Using Multi-State Tax Reciprocity to Expand the U.S. Green Municipal Bond Market

A CAPSTONE PROJECT FOR SAMUEL A. RAMIREZ & CO., INC.

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Abstract

The United States needs greener infrastructure to ensure the country is well positioned for a low-carbon future. This Columbia University School of International and Public Affairs (SIPA) capstone project led by six master's students focused on financing green infrastructure with municipal bonds, a key funding vehicle for public infrastructure. We examined the potential of multi-state tax reciprocity (MSTR) to scale up the issuance of green municipal bonds by expanding investor pools and unlock new sources of capital for this critical infrastructure investment pool. To do so, we researched the state of the U.S. green municipal bond market and identified examples of successful and failed tax reciprocity programs; we extensively reviewed primary and secondary research from academics and practitioners; and we interviewed dozens of experts central to today's green municipal bond market. Ultimately, we developed a comprehensive cost-benefit analysis model to examine the viability of MSTR.

Our model focused primarily on New York and California, the two largest players in the U.S. green municipal market, in addition to a prototypical "small state." Green municipal bonds inherently carry many benefits such as fostering social welfare, diversifying investors' portfolios, and potentially improved pricing. We quantified the many expenses associated with issuance, such as the state and local tax deductions, implementation cost, such as registration costs, monitoring and evaluation costs. We also developed a four-phase implementation plan for MSTR and suggested alternatives and complementary approaches to eventually scale up green municipal bond issuance in the U.S. market.

Ultimately, over a 20-year time horizon, our model and research concluded that MSTR could generate hundreds of millions of dollars in value and provide a significant return on investment for participating states. Even considering significant political risks, we asses that an MSTR program is a viable policy to scale up the green municipal bond market in the United States and propel the country toward a low-carbon future.

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Matthew Kuchtyak, Moody's Investors Service
Olivier Laut, New York State Homes and Community Renewal
Ryan Lawler, Government Finance Officers Association
Caitlin MacLean, Milken Institute
Frank Mamo, Moody's Investors Service
Timothy Martin, New York City Office of the Comptroller
Patrick McCoy, New York Metropolitan Transportation Authority
James McIntyre, New York State Homes and Community Renewal
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Candace Partridge, University College London
Karen Phillips, New York State Homes and Community Renewal
Richard Robb, Columbia University
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Douglass Sims, Natural Resources Defense Council
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Disclaimer

This report is was written by a group of master's students at Columbia University's School of International and Public Affairs (SIPA) in fulfillment of the capstone requirement.

The findings, interpretations, and conclusions expressed herein do not necessarily reflect the views of the Columbia University, SIPA, Samuel A. Ramirez & Co. Inc., or any parties interviewed by the authors.

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1. Background Information

1.1. Market Overview

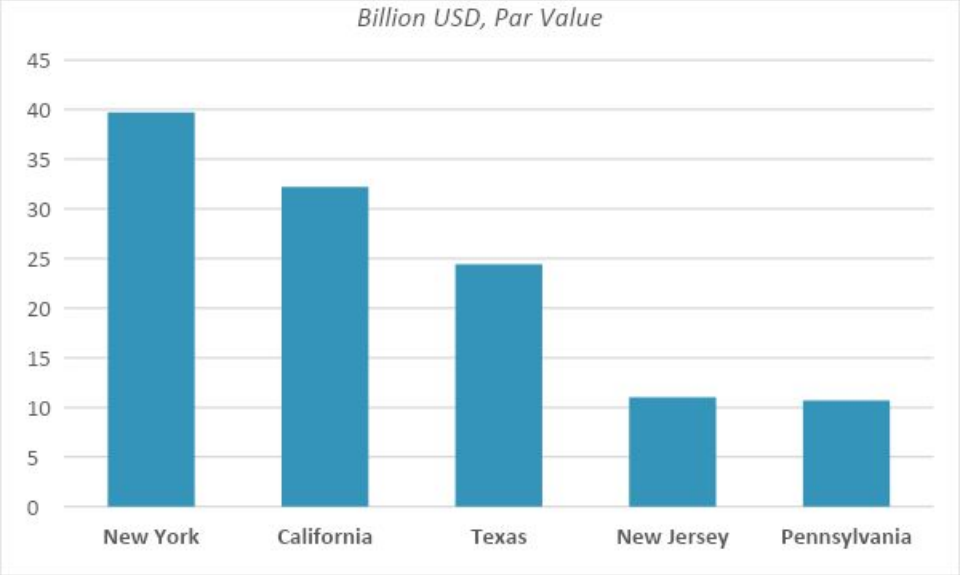
1.1.1. U.S. Municipal Bond Market

Market Overview

A municipal bond is a debt security issued by a state, municipality, or county to finance its expenditures, including the construction of infrastructure such as bridges, schools, water treatment facilities, etc. As of 2019, the U.S. municipal bond market had a market capitalization of $3.8 trillion, nearly two-thirds of which were held by individual investors through mutual fund products or directly, according to Municipal Securities Rulemaking Board.[1] There are about 1 million outstanding municipal securities, and nearly 40,000 securities trade on a daily basis. In 2018, U.S. municipal bond issuance reached $388 billion. On average, the default rate of municipal bonds was 0.18 percent, much lower than 1.74 percent default rate for corporate securities.

California and New York are the two biggest municipal bond issuers by state. In 2018, these two combined issued more than $70 billion in bonds, accounting for more than 25 percent of total issuances that year.[2]

Chart 1: Municipal Bond Issuance in 2018



Data source: EMMA Database[3]

Current Tax Exemption Policy

[1] MSRB, "Muni Facts: Municipal Market by the Numbers" (Municipal Securities Rulemaking Board, 2019), http://www.msrb.org/msrb1/pdfs/MSRB-Muni-Facts.pdf.

[2] MSRB.

[3] "EMMA: Municipal Trade Statistics - 2018," 2018, https://emma.msrb.org/MunicipalTradeStatistics/ByState.

In addition to relatively low default rates, municipal bonds are attractive to individual investors and institutional investors because of tax benefits. Under federal law, the interest that an investor earns on municipal bonds is exempt from federal income tax. In many states, municipal bond interest income is also exempt from state and local taxes if the investor purchases bonds issued in their state of residence. Additionally, investors in municipal bonds issued by U.S. territories—Puerto Rico, Guam, etc.—enjoy triple tax exemption (i.e. federal, state, and local taxes exemption) regardless of their state of residence.[4]

Major Trends

The municipal bond market in the U.S. has steadily grown since 2011 but experienced a sharp drop in 2018. The decline was due in large part to Tax Cuts and Jobs Act (TCJA), which came into effect in January 2018 because it placed limits on advance refunding, which pushed down the supply of municipal bonds. On the demand side, the TCJA also put a cap of $10,000 on state and local tax deductions for investors. In addition, the TCJA lowered tax rates, which would reduce the value of the tax exemption to investors. However, over time the tax changes could stoke additional demand for tax-exempt securities for investors who are seeking stable returns, according to RBC Wealth Management.[5]

1.1.2. U.S. Green Municipal Bond Market

There is no standard definition of "green bonds," but they typically must be used to finance environmentally sustainable projects and incorporate some amount of monitoring and evaluation to ensure the good use of the proceeds. Many green issuers—which include municipalities, corporates, sovereigns, and more—follow the standards laid out in a voluntary set of guidelines known as the Green Bond Principles (GBP). In 2018, green bond issuance globally reached $167 billion, growing by 3 percent over 2017, according to the Climate Bonds Initiative.[6] The United States ranked first among all the countries in terms of the issuance, and although the green bond market in the US is not a large share of the total green bond market, it is on the track to grow in the coming years.

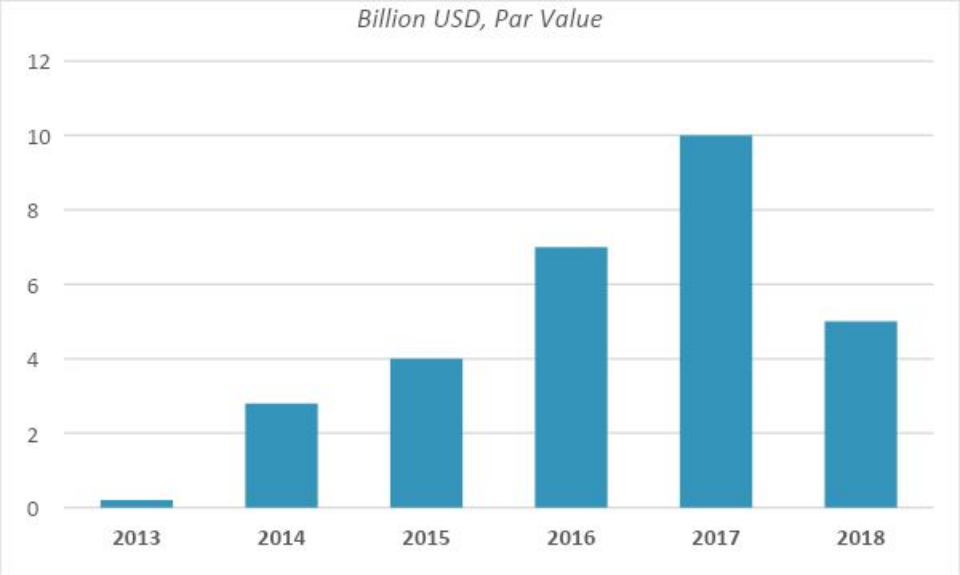
Municipal green bonds are securities issued by state and local governments to fund environmentally beneficial capital projects. The Commonwealth of Massachusetts issued the first green municipal bond in 2013. Since then, green municipal bond issuance has increased dramatically, peaking in 2017 at about $10 billion, judging from S&P Ratings Direct analysis.[7]

[4] See Section 1.2 for further discussion on Triple Tax Exemption in Puerto Rico.
[5] "Market Analysis and Commentary," RBC Wealth Management, accessed May 12, 2019, http://www.rbcwealthmanagement.com.

[6] "2018 Green Bond Market Highlights" (Climate Bonds Initiative, January 2019), https://www.climatebonds.net/resources/reports/2018-green-bond-market-highlights.

[7] Erin Boeke Burke and Andrew Bredeson, "2019 U.S. Municipal Green Bond and Resiliency Outlook: Will the Self-Labeled Market Rebound?," RatingsDirect (S&P Global, March 14, 2019).

CHART 2: GREEN MUNICIPAL BOND ISSUANCE, 2013-18



Source: S&P Global[8]

Benefits of Issuing a Green Municipal Bond

Setting aside the environmental and potential reputational benefits of issuing a green municipal bond, the biggest benefit lies in the potential presence of a green bond premium ("Greenium"). A Greenium is the increased price an investor is willing to pay for a green bond compared to a conventional equivalent, which lowers the yield. The lower yield translates into reduced borrowing costs for issuers, which can offset the additional costs associated with green bond issuance, such as monitoring, evaluation, and certification.

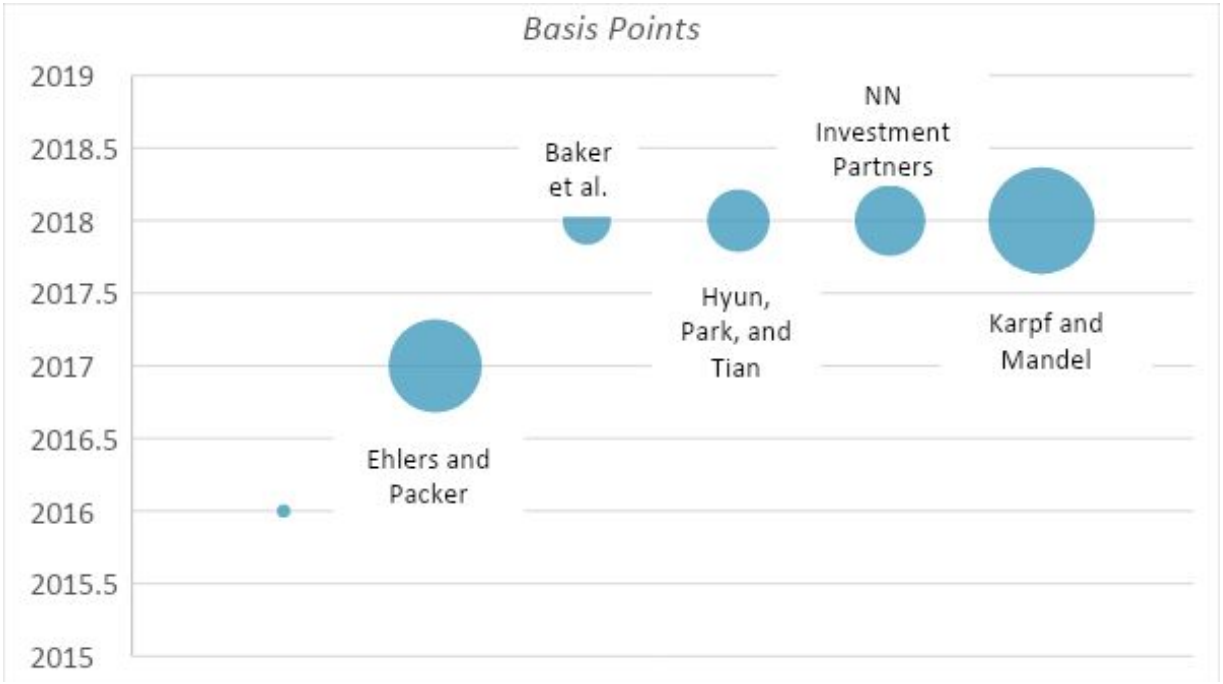
There is not yet a consensus on the size—or even the existence—of the Greenium in the U.S. green municipal bond market. However, a review of academic and practitioner literature reveals that the weight of the evidence suggests the presence of a positive green bond premium. Generally, green bonds may be pricier than conventional bonds because of higher demand for instruments with a greener purpose and a stricter requirement to report the use of proceeds exceeds supply.[9] In 2018, green bonds were more heavily oversubscribed, especially when compared to conventional bonds, indicating a higher demand versus its counterparts. The market appears to be on the upswing, with some agencies, such as Moody's expecting it to increase by 20 percent over 2018, reaching $200 billion.[10]

[8] Burke and Bredeson.

[9] Gail Counihan, "Is the Green Bond Market Running out of Steam?," *Environmental Finance*, February 22, 2019, https://www.environmental-finance.com/content/the-green-bond-hub/is-the-green-bond-market-running-out-of-steam.html.

[10] Matthew Kuchtyak and Jim Hempstead, "Moody's: Green Bond Market Poised to Hit $200 Billion in 2019" (New York: Moody's, January 31, 2019).

CHART 3: GREEN BOND PREMIUM LITERATURE REVIEW



Sources: Selected Academic Articles[11,12,13,14,15]

U.S. Green Municipal Bond Market Issued by States

The first U.S. municipal green bond was issued in 2013 by the Commonwealth of Massachusetts. By the end of 2018, cumulative issuance reached about $28 billion, according to S&P Ratings Direct, less than percent of the municipal market.[16] Just three states account for the bulk of U.S. green municipal bond issuance: New York ranks

[11] Olivier David Zerbib, "Is There a Green Bond Premium? The Yield Differential Between Green and Conventional Bonds," SSRN Scholarly Paper (Rochester, NY: Social Science Research Network, December 25, 2016), https://papers.ssrn.com/abstract=2889690.

[12] Torsten Ehlers and Frank Packer, "Green Bond Finance and Certification," *BIS Quarterly Review*, September 17, 2017, https://www.bis.org/publ/qtrpdf/r_qt1709h.htm.

[13] Malcolm P. Baker et al., "Financing the Response to Climate Change: The Pricing and Ownership of U.S. Green Bonds," SSRN Scholarly Paper (Rochester, NY: Social Science Research Network, October 12, 2018), https://papers.ssrn.com/abstract=3275327.

[14] Suk Hyun, Donghyun Park, and Shu Tian, "The Price of Greenness: Some Evidence from Green Bond Markets," August 2018, https://drive.google.com/file/d/11Ysr2L051Amy9OjPIRmoi7GJSj3dzayF/view.

[15] Andreas Karpf and Antoine Mandel, "The Changing Value of the 'Green' Label on the US Municipal Bond Market," *Nature Climate Change* 8 (January 29, 2018), https://doi.org/10.1038/s41558-017-0062-0.

[16] Burke and Bredeson, "2019 U.S. Municipal Green Bond and Resiliency Outlook: Will the Self-Labeled Market Rebound?"

first ($6.9 billion), followed closely by California ($6.4 billion). The third largest is the pioneer: Commonwealth of Massachusetts ($2.9 billion). These states rank high in green municipal bond issuance for a number of reasons, including the size of their economies, high tax rates, and aggressive environmental targets.[17]

1.2. Tax Reciprocity Program

Multi-state tax reciprocity (MSTR) is an agreement between states that allows out-of-state green municipal bond investors to enjoy tax exemption if they buy green bond issued by the other state. For example, if New York state and California enter into an MSTR program for green bonds, California residents investing in New York green municipal bonds would receive tax exemption at the federal, state, and local level. Several income reciprocity agreements—a parallel to MSTR—already exist in the United States, in states such as New Jersey and Pennsylvania, for example.

There is also historical precedence for multi-state tax reciprocity for municipal bonds. Puerto Rico, one of the United States' territories, has a triple tax exemption policy for buyers of the bonds issued by the territory. The policy came into existence in 1917 when the Jones-Shafroth Act was passed, giving the bond issuers in Puerto Rico great advantages. The policy says "All bonds issued by the Government of Puerto Rico, or by its authority, shall be exempt from taxation by the Government of the United States, or by the Government of Puerto Rico or of any political or municipal subdivision thereof, or by any State, Territory, or possession, or by any county, municipality, or other municipal subdivision of any State, Territory, or possession of the United States, or by the District of Columbia."[18] The intention for the policy initially was to help Puerto Rico to develop and build its infrastructure.

The main takeaway from the Puerto Rico case is that multi-state tax exemption policies can be very attractive to investors. In addition, debt sustainability and investor demand are important factors for states to weigh in determining whether to participate in such a program.

1.3. Problem Statement

Our background research led us to the following conclusion: although the green bond market has been developing very rapidly, U.S. municipal bond issuers are lagging in their use of green bonds to finance public project which means there is much room for the green bond market to growth. This capstone project explores ways to boost growth in the U.S. municipal green bond market.

[17] "Climate Bonds Certified Bonds," Climate Bonds Initiative, April 2019, https://www.climatebonds.net/certification/certified-bonds.

[18] "48 U.S. Code § 745 - Tax Exempt Bonds" (Legal Information Institute, Cornell Law School, n.d.), https://www.law.cornell.edu/uscode/text/48/745.

2. Results

We used cost-benefit analysis (CBA) to examine the viability of using MSTR to boost growth in the U.S. green municipal bond market. CBA is a practical tool that allows researchers to quantify and monetize any type of benefit and cost associated with a program, and discount these back to present values. Ultimately, a CBA can help decision-makers understand the value of any individual programmatic investment.

We assessed the savings to borrowers from the presence of a greenium and reduced subsidy costs, and we examined a variety of costs, including monitoring, evaluation, and registration expenses. See Section 4.3 for a detailed discussion of methodology, assumptions, and scenario analysis.

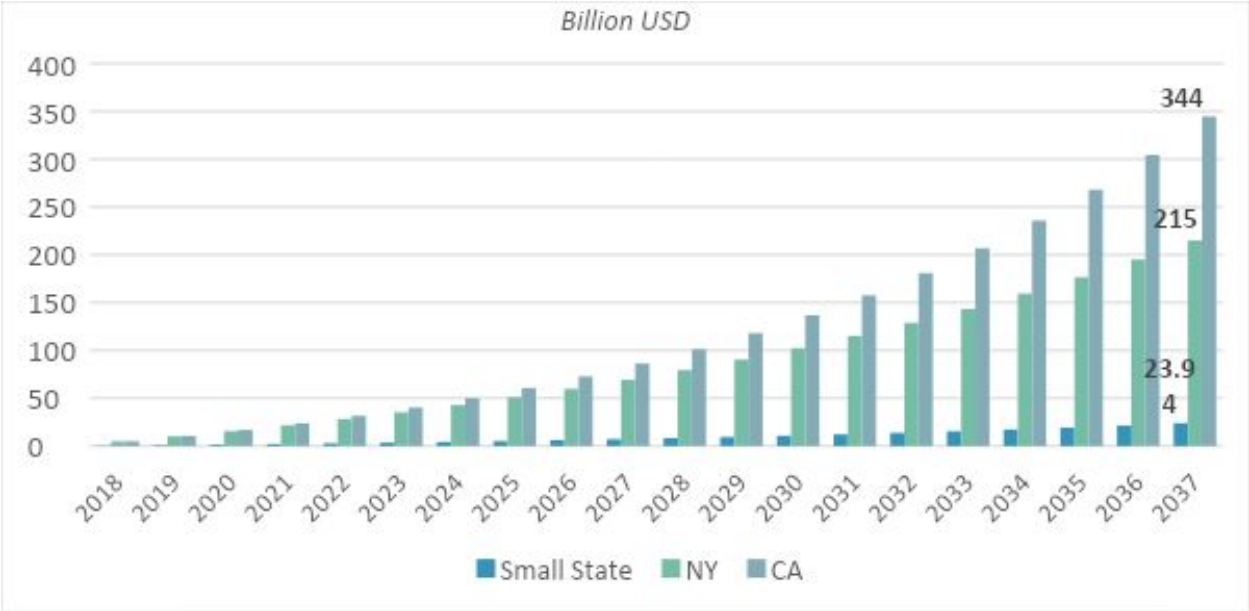
2.1. Key Findings

Our cost-benefit analysis, which relied on expert interviews and surveys and extensive desk-based research, found that implementing MSTR would generate $3.30 in benefits for every $1 in costs for California and New York, and $1.20 in benefits for small states over 20 years. In addition, MSTR will generate more than $1 billion in net present value for participating states combined and rapidly expand the size of the green municipal bond market to nearly $600 billion. See Section 4 for an extensive methodology review.

2.1.1. Key Finding 1: Growing the Green Bond Market

MSTR will grow the U.S. green municipal bond market from about $29 billion in cumulative issuance to $580 billion by 2037. Green municipal bonds in 2037 will account for 20 percent to 27 percent of the total municipal market.

Chart 4: Cumulative Green Municipal Bond Market Forecast

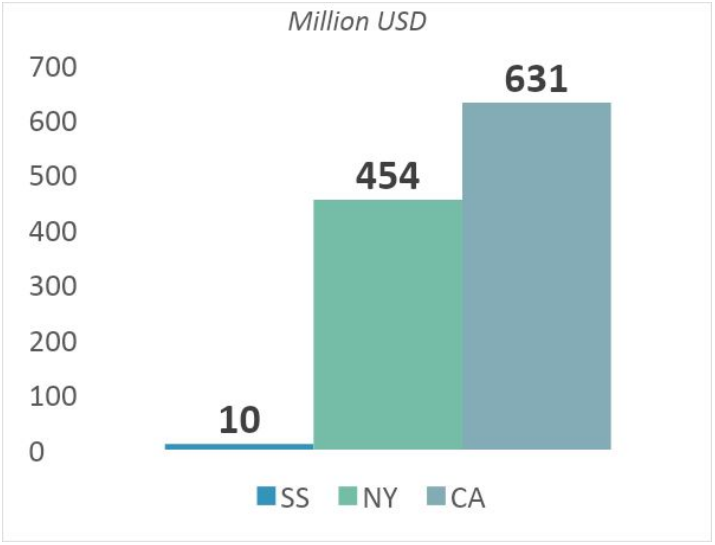


Source: Author Calculation

2.1.2. Key Finding 2: Hundreds of Millions of Dollars in Benefit

MSTR will generate more than $1 billion in net present value for California and New York. The program's benefit will be net positive for small states, but miniscule in relative terms, at just $10 million in net present value because of a small state's low level of green bond issuance.

Chart 5: Net Present Value for Multi-State Tax Reciprocity



Source: Author Calculation

2.1.3. Key Finding 3: Strong Benefit-Cost Ratios

The benefit-cost ratio (BCR) is greater than 1 for all participating cases, which suggests that all participants will generate more benefits than costs from MSTR. However, the program is heavily weighted toward large states, such as California and New York, who generate more than $3.30 in benefits for every $1.00 in cost.

Chart 6: Benefit-Cost Ratio for Implementing Multi-State Tax Reciprocity

Source: Author Calculation

2.1.4. Key Finding 4: Greenium Breakeven

CA: 1.8 bps
NY: 1.8 bps
SS: 3.5 bps

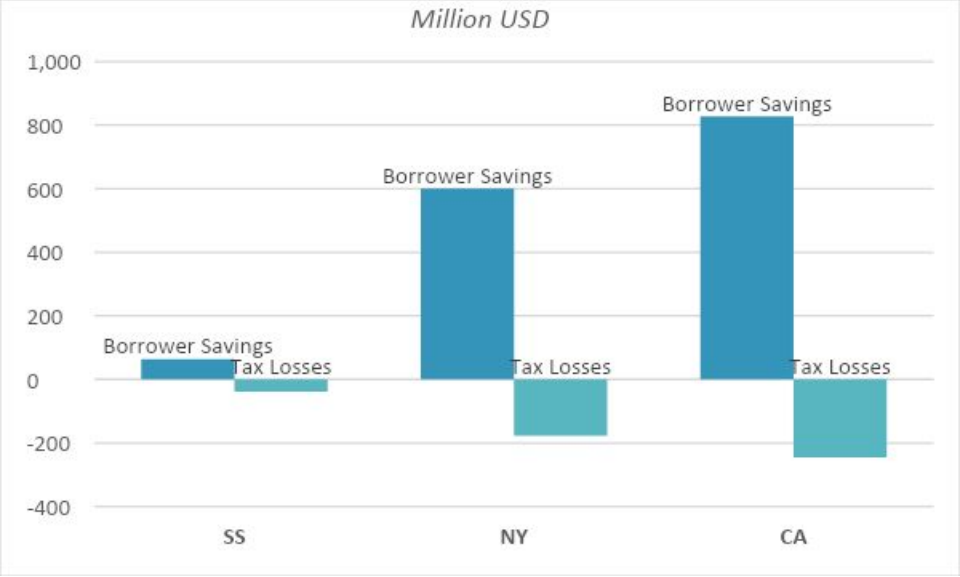
Base Case:
6 bps

The single-most important variable for the MSTR program is the size of the Greenium. The base case assumes a Greenium of 6 basis points (bps), but break-even analysis revealed that the Greenium can be as low as 1.8 bps for large states and 3.5 bps for small states to still make MSTR valuable to participants, all else being equal.

2.1.5. Key Finding 5: Borrower Savings and Tax Losses

Borrower savings and tax losses represent the single-largest benefit and cost, respectively, in the MSTR program.

Chart 8: Present Value of Borrower Savings and Tax Losses



Source: Author Calculation

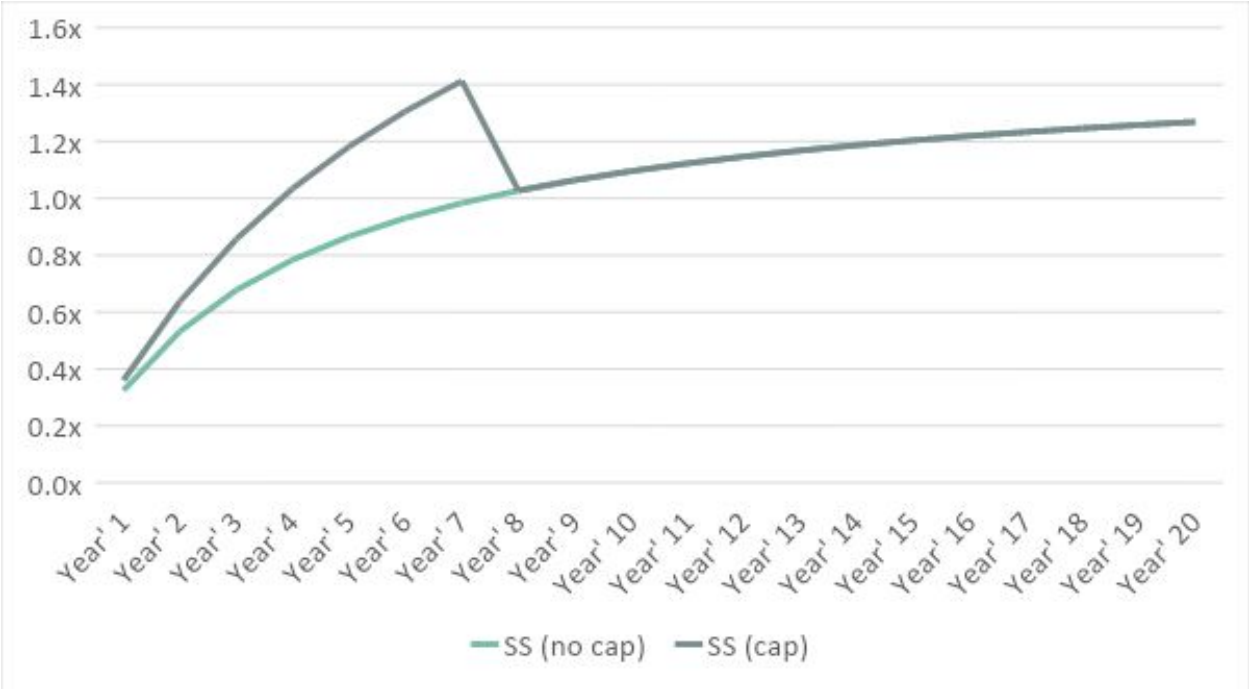
2.1.6. Key Finding 6: Small State Tax Loss Cap Necessary

Under the base case scenario, small states would achieve a BCR of greater than one[19] in Year 8, versus large states that immediately achieve a BCR of greater than one. However, capping tax losses at 50 percent in every year where costs do not exceed benefits allows the MSTR program to accelerate the accrual of benefits for small states

[19] A benefit-cost ratio of greater than one means that the program has generated more benefits than costs.

to Year 4. In Chart 9, the “no cap” line identifies the BCR without a tax loss cap, and the “with cap” line shows the acceleration of benefits after installing the tax loss cap.

CHART 9: SMALL STATE BENEFIT-COST RATIO, CAP VERSUS NO CAP



Source: Author Calculation

3. Solutions

3.1. Pathway to Implementation

3.1.1. History: Origins of The Tax Exemption

The Tenth Amendment to the Constitution, the Tax Equity and Fiscal Responsibility Act of 1982, and the Revenue Act of 1913 form the legal basis on which states can exempt interest income on municipal securities from state income tax (Spiotto, 2013).

3.1.1.1. Tenth Amendment to the Constitution

Justification of tax exemption of interest on government securities and bonds dates back to the United States founding fathers' belief that taxes levied against the Nation's own debt securities would destroy its foreign credit. Powers not expressly granted to the national government are reserved to the states.

3.1.1.2. Tax Equity and Fiscal Responsibility Act of 1982

The Tax Equity and Fiscal Responsibility Act demonstrates that state and local government taxation of interest income on municipal securities is determined by individual state laws.

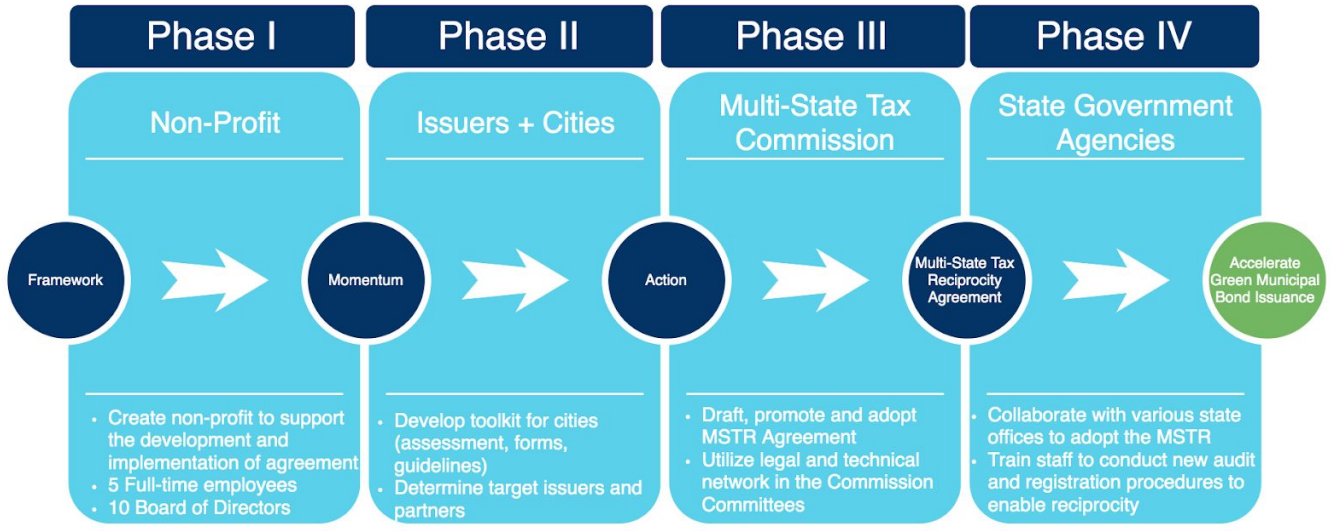
3.1.1.3. Revenue Act of 1913

Section 103(a) of the Internal Revenue Code excluded interest on municipal bonds from federal income tax (Spiotto, 2013). Therefore, an MSTR program need only focus on state-level income taxes.

3.1.2. Future: Pathways to Implementation

An implementation plan could be designed from the perspective of a state government, individual issuer, or non-profit. This report provides a plan that involves various stakeholders of the green municipal bond sector. This plan outlined below.

Figure 10: Implementation Phases



3.1.2.1. Create a Non-Profit to Implement and Develop the Tax-Reciprocity Agreement

The MSTR will be associated with a registered 501(c)(3) non-profit corporation, called MSTR, Inc. The main objective of the non-profit would be to support the development and implementation of the MSTR among states: California and New York would be the two states in the agreement. Initially, the governors of California and New York would need to sign a Memorandum of Understanding (MOU) to increase the issuance of municipal green bonds. After a trial year, this agreement can potentially grow to include more states and or Observing Members.

This model mirrors the Regional Greenhouse Gas Initiative (RGGI), a carbon-trading, multi-state program with nine signatory states. The operating costs of RGGI is funded by the states, and an MSTR entity would strongly benefit from similar support. However, there are many challenges to convince states to bear administration costs, while many of the municipalities and issuers would receive the benefits.

3.1.2.1.a. Costs and Staff

Mirroring the RGGI model, technical support of the analysis and evaluation of the agreement would cost $437,000 annually and $192,000 for annual monitoring.[20] The non-profit would operate with 5 full-time staff members. These staff members would include an Executive Director, Director of Program Implementation, Director of Program Administration, Director of Communications and Business Manager. Additionally, the non-profit may consist of 10 board of directors that are from various green municipal bond, tax law, and government leaders. The board of directors would not be compensated for their contribution of an estimated 5 hours a month.

3.1.2.1.b. Timeline

The entire process of establishing the non-profit hinges on the amount and time it takes to get funding from the state governments. Once the funding is approved, it would take approximately one month to select and hire 5 staff members and 10 board members.

3.1.2.2. Develop Momentum with Municipal Governments and Issuers

MSTR Inc. would adopt a grassroots movement to catalyze the creation of the MSTR agreement. MSTR Inc. will need to gain support from municipal governments and various green municipal bond stakeholders to demonstrate a need to increase the issuance of green municipal bonds. These stakeholders can provide accountability and create pressure to transform the MSTR into action. Additionally, MSTR Inc. could create an external committee to engage with the recommendations and actions executed by MSTR Inc.

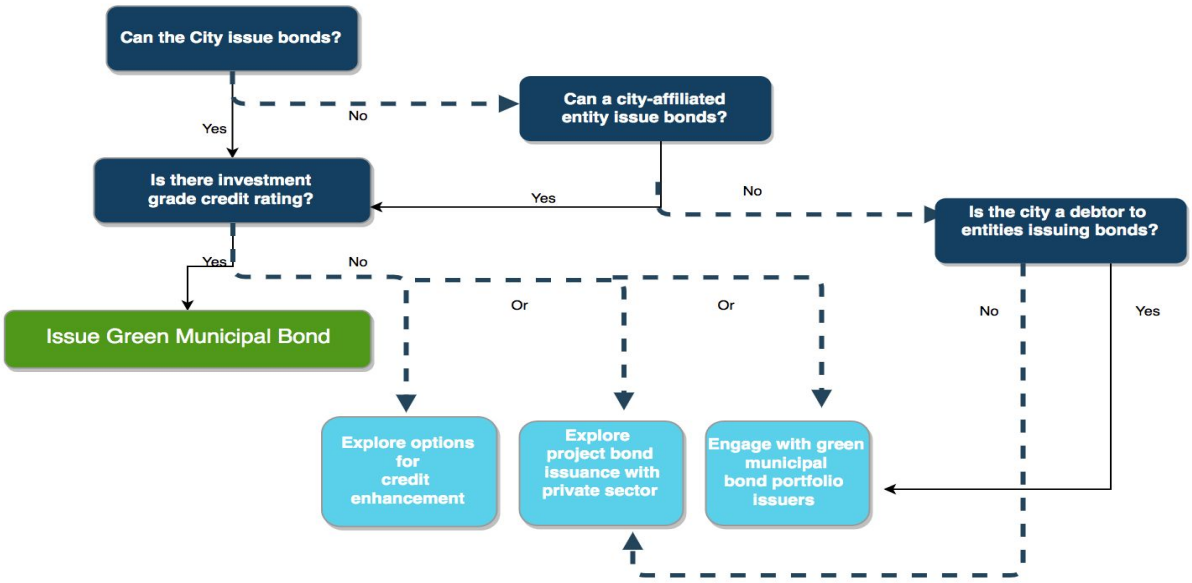
3.1.2.2.A. Tool-kits for issuers

MSTR Inc. would create a toolkit for issuers that could include guidelines and forms for new green municipal bond issuers. These guidelines could enable issuers to assess the credit worthiness of their balance sheets, size and risk profile of the green infrastructure investments, and cities' project eligibility to issue green municipal bonds.

An example of a toolkit material is the assessment illustrated below. Issuers can use this quiz in order to understand whether they can issue green municipal bonds.

[20] RGGI, "Program Design," 2019, https://www.rggi.org/program-overview-and-design/design-archive.

FIGURE 11: TOOLKIT COMPONENT FOR ISSUING GREEN MUNICIPAL BONDS



Source: Climate Policy Initiative[21]

3.1.2.2.B. TARGET MUNICIPALITIES

It will be critical to rapidly identify and cultivate partnership for the MSTR. Such partners could include large cities initially because of their increased capacity for debt issuance: New York, Los Angeles and San Jose. Then, MSTR Inc. could begin incorporating other cities in New York and California.

3.1.2.3. CREATE A TAX-RECIPROCITY AGREEMENT WITH THE MULTISTATE TAX COMMISSION

The MSTR Inc. would also work with the Multistate Tax Commission to draft, promote, and adopt the agreement between states.

The objective of the Multistate Tax Commission is to promote uniformity in tax administration among states. Over the past twenty years, the Multistate Tax Commission has been facilitating the uniformity and fairness in state taxation in the United States. It achieves this mandate by drafting and adopting uniform rules. Additionally, the Commission resolves issues of over taxation and under taxation through research and meetings between states (Multistate Tax Compact, n.d.).

The MSTR non-profit could work with the Commission to create the MSTR agreement through the following process:

Develop the MSTR agreement: The Multistate Tax Commission would utilize its network of legal and tax experts to draft the Agreement into a feasible plan. Additionally, the Commission is aware of the state and local tax systems across the United States. Therefore, they can help the non-profit understand the specific state laws that will need to be updated in order to make the Agreement into a reality.

[21] Padraig Oliver, "Green Bonds for Cities: A Strategic Guide for City-Level Policymakers in Developing Countries" (Climate-KIC, December 2016), https://climatepolicyinitiative.org/wp-content/uploads/2016/12/Green-Bonds-for-Cities-A-Strategic-Guide-for-City-level-Policymakers-in-Developing-Countries.pdf.

Release draft for public comment: Once the draft Agreement is created, the non-profit and commission could open-up a 90-day period where stakeholders can submit comments and feedback. This feedback can be received through online platforms, in-person meetings, and by mail.

Update the Agreement: Afterwards, the commission and the non-profit would conduct extensive research to the concerns and feedback from stakeholders. The goal of this process is to create a uniform agreement that will not be more advantageous for one state or issuer.

Compile and Publish: The Multistate Tax Commission and the non-profit would assist California and New York adopt the agreement into their own laws and procedures. Additionally, the Multistate Tax Commission could help states develop mechanisms to perform interstate audits.

Certification: An MSTR program will need to set standards for which "green" bonds are eligible for tax exemption. A few international programs exist to certify the "greenness" of a green bond, the most recognized being the Climate Bonds Initiative. CBI's Climate Bonds Standards and Certification Scheme uses rigorous scientific criteria to ensure that Climate Bonds Certified Bonds are consistent with the 2 degrees Celsius warming limit in the Paris Agreement (Fernandez, 2018), and it appears most appropriate for an MSTR standard. Climate Bonds Certification comes with internal and external costs. Internal costs are born by the issuer when they establish internal processes and controls to meet the certification requirements. External costs are based on commercial negotiation, but are often equivalent to $1/10^{th}$ of a basis point of the bond principal. This fee is only paid once after the issuance of the bond. The fee of the certification process is not a barrier. Instead, it acts as a signal to the rest of the market that company is applying environmentally-progressive initiatives.

3.1.2.4. Roll-out the Implementation Plan through Government Agencies

Experts surveyed (see Section 4) concluded that it will take one to five years to complete an MSTR Agreement from inception to adoption. This timeline will strongly hinge on how long it takes the state and city government to adopt the reciprocity agreement into their systems.

One point of entry into the mechanics of the government bureaucracy is through the Budget Code system. Budget codes are 4-digit numbers assigned to an agency and tracks the financing of the bonds.[22] The Comptroller's Bureau of Accountancy and the Office of Management and Budget would need to create a Green Municipal Bond status code to automate the funding process. Then, the Bureau of Accountancy would assign the status to all the Green Municipal Bond Codes to ensure the processes are applied and updated automatically. Once these codes are registered and the spending occurs, the proceeds can be used to fund green projects. This coding system would need to expanded to include the place of registration and the interest income amount, which suggests a great deal of coordination between the taxation offices and the comptroller's offices for each state and city is needed.

3.2. Risks and Concerns

Multi-State Tax Reciprocity faces many risks and challenges to adoption and implementation. First, political concerns, as highlighted in the Expert Survey, are the primary problem. For a program that involves various states, it could be a lengthy process to lobby the state or local governors, treasurers, comptrollers, and other politicians from different political parties to approve this multi-state program. In particular, it would be difficult to reconcile the interests of different stakeholders and the differences in economic development goals and tax policies.

[22] Scott Stringer, "A Green Bond Program for New York City" (New York City Office of the Comptroller, September 1, 2014), https://comptroller.nyc.gov/reports/a-green-bond-program-for-new-york-city/.

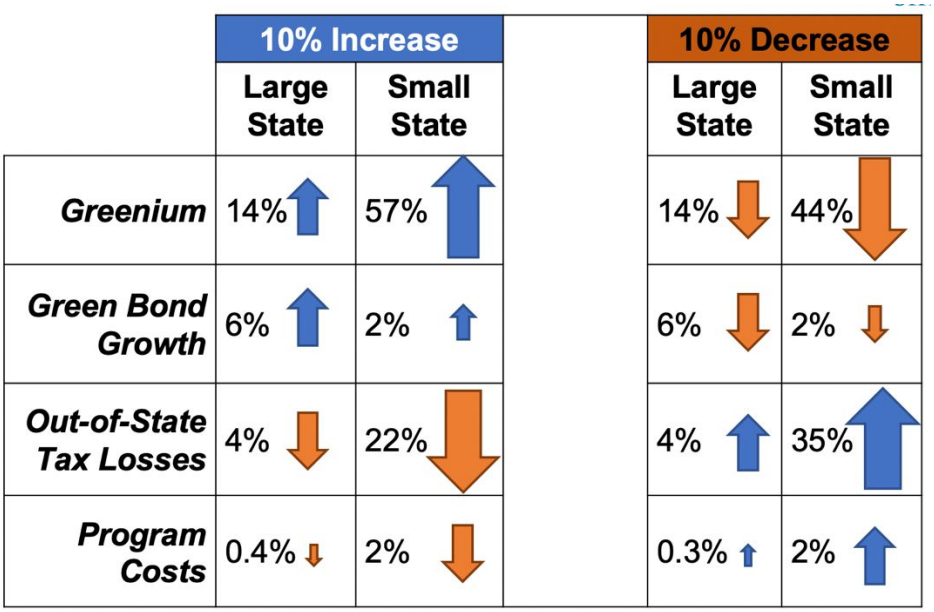
Second, our model relies on several imbedded assumptions, which could change over time or be different from the real world, even though these assumptions are the result of extensive market research and outreach to dozens of experts. Therefore, more work is needed to quantitatively estimate the tradeoff between the costs of the MSTR program and the benefits of scaling up the green municipal bonds issuance to finance green infrastructure for individual states or municipalities. This may hold back green municipal bonds issuers from accelerating issuance.

As estimated, the costs associated with the establishment and implementation of the MSTR program are quite sizable, especially to small issuers. The additional costs or time requirement for issuing municipal bonds could be very burdensome on them because they do not have requisite resources.

Another roadblock for the MSTR program is the legal issue, which was also recognized by our experts in the survey (see Section 4). To implement the MSTR program, program administrators would need to seek legal support from state and municipal governments, which may also take a large amount of time and coordination.

Last, the CBA shows that the net present value (NPV) of the MSTR program in small states is more sensitive to changes in the cost benefit analysis variables than in large states. For instance, a 10 percent increase in out-of-state tax losses would decrease the NPV of the MSTR to a small state by 22 percent compared to a much smaller 4 percent to a large state. And a 10 percent decrease in the greenium would decrease the NPV of the MSTR to a small state by 44 percent compared to just 14 percent in a large state. This may be hard to reconcile and then discourage the small states to take part in the program. See Section 4.3 for more information on the CBA methodology.

Chart 12: Result Sensitivity to Changes in Variables



Source: Author Calculations

3.3. Alternatives and Complements

Although we estimate that the MSTR program could generate hundreds of millions of dollars in benefits, it is not the sole means of scaling up the issuance of U.S. green municipal bonds. This section reviews several other methods of increasing green bond issuance.

3.3.1. Credit Enhancement

What is credit enhancement? It is a risk-reduction technique whereby a company improves its credit rating, lowering its cost of capital. Bond insurance is a type of credit enhancement, in which a bond insurer unconditionally and irrevocably guarantees that interest and principal will be paid as scheduled even if the bond issuer defaults. If a bond carries insurance, it typically is insured in the primary market, at the time of issuance, but it may also be insured at any time in the secondary market. For some small municipal issuers, access to capital markets is made more affordable and easier because of bond insurance. Some of today's municipal bonds are insured by monoline insurers, or insurers that back debt securities only and are not exposed to risks from any other lines of business. They may, however, be exposed to other forms of risk, and are closely monitored by the major credit rating agencies.[23]

Monoline insurers conduct an underwriting process before insuring a municipal bond: the insurers examine the issuer's tax base (if applicable) and operations, regional economy, financial condition, existing debt, expected future borrowing, and spending requirements, as well as the legal provisions securing the bonds. Bond issuers, or the investment banks and securities dealers that sell the bonds, typically pay the insurance premiums. There are no direct charges for investors, but the investor may earn less income than if the bond were not insured because of the added protection provided by the insurance.

Why do bond issuers buy insurance? It improves the credit quality of a bond, making it easier to sell. Bond insurance boosts credit quality by offering protection against default or downgrade if a bond issuer cannot meet its obligations to pay interest and principal to bondholders.

Insured municipal bonds are rated based on the credit of the insurer rather than the underlying credit of the issuer. A higher credit rating would allow the issuer to benefit from lower financing costs because bonds with high ratings—and, therefore, greater security—paying lower interest rates. This also leads to enhanced liquidity for insured bonds because there is greater demand among investors for highly rated securities. Even highly rated bond issuers use bond insurance to lower the costs of borrowing.[24]

Application to green municipal bonds: In order to expand the issuance of green muni bonds, bond issuers can enhance the credit quality of the green muni bond by buying insurance, making it more attractive to investors. States, such as California or New York, could use existing authorities to offset the cost of insuring green bonds, therefore indirectly subsidizing the enhanced credit rating for green bond issuance.

3.3.2. Pooling Small Bonds Using a Regional Fund

What are regional municipal issuer funds? A regional fund is a mutual fund run by managers who invest in securities from a specific geographic area. It is an investment vehicle made up of a pool of money collected from many investors for the purpose of investing in securities such as stocks, investment grade bonds, high-yield bonds, leveraged loans and other assets. Some regional funds invest in a specific segment of the region's economy.[25] Most

[23] "Frequently Asked Questions About Municipal Bonds," Investment Company Institute, 2019, https://www.ici.org/faqs/faq/other/faqs_muni_bond.

[24] "Frequently Asked Questions About Municipal Bonds."

[25] Investopedia, "Regional Fund," June 24, 2018, https://www.investopedia.com/terms/r/regionalfund.asp.

green municipal bond issues are often too small to attract institutional investors. For example, according to the Milken Institute, the minimum outstanding amount for a bond to be included in the U.S. Aggregate Bond Index is $300 million and the average U.S. green municipal bond at issue is $106 million.[26]

One solution to overcome this obstacle is to aggregate small green bonds into one larger offering. For example, municipalities could replicate the work of Connecticut's Metropolitan District (CMD), a group of eight municipal issuers from the Hartford metropolitan area that provide water supply, pollution control, and waste collection services. Individually, none of these municipalities can issue bonds large enough for inclusion in an index, but together, they are able to make larger offerings. In California, they are various regions that could benefit from a pooled issuance model, especially the largely agricultural Central Valley.[27]

Application to green municipal bonds: An existing issuing authority could be used for pooled issuance, such as one of the authorities chaired by a State Treasurer or a regional authority. Alternatively, like-minded agencies already have authority to enter into "joint powers agreements" that could enable pooling. Creating such a pooled arrangement requires political will from local legislators. The first step would be to identify interested municipalities and agencies and to determine how to aggregate them to make larger issuances feasible and creditworthy. One could then nudge regional fund managers to invest in pooled green municipal bonds within the specified geographic area. For those average investors interested in investing in green municipal bonds, regional funds could also help them manage their portfolio by buying and selling the green muni bonds in the market and make them better off.

3.3.3. Municipal Bond Funds

What is a municipal bond fund? This is a kind of specialty fund that invests particularly in municipal bonds. Municipal bond funds can be managed with varying objectives that are often based on location, credit quality, and duration. Municipal bond funds are exempt from federal tax and may also be exempt from state and local taxes for residents of that state.

Why municipal bond fund? Municipal bond funds are an attractive option for an investor's conservative allocation due to their income and tax exemption. They are often sought by high-net-worth investors in higher tax brackets specifically for their tax exemption advantages. [28] In addition to tax exemption, municipals offer distributions that make them top investment choices for income investors.

Application to green muni bonds: Such municipal bond funds already exist at the single state level, and the idea is to expand the scope of this fund to regional level. Accompanied with the MSTR program, the municipal bond fund could also establish a tax-exempt framework across states. Currently, the municipal bond funds are only exempt from federal tax and state and local taxes for residents of that state. By establishing tax reciprocity across states, the municipal bond funds can be exempt from federal tax and state and local taxes for residents of other states. Since tax exempt municipal bond funds are particularly popular among investors with higher net worth and higher tax brackets, it would be a great idea to drive municipal bond fund managers to invest in the green muni bonds, further increasing the demand for that security in the market, thus helping scale up the issuance of green municipal bonds in the US.

[26] Caitlin MacLean and Maressa Brennan, "Growing the U.S. Green Bond Market - Volume 2: Actionable Strategies and Solutions" (The Milken Institute Financial Innovations Lab, 2018).

[27] MacLean and Brennan.

[28] "Frequently Asked Questions About Municipal Bonds."

4. Methodology

4.1. Expert Interviews

4.1.1. Summary of Interview Status

In total, our team has interviewed 25 individuals whom we have deemed area experts in the industry of either the municipal debt market, the green debt market, or a combination of the two. In total we reached out to approximately 75 individuals. Though our sampling of area experts is overwhelmingly tilted towards the positive side, we made it a point to interview all angles of the industry, including experts whom are strongly tilted against the idea of a green municipal bond industry. Spanning both academics and industry practitioners, this is a group of people who are clearly knowledgeable about the future of financing and especially debt markets. Examples of professions include that of municipal and city treasurers/comptrollers, public tax specialists, financial administrators, university professors, the private sector financial industry, and those working within non-governmental organizations (NGOs). Green bonds are generally considered a niche market segment, while the combination of both green and municipal debt is considered niche further still. Finding such experts that can attest to both areas is difficult, however area experts in one of the two main areas are more abundant and easier to source.

Each of these four general silos play an important part in pushing forward the frontier of this budding industry. NGOs and industry coalitions play a crucial role in expanding an industry via various forms of public-private partnerships. Since private industry will usually not act unless there is some form of financial incentive and the public sector generally lacks creativity as a conventional norm, it is the NGO space that usually steps into this space to bridge the two. One of the most prominent actors in the green bond NGO space is the Climate Bonds Initiative (CBI). CBI "promote(s) investment in projects and assets necessary for a rapid transition to a low carbon and climate resilient economy." CBI is, in many respects, a leading authority within the universe of green bonds.

As the private sector financial industry plays a critical role in creating new financial products, this is a critical segment of the equation that will push forward the overarching international industry of green bonds. Ratings agencies (Moody's Investors Service, Standard & Poor's (S&P), and Fitch Ratings) will continue to play an important role in the expansion of this industry as they send signs to the general market that legitimizes the industry. Another area representative of the private sector financial industry is that of fund managers, who make direct or indirect investments. This group can provide a critical vantage point that is unique to the other silos because it is a vantage point based on financial return as opposed to other types of motivations.

Our access to the academic practitioner is perhaps the most abundant because as students we share the same environment. As many of the academics at Columbia University's School of International and Public Affairs (SIPA) is made up of individuals who also are industry practitioners, we conducted numerous interviews with individuals who have achieved a substantial degree of authority in both fields.

The third element of our interview group consists of public servants working at the municipal, state, and federal levels. As we identified the states of California and New York as having the greatest ability to expand the municipal green bond market, we focused our attention on municipal and city treasurers/comptrollers, tax departments, and internal revenue departments of both states. As the industry as a whole is still in the early stages of development, most of the issuances have come from larger cities and metropolitan areas, specifically that of New York City, the Silicon Valley-Bay Area, and metropolitan hub of southern California.

4.1.2. Expert Interview Results

We conducted in-person or phone interviews of 23 experts who are in some way relevant to green municipal bonds. These experts came from academia and the industry and provided their perspective on how the market operates currently, its potential for growth, alternatives to scaling the green bond market, and more. One caveat is that many of the interviewees are actively participating in the industry because they share a common vision the importance of a green economy, which may therefore bias their responses.

4.2. Cost-and-Benefit Analysis

4.2.1. Model Design

4.2.1.1. Process

Determine Scope of Model: The first step to creating a CBA model is to determine the relevant actors involved and the time horizon for the model. For MSTR, we are interested in examining how three states would be affected by the program: California, New York, and a typical small state. We chose these options because California and New York are by far the largest issuers of green bonds and have large economies to support future growth. The small state example helps modelers understand how a state that may generate less benefit from MSTR would see the value of investing in the program, using representative inputs that can be extrapolated for any relatively small state, such as Connecticut or Maryland. For the model scope, we chose 20 years because that is a typical maturity for municipal bonds.

Identifying and Calculating Costs and Benefits: The second component of a CBA is to identify the costs and benefits associated with the project. In this case, we evaluated the costs and benefits associated with implementing a Multi-State Tax Reciprocity (MSTR) program to scale up municipal green bond issuance in the United States. Our main channels to understand the costs and benefits were by interviewing industry and academic experts and conducting desk research. The next step is to assign monetary values to each of the costs and benefits. The data for this assessment comes from our interviews with 26 industry and academic experts, state and local government databases, tax policy non-profit(s), and financial institutions.

Benefit: Cheaper Borrowing Costs

Assuming the presence of a green bond premium, green bonds would sell at a higher price to comparable "vanilla" bonds, which would reduce the bond's yield. The reduced yield decreases the coupon payments issuers must make to investors, resulting in cheaper borrowing costs. Quantifying cheaper borrowing costs required forecasting cumulative municipal bond and green municipal bonds, assuming a Greenium and vanilla bond yield, calculating the difference.

$$Borrowing\ Savings = Cumulative\ Green\ Bonds * (Yield - Greenium)$$

Benefit: Reduced Subsidy Costs

A bond's reduced yield would also lower the taxable interest that investors generate. Tax exemption is effectively a subsidy that the states provide to borrowers, and any reduction in interest generated necessarily reduces the cost of tax exemption to the state.

$$Reduced\ Subsidy\ Costs = Borrowing\ Savings * Tax\ Rate$$

Cost: Tax Losses

Expanding tax exemption to out-of-state bonds would reduce a state's tax revenue because they would no longer be able to collect if an in-state investor purchases a bond from a state participating in MSTR. Calculating tax losses requires determine the number of green bonds that were issues out of state in a state participating in the MSTR program, and then apply the average tax rate against it.

$$Tax\ Losses = Cumulative\ Green\ Bonds * Out\ of\ State\ Proportion * Tax\ Rate$$

Cost: Monitoring and Evaluation

Monitoring and evaluation costs are required to file regular reports with investors to confirm a bond's proceeds are being used for green projects and to keep up the back-office tasks that come with green bond issuance. There are very few programs that convey tax reciprocity for municipal bonds, and finding reasonable monitoring and evaluation costs was challenging. Ultimately, our model relied on the costs associated with the Regional Greenhouse Gas Initiative as a reasonable proxy. The model also assumes that these costs escalate at the same rate as the green bond market grows.

$$Monitoring\ and\ Evaluation\ Costs = Monitoring\ Costs + Evaluation\ Costs + Staff\ Costs$$

Cost: Registration Costs

Many investors require self-labeled green bonds to undergo third-party verification and Climate Bonds Initiative certification. Verification costs can range from $30,000 to $100,000 and CBI charges one-tenth of a basis point on a bond's par value.

$$Certification\ Costs = Green\ Bond\ Issuance * CBI\ Certification\ Fee$$

$$Third\ Party\ Verification\ Costs = Green\ Bond\ Issuance * Verification\ Costs$$

$$Registration\ Costs = Certification\ Costs + Third\ Party\ Verification\ Costs$$

Discounting: After calculating the costs and benefits of MSTR over a 20-year time horizon, we discounted the cash flows back to present terms. To do this, we used a discount rate in line with the General Accounting Standards Board methodology to discount future pension obligations. This discount rate is represented by the yield of a highly rated, general obligation municipal bond index. We chose to use the Bond Buyer's 20-year GO Bond index, which led to an interest rate of 4 percent.

Calculating Net Benefits: The final step in a CBA is to sum all costs and benefits, subtract the total costs from the total benefits, and discount to present terms. The ultimate result is a net present value for the MSTR program as a whole and a benefit-cost ratio.

Tax Loss Cap for Small States: Recognizing that small states face disproportionately high costs from an MSTR program, we built a tax loss cap to reduce the present value of MSTR costs. The cap is triggered when the original per-period benefit-cost ratio (BCR) is less than one, in which case the model reduces tax losses—the biggest component of MSTR costs—by 50 percent. The cap remains in place until the original BCR rises to at least 1.0.

Scenario Analysis: The CBA model we created has 10 additional scenarios beyond the base case to ensure the model results were robust to a variety of sensitivities. To adjust the scenario routed through the model, select the

"Scenarios" tab and change the "Case Selector" value in Cell E8 to any number from 1 to 11. Each case is clearly defined in the Scenario Manager table.

Limitations: The CBA model does not incorporate the potential shifting demand of for green municipal bonds in California, New York and the small states because investors' appetite for green municipal bonds is hard to estimate--even generally--and is prone to change due to market dynamics. High oversubscription rates lead us to believe that demand for green bonds significantly exceeds supply, but the model does not take a view on how this dynamic might change in the long term.

4.2.1.2. Input Calculations and Assumptions

4.2.1.2.A. Municipal Bond Market Forecast

California	New York	Small State
64,596	47,042	5,000

Units: Million USD
Data Source: EMMA Database, Municipal Securities Rulemaking Board.

Actual Cumulative Municipal Bonