationary (the AR roots lie inside the unit circle and the correlogram is flat) and whether the estimated ARMA process is invertible (the MA roots lie inside the unit circle and the correlogram is flat) (Box & Jenkins, 1976). If the conditions are met, the final stage is to forecast the model. If that is not the case, the selection and estimation will be repeated, in order to find another potential model (Box & Jenkins, 1976).

Results and Discussions

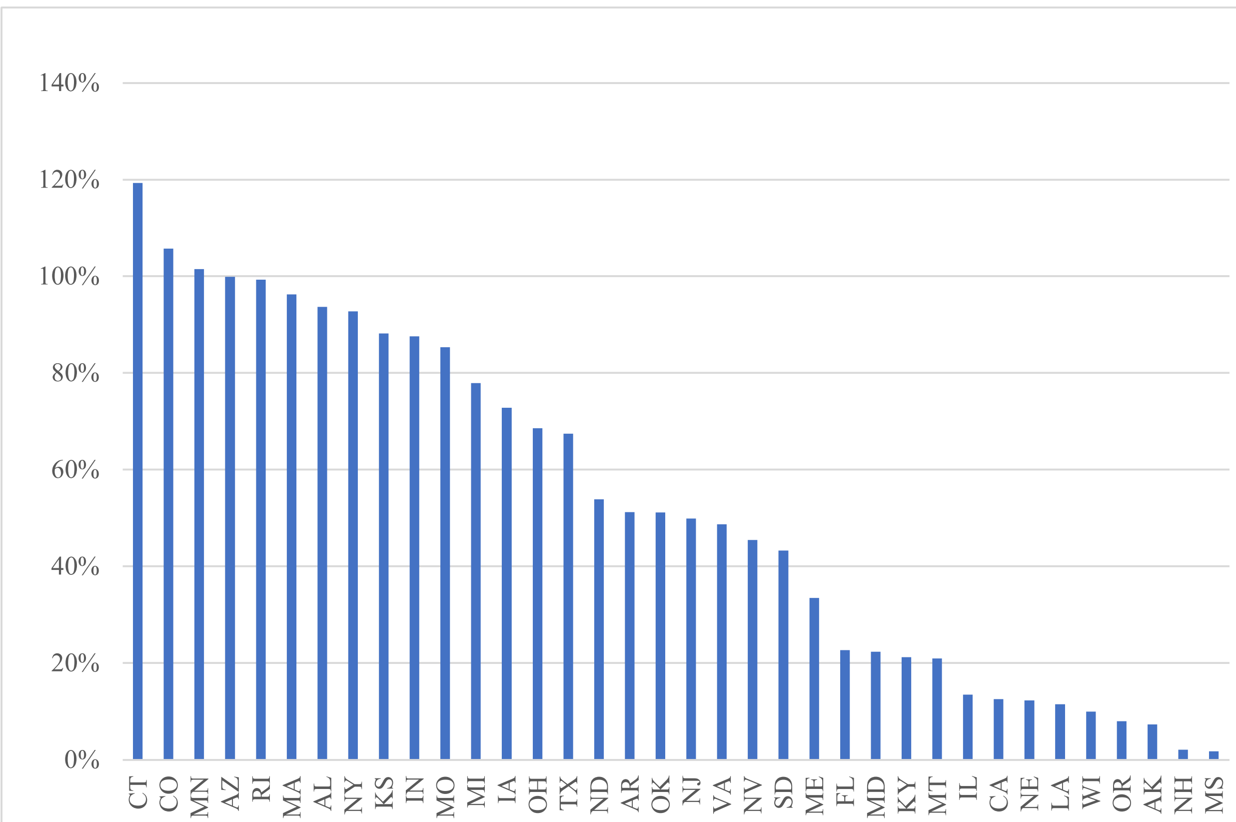
Descriptive Analysis

For descriptive purposes, this essay calculated the debt service ratio of leveraged CWSRFs and compared it with previously documented ratios of state General Funds, as well as Road Funds, as reported by Denison et al. (2006). For CWSRF, the debt service includes leveraged bond principal repayment (NIMS 211), match bond principal repayment (NIMS 224), and bond interest paid (NIMS 228). The revenues include non-operating revenue: the federal contribution (NIMS 74), the annual state match (contribution) (NIMS 76), and the operating revenues: loan interest (NIMS 235) and interest earning on investment (NIMS 241). On average, for all leveraged states during the study period, the mean debt service ratio was 52.7 percent, which is much higher than the ceiling range (around a ten percent rule) for general state finance. For instance, the actual debt service-to-revenue ratio of the state General Fund ranged within 3-4 percent during 1990-2000, and that of Road Fund was around 10 percent. As pointed out by Denison et al. (2006), the debt service ratio of the Road Fund is higher because Road Fund revenues are used for infrastructure financing, whereas the General Fund revenues are for operating purposes. In addition, Road Funds have stable revenue from earmarked resources, as well as toll and fee revenues, which explains why Road Funds can have more debt than a General Fund. In a similar approach, there are reasons explaining why CWSRFs have higher debt, as compared to others. CWSRFs also have large non-operating revenues from federal and state governments, in addition to stable operating revenues. CWSRF can set aside a reserve from federal capitalization as collateral for borrowing; this facilitates the bond issuing process and helps CWSRF borrow faster and easier. In addition, CWSRFs are allowed to borrow for state-match, which is not the case in Road Fund. As a result, CWSRF has much higher leveraging, as well as the debt service-to-revenue ratio, than the Road Fund.

Figure 4.1 presents the average debt service-to-revenue ratio by state. Consistent with previous essays, states with a higher leveraged profile also had a higher debt service ratio (Connecticut, Colorado, Minnesota, Arizona, and Rhode Island), with an average ratio of more than 100 percent.

Figure 4.1

Mean Debt Service to Revenues

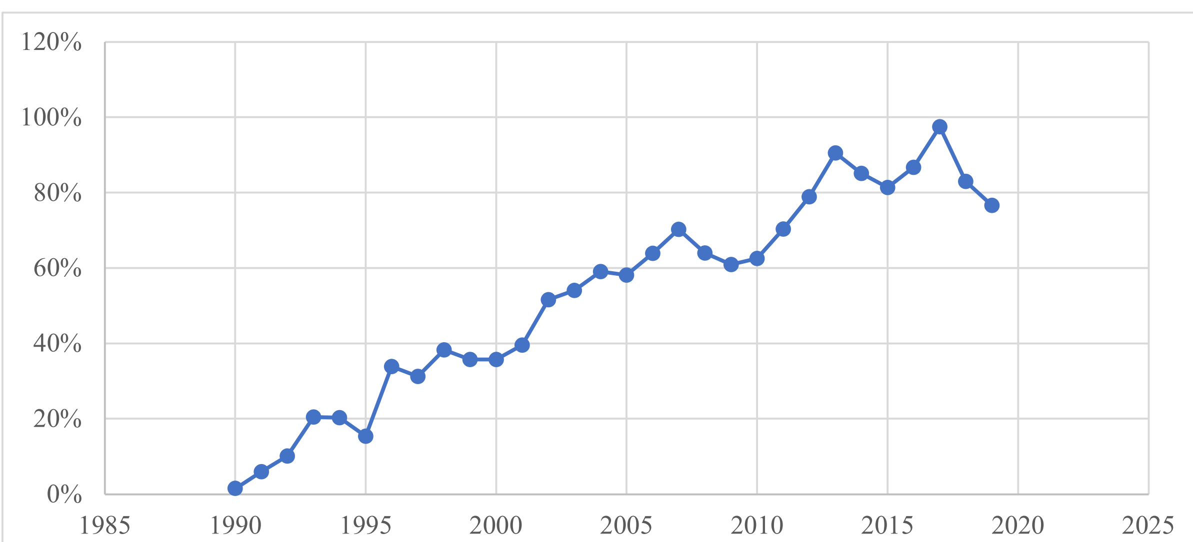


These extremely high ratios signal an alarm that all of the revenues of these aggressively leveraged CWSRFs are just enough to pay back the debt service. Paying for such a tremendous debt service curtails many financial resources dedicated to repaying bond interests, making it challenging for CWSRF to meet other loan assistance priorities or extend its activities. This also calls to mind the concern over the sustainability of the CWSRF, especially when the federal government discontinues the annual contribution. Also, the mean debt service-to-CWSRF revenue ratios vary significantly among states, as expected (with the highest states in the 100-119 percent range and the lowest states in the 2–10 percent range), likely due to the states' diversity of debt treatment and their preferences to use debt financing.

The mean annual debt service ratio shown in Figure 4.2 presents a zigzag uptrend starting from 2 percent in 1990 and reaching a peak of 98 percent in 2017. It declined to 83 percent in 2018 and to 77 percent in 2019. This recent decreasing tendency seems to consistently correspond to the decreasing trend of total debt ratio noted in Chapter Two; however, it shows some delay in time.

Figure 4.2

Mean Annual Debt Service to Revenues



Empirical Results

Table 4.1

Regression Results of Annual Debt Service Model

Replicated Model			Adjusted Model		
Model		8.4236e+17			8.3944e+17
Residual		1.1071e+16			1.3993e+16
Number of Obs.		30			30
F(4, 25)		475.54			374.93
Prob > F		0.0000			0.0000
R-squared		0.987			0.9836
Adj R-squared		0.985			0.9810
	Coefficient	t		Coefficient	t
Constant	-692000000***	-4.4	Constant	79500000*	1.84
Revenue	1.178408***	9.59	Revenue	1.305788***	13.27
Capitalization	0.0098445	0.35	Capitalization	0.0766178**	2.34
Income	-5065.537**	-2.29	Prin. Rep.	0.2988408***	3.43
POPDEN	5817141***	3.81	WAILR	-26000000**	-2.55

Note. * p<0.10 ** p<0.05 *** p<0.01

For calculating purposes, the annual debt service amount was used, instead of the ratio. For the replicated model, the multiple regression results shown in Table 4.1 indicate a fit model with R^2 = 0.98 and F=475.54. Thus, the model can be used to predict the future debt levels. Equation (1) was estimated using New York data for the time period from 1990-2019. The results are shown in the equation below.

$$Y=-692{,}000{,}000+1.178408\, X_1+0.0098445X_2-5065.537X_3+5817141X_4 \quad (1)$$

Similar to the Ramsey et al. (1988) model, this CWSRF model also encountered a multicollinearity problem, as expected (high variance inflation factor -VIF score for per capita income and population density). Federal and State capitalization was found not to be significant. According to Ramsey et al. (1988), despite the insignificant independent variable, for predicting purposes, the model can still be used because this set of variables has been previously identified as appropriate for state policy makers in deciding that the debt capacity. Also, the presence of multicollinearity (that holds in the past as well as in the future) would not affect the predicting power of the model.

For the adjusted model, the regression results in Table 4.1 also indicated a fit model with R^2 = 0.98 and F=374.93. This model appeared to be less subject to the multicollinearity issue (mean VIF 4.3) and all four independent variables were significant. Thus, the model can also be used to predict the future debt levels. Equation (2) was estimated using New York data for the time period 1990-2019. The results are shown in the equation below.

$Y=79{,}500{,}000+1.305788X_1+0.0766178X_2+0.2988408X_3-26000000X_4$ (2)

Table 4.2 presents the results of the ARIMA three-stage process including all independents for both replicated model and adjusted model: the selected ARIMA model of operating revenue (X1), Federal and State capitalization (X2), per capita personal income (X3), and population density (X4), loan principal repayment, and the weighted average rate on loans. These selected ARIMA models are believed to most accurately describe the trend of each independent variable (X) and they, accordingly, provide the greatest accuracy in forecasting. Each model choice, in accordance with the procedure set out in the method section, involves judgments of evaluating indicators, as well as post test results, with the aim of creating a parsimonious model. Among the six selected models in Table 4.2, the ARIMA (0,1,0) of the principal repayment variable is a special type known as a random walk model. “This model assumes that in each period the variable takes a random step away from its previous value, and the steps are independently and identically distributed in size” (Nau, 2014, p. 1). The forecast value of this model is usually flat and equal to the last observation (Nau, 2014). Population density variable is only stationary at the second difference.

Table 4.2

Selected ARIMA Models

	Operating Revenues	**Capitalization**	**Per capita personal income**	**Pop. Density**	**Principal Repayment**	**WAILR**
Model	2 1 2	3 1 0	1 1 1	3 2 0	0 1 0	1 1 1
No. of Obs.	29	29	29	28	29	29
Significance	4/5	3/4	1/3	2/4	1/1	1/3
Sigma	20300000	150000000	1025.294	0.353547	42100000	0.4303811
Log likelihood	-530.8047	-587.8357	-242.3705	-11.17635	-550.2457	-16.88433
Akaike (AIC)	1071.609	1185.671	492.7411	32.35271	1104.491	41.76866
Bayeseian (BIC)	1078.446	1192.508	498.2103	39.01373	1107.226	47.23785
Portmanteau test						
(Q) statistic	4.0214	11.3622	4.9781	7.0584	10.782	8.9542
Prob.	0.983	0.4982	0.9587	0.8537	0.5477	0.7068
AR parameters	0.850867	0.821726	0.07043	0.850823		0.23199
MA parameters	0.999992		0.48676			0.37105

Note.

Portmanteau test: if p>0.05 cannot reject the null hypothesis then residuals are white noise.

AR/MA roots (-1 to 1): AR/MA parameters satisfy stability/inversibility conditions

Using the selected ARIMA models, the essay produced the predicted values of each independent variables for the main model, which then were substituted into Equation (1) and Equation (2) to forecast the debt service level that can be afforded for the CWSRF of New York for next ten years. Equation (1) and Equation (2) then give the following results in Table 4.3.

Table 4.3 shows that the predicted values of annual debt service drawn from replicated model were relatively smaller than the series of predicted values of the adjusted model, although the difference was not significant. The greater amount of predicted value implies a greater affordability of CWSRF's debt service level. The replicated set of independent variables appeared to be more suitable with general state finance because debt service payment is backed by taxes for their issued GO bonds. While the majority of CWSRF's issued bonds are revenue bonds which are backed by the income from the CWSRF itself, the adjusted model may produce more relevant predicted annual debt services.

Table 4.3

Predicted New Debt Service

	New Debt Service Affordable ($)	
Year	Replicated Model	Adjusted Model
2020	496,670,279	511,606,494
2021	508,027,451	516,900,703
2022	525,444,196	550,302,428
2023	541,592,807	575,284,284
2024	556,810,125	583,736,219
2025	571,945,678	602,041,161
2026	588,220,423	628,786,277
2027	601,974,460	645,942,190
2028	614,015,175	657,049,891
2029	627,975,506	676,657,763

Thus, both models predicted that New York's CWSRF can incur new debt during the next ten years with a debt service; this is presented in Table 4.3. Most importantly, the New York CWSRF can expect to be able to repay such a debt service amount without crowding other loan assistance or activities and without risking its current credit rating. With a given interest rate on debt, the total principal amount of debt for New York's CWSRF can be estimated. As noted earlier, since the regression approach is the only empirical method to assess debt affordability besides debt ceiling and benchmarking, these predicted values can be a good source of reference for the state revolving fund managers. For instance, compared with the most current debt service amount in 2019 ($496,355,382), the higher predicted values of annual debt service may imply that New York's CWSRF may still have room for more affordable leveraging.

However, the gap is minimal, suggesting that New York will reach its maximum affordability level soon. This is consistent with the fact that New York's CWSRF has a high mean debt service-to-revenue ratio (93 percent), which signals a need for careful consideration for additional leveraging. Nevertheless, with the recently passed bill of infrastructure, in the coming years, billions of dollars will inflow into the SRFs. CWSRFs will expect a larger scale of federal appropriation, which will increase their expected total of assets accordingly. This means that states (for instance, New York) will have a greater ability to incur new debt because non-operating revenue (federal grants) will be so much higher.

Conclusion

Borrowing the set of identified predictors for debt capacity, including tax capacity and revenue rising components, per capita income and population from state debt affordability literature, this essay built an estimation equation to explain the annual debt service of CWSRF. An adjusted model with specific indicators relevant to CWSRF was also constructed. Considering the specific characteristics of CWSRF that offer loans to local governments and communities and considering that loan repayment is the most significant inflow of resources, this model treats loan repayment as a proxy for revenue in the adjusted model. Replicating the regression method employed by Ramsey et al. (1988), this essay performed two component tests. First, the multivariate regression was used to test the fitness of the CWSRF debt service model and to identify the respective coefficients of the equation (1). In the second step, the ARIMA model with historical time series data was used to predict the future value of the respective independent variables. The predicted values from the second step were then substituted in the equation in the first step to produce the estimated debt service, with the assumption that interest rate, credit rate, and so on remained unchanged. The statistical models presented here indicate the amount of debt service a state can incur.

The predicted results of both models were relatively greater than the current values, suggesting that the New York CWSRF can afford a slightly higher level of leveraging in the near future. However, the difference is not significant; coupled with the high debt service-to-revenue ratio, it is recommended that the New York CWSRF carefully consider any additional leveraging. While New York is selected as an example of a moderately aggressive leveraging state, the practice can be performed for other leveraged states. This essay chose to predict annual debt service, which is intended for near-term affordability. The total debt, for a long-term perspective, can be also predicted. It should be noted that, because each state has a different time series, the ARIMA candidate model for each independent variable will be, accordingly, changed. Also, in general, different states have different debt policies and/or debt priorities. While the regression approach can be applicable to every leveraged state, the predicted value of debt service is for the state's own reference to decide on an affordable debt level, rather than for a comparison between states.

It is noted that the regression approach is known as the science based and data supported method, a useful tool for predicting the future value of a debt level. However, the more important issue is to decide which relevant set of independent variables should be used to reflect the debt level most accurately. The internal financial-based set of independent variables appears to provide a more relevant prediction of CWSRF's debt. Since the literature also indicates the limitations of the regression method, it is recommended to use the results of this regression approach in combination with different methods, such as the benchmark and ceiling as indicated in the literature, and especially the cash flow model currently recommended in the SRF Financial

Management Handbook, as well as other indicators, to decide on the acceptable debt affordability levels of CWSRF.

CHAPTER 5

SUMMARY AND FUTURE RESEARCH

Dissertation Summary

The Clean Water State Revolving Fund (CWSRF) is an innovative financing mechanism created in order to bridge the public infrastructure financing gap. It is known as a capitalized state loan program that was introduced in addition to traditional block grants. At the same time, its birth is also the result of Congress's intent to reduce the role of the national government, while providing more control and more discretion to states in their water quality funding (Morris, 2022). Given the uniqueness of this state-run entity, its operation and performance are essential for administrators and policymakers. This study's purpose is to examine the debt financing decision of CWSRF: whether or not, and to what extent, states should leverage or use debt financing to meet their goals of providing assistance loans for local community wastewater infrastructure. This dissertation contains three essays that address three unique topics related to the motivations that underlie states' choices of debt financing and how they manage their debt affordability during the first three decades of operation. This research has five chapters: the introduction chapter, three main essays, and a conclusion chapter. The study period covers three decades from 1990 to 2019 (the two first years were eliminated because the program was not yet fully operational). Most of the data used in this dissertation comes from the National Information Management System database, collected and managed by the Environmental Protection Agency (EPA). The following is a summary of the three main content chapters.

Chapter Two examines the relationship between a set of internal financial indicators and leverage ratios (total leveraging and new leverage) from 1990 through 2019. Considering

CWSRF as an enterprise fund that is operated as a private business enterprise, the chapter constructs CWSRF's leveraging model based on the assumptions of pecking order theory. It then tests whether the entity's total assets, the growth of total assets, the operating net ratio, the debt service reserve ratio, and the volatility of operating net change (risk) and others would influence the capital structure of CWSRFs.

Descriptive analysis results indicate that leverage in the CWSRF is relatively low to moderate. The mean value of the total leverage for the entire sample is about 20 percent, and the average new leverage is about 3 percent. Two ratios are higher, at 27.1 percent and 4.2 percent, for leveraged states only. As expected, these ratios obscure significant variations among states. The ten most aggressive leveraging states have total leveraging at about 50 percent; on the opposite side, the average total leveraging is less than 10 percent. The zero ratios belong to those states that are only leveraged for meeting state-match purposes. Such a state-match amount of bonds issued is then repaid within the year. Over thirty years, the mean annual total leverage maintained the highest rate during the second decade (2002-2012) at about 30 percent; however, it has tended to decline in recent years, reaching 23.8 percent in 2019. The empirical findings suggest that the size (log of total assets), the growth (change in total assets), and the federal return on investment (FROI) are relevant predictors of CWSRF leveraging. Larger and expanding CWSRFs tend to issue more new bonds and maintain a high level of outstanding debt. On the contrary, small and slower-growing states are likely less to be dependent on leveraging. FROI is found to be negatively related to the total leverage; this suggests that states with high utilization of federal seed money tend to maintain a lower level of outstanding debt. The findings are mixed regarding the pecking order theory's assumptions, but they are consistent with previous studies that use more than one theory to estimate capital structure determinants.

Chapter Three analyzes the external factors that determine the debt financing decisions of CWSRFs. Following the voter median theory and empirical studies from the literature on state financing, this chapter constructs a leverage model that consists of three groups of independent factors: socioeconomic factors, political factors, and institutional factors. The proxies for leveraging are measured by debt as a percentage of loan assistance and new debt per capita. The descriptive analysis reveals that, on the average, CWSRF's debt accounts for 28 percent of its funding for loan assistance, annually. That share percentage also significantly varies among states. In some states, the debt covers more than 80 percent, while, for other states, the debt share ratio ranges from 0.5 to 15 percent. Over the years, debt share and debt per capital illustrate a similar unstable zigzag trendline, with a peak in 2004 and the lowest point in 2014. It must be noted that CWSRFs received a substantial amount of federal appropriation right before and during the Great Recession (2010), not including the $2 billion from American Recovery and Reinvestment Act. Thus, states had sufficient funding to support loan assistance, even during the recession. The regression results show a strong connection between historic outstanding debt (a proxy for debt capacity) with both debt ratios suggesting that states used to high leverage will continue to do it in the future. On the other hand, the empirical findings indicate a limited association between other external factors and debt share and debt per capita. The federal share of loan assistance, an election year, and environmental needs are each found to have a relationship with the debt share, whereas the income and the House being controlled by Democrats (HDEM) variables are identified as relevant predictors of debt per capita. The findings show a weak connection to the assumptions of median voter theory and to other factors in the state financing literature.

Unlike Chapters Two and Three, which include all 50 states into analysis, Chapter Four focuses on only 36 leveraged states. It reviews the state debt affordability literature and then uses the regression method to calculate the predicted value of the annual debt service of CWSRF. Debt service-to-revenue is identified as the most popularly used ratio among the states for measuring debt capacity. The regression method is also known as the science-based and data-supported technique for predicting future debt levels. Replicating Ramsey et al. (1988)'s equation and regression method, this chapter predicts the future value of the debt service of the New York's CWSRF. The average debt service-to-revenue ratio of CWSRF ranges from 2 percent to 123 percent, which appears to be relatively high compared to that of General Finance or of Road Funds (at around ten percent). The nature of CWSRF – using federal appropriation as a reserve for bond issuance, targeting to increase the utilization of such seed money, and acting as an environmental infrastructure bank to meet the huge wastewater infrastructure needs from the communities – makes it easier to borrow money; that explains why CWSRF has a higher level of leverage than Road Funds. The predicted value of New York's future annual debt service level appears to be both relevant and valuable for reference, suggesting that the regression method is a relevant debt affordability predicting tool for other CWSRFs.

Contribution and Significance

This research arrives right on time. Despite over thirty years of operation, limited research pertaining to CWSRF's leveraging has been documented. As indicated previously, leveraging has been and will be the essential component of CWSRF, since it cumulatively contributes around half the amount to the CWSRF pool of funds; it is now time to review their debt financing behavior, their debt management practices, and the way in which those behaviors and those practices influence the program's performance and sustainability. More importantly, vast inflows of dollars from the recently passed infrastructure bill will channel into both the CWSRF and the DWSRF in the years to come. Thus, the results of this study will have some practical implications for future research, as well as for the long-term viability of the SRF model.

Implication for Research

This study extends a private sector theory – the pecking order theory – to the public sector, and it is the first piece to focus on the capital structure of a state-run entity. By highlighting the capital structure patterns and trends of CWSRF and the determinants of CWSRF leveraging, the study enriches the literature on not-for-profit organizations' capital structure. The empirical evidence shows that the pecking order theory is applicable to a quasi-public/public entity. It can be combined with other theories, such as trade-off theory, to predict the debt financing behavior for those "enterprise funds" such as CWSRFs. This study can be replicated for the Drinking Water Revolving Fund and other increasing numbers of SRFs.

Simultaneously, this study establishes the first empirical evidence regarding this particular SRF innovative financing mechanism and its leveraging. CWSRF or SRF is a unique organizational setting that reflects the crosscutting of government mandates, infrastructure financing, business-like operating, and infrastructure banking business. Examining CWSRF through different lenses of respective literature draws a closer picture of CWSRF’s leveraging. CWSRF tends to have a lower leveraging profile, when compared with the private sector. However, CWSRF seems to have a much higher leveraging and debt service-to-revenue ratio than general state finance and highway infrastructure. The leveraging motivation is also different. CWSRF appears to be less associated with state politics, socioeconomic factors, TELs, and debt limits, but more related to financial factors. CWSRF also has its own identification, such as a change in federal appropriation that would encourage more leveraging for state match in CWSRF. This positive relationship is different from the often-found negative relationship in previous studies. More research into SRF, such as the Drinking Water SRF, state infrastructure banks, and other similar revolving funds would be beneficial, in order to gain better insights into these differences and to build up the literature for these SRF-niched areas.

Lastly, this study extends the regression method to predict the debt affordability from the general debt finance to CWSRF. The replicated and adjusted models provide relevant and valuable predicted values of the annual debt service for CWSRFs. The study, therefore, supports the contention that this method can be used to estimate debt affordability in the revolving fund setting. In addition, this dissertation also supports the claims from previous studies that no single theory or method can exclusively explain leveraging/financing behavior or debt affordability decisions. Thus, a combination of more than one theory or method should be employed, when researching CWSRF's leveraging.

Implication for Policymakers

Leveraging decisions exert influences differently on different groups of states. This study's findings indicate that states that are small and growing more slowly appear to use less leverage. The reasons associated with that may include their own constraints (such as credit rating and debt managing capacity) as well as other external challenges. These states may be starved for more financial resources, and they likely intend to issue bonds to meet such needs, but they may not yet be able to do that. The EPA should consider further favorable treatments such as, but not limited to, subsidies in order to encourage these states to access the bond issuance. At the same time, the group of larger and faster-growing states which tend to issue more bonds may encounter the pressure of high debt service repayment and should pay more attention to their debt affordability management.

As the EPA points out in its audit report and its Financial Management Handbook, the policy that allows states to use bonds to meet state match requirements obviously reduces the funding available for water projects. By 2007, it was reported that current borrowing for a state-match caused an estimated $937 million to be less available for loans since the inception of the SRF program (both CWSRF and DWSRF) (EPA, 2007). This practice may trigger other states which have issued GO bonds that retire from state general funds to potentially transfer to retiring their bonds from SRFs, significantly reducing the amount of funds available for future projects. Due to the expectation of Congress that the CWSRF funds would continue to grow into perpetuity, the Inspector General has recommended that the EPA revise its regulations on state matches and no longer allow states to use bonds repaid from CWSRF to meet state match requirements.

This dissertation provides some evidence that supports these negative impacts of allowing states to issue bonds to meet the state match requirement. From a private sector perspective, the capital structure of CWSRF can be considered a low leveraged profile (27.1 percent for leveraged states) on average, as seen in Chapter Two. However, the debt affordability level of these CWSRFs (mean debt service-to-revenue 52.7%) in Chapter Four seems to be relatively higher than its leveraged level – the low-profit margin results from a low-interest loan, which is expected and is widely accepted in CWSRFs. However, the loss incurred due to the repayment of match bond principal and interest adds another layer to reduce CWSRF’s operating revenue significantly. As discussed in Chapter Three, if the state match is GO bonds secured by the general fund, as recommended by the general inspector, the current loss revenue would be added back to the operating income. The allocation of the general state budget for the CWSRF state-match would promote the importance of CWSRF in state budgeting and financing. Despite the recommendation since 2007, the practice of issuing bonds secured by CWSRF for state matches continues in 24 states (out of the 36 leveraged states). Continuing this practice would threaten the sustainability of CWSRFs in the future.

For CWSRF Managers

Each CWSRF may follow its own state regulations or guidance concerning debt affordability. This practice is widely accepted due to the diversity of the state and its unique tax and debt treatments. EPA also recommends other models/methods for CWSRF managers to deal with debt capacity issues. States can also hire external consultants to help with recommendations on debt affordability level. However, each approach also has associated issues. Hiring a consultant can be costly, and CWSRF cannot do it often. Debt or cashflow models and methods can be too complicated for CWSRF staff to handle. The regression method in Chapter Four could be a good candidate for CWSRF to adopt since it is a viable method that does not require complicated calculation but produces reliable and relevant predictions because it is a science-based and data-supported technique that lets the historical debt-related data of CWSF "tell" about themselves. This regression method can be a standard tool for leveraged states to predict affordable debt value. The prediction values of this regression method can be comparable sources of reference across states.

Directions for Future Research

This dissertation has highlighted some notable results; however, many insights gained from this study lead to further areas of study. First, this research has brought up the need to conduct a qualitative or mixed-method study, perhaps a case study including an interview with the key finance decision-makers of the CWSRF of three to five states. The choice of state would take into consideration its size, location, and levels of leveraging. There could be a survey sent to the CWSRF's managers for collecting information related to both aspects: motivations of leveraging and debt management practices. The data collected would provide more in-depth and comprehensive information that would later supplement or validate some of the findings of this study.

This research is among very few studies related to the SRF innovative financing mechanism; a replication of this study for the Drinking Water State Revolving Fund and the State Infrastructure Bank (the highway SRF) would accumulate more evidence on leveraging and debt management in the SRF setting. In addition, the current leveraged CWSRF model can be revised to include some more indicators. Bond-rating, issuing cost, sewer user charge as a percent of Median Household Income (MHI), and poverty data are some potential determinants of CWSRF's leveraging.

Local demand for CWSRF's loans seems to be a more relevant determinant of leveraging than environmental needs. It is assumed that local communities have a high demand for loans similar to their environmental needs, and the CWSRF is actively responding to it. However, there is little documentation about such loan demand from local communities. States may have different demands for loans, regardless of their environmental needs. For instance, a state with substantial environmental needs but little loan demand may not need leverage. On the other hand, higher demand for loans might convince states that have the capacity to take on greater debt to meet that demand. Thus, a future study should investigate the local demand for CWSRF's loans and their impacts on leveraging.

Finally, public debt receives significant concern at all different levels of government; however, it is a complex issue. According to The Pew Charitable Trusts, 29 states have done their debt affordability studies, examining the debt level that those states can prudently take on (Murphy & Levin, 2017). Thus, this state debt affordability report will likely include an affordability analysis for CWSRF. The recent 2021 debt affordability study for Rhode Island treats CWSRF as a quasi-public agency and uses the debt service coverage and the assets-to-liabilities ratio. The state recommends that CWSRF maintain a minimum of 1.25 x debt service cover and a minimum of 1.3 x assets to liabilities (Office of Debt Management, 2021). A further study focusing on the content analysis of these debt affordability studies gathers a supplemental and comparable source of reference, in addition to the regression methods described in Chapter Four.

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APPENDIX A

NIMS Data Code

Table A.1

List of NIMS data code

Code	Description
70	Annual federal capitalization
71	Cumulative Federal capitalization
74	Federal CWSRF Contributions Adjusted for Transfers - Annual
75	Federal CWSRF Contributions Adjusted for Transfers – Cumulative
76	Annual state-match
77	Cumulative state-match
208	Gross Leveraged Bonds Issued - Annual
211	Leveraged Bond Principal Repaid - Annual
212	Debt Service Reserve for Leveraged Bonds annual
213	Debt Service Reserve for Leveraged Bonds - at the end of the reporting period
216	Gross Leveraged Bonds Issued - Cumulative
222	Leveraged Bonds Outstanding - Balance at End of Reporting Period
223	Match Bonds Issued - Annual
224	Match Bond Principal Repaid - Annual
225	Match Bonds issued - Cumulative
227	Match Bonds Outstanding - Balance at End of Reporting
228	Interest Paid from Capitalized Interest Account and Other CWSRF Funds- Annual
230	Interest Paid on Leveraged and Match Bonds - Annual
235	Interest on loans-Annual
240	Weighted Average Interest Rate on Loans
241	Interest Earnings on Investments Annual
307	Federal return on investment-Cumulative
319	Sustainability (Retained earnings) -Cumulative

Panel Unit Root Tests

Levin-Lin-Chu model (first generation) and Pesaran (2007) model (second generation) model were used for testing whether variables are stationary. Most first-generation models such as Levin-Lin-Chu and the Im-Pesaran-Shin test assume cross-sectional independence, which is not the case for both total leverage and annual/new leverage models. However, the Levin-Lin-Chu (2002) model suggests removing cross-sectional averages from the data to help control such correlation. LLC is also applicable to datasets with small T (period) and large N. Levin-Lin-Chu's results in Table A.2 suggest that all variables are stationary at level I(0) except for the total leverage and reserve, which are stationary at the first difference I(1). The Pesaran CIPS test results in Table A.2 suggest that all variables are stationary at level except for total leverage, size, and risk, which are stationary at the first difference I(1). The reserve ratio is not stationary even after the second difference.

Table A.2

Panel Root Test Results

	Levin-Lin-Chu		Pesaran Panel Unit Root (CIPS)	
Variables	Level I(0)	First difference I(1)	Level I(0)	First difference I(1)
Total leverage	16.680	-9.178***	-0.920	-2.928***
New leverage	-11.367***		-2.737***	
Profitability	-4.355***		-3.414***	
WAIRL	-5.851***		-3.844***	
Size	-17.579***		-1.128	-5.321***
Logsize	-22.993***		-3.700***	
Growth	-48.929***		-6.012***	
FROI	-2.847***		-3.458***	
DRSR	2.3365	-7.9671***	0.288	-1.288
Risk	-9.252***		-2.075	-4.685***

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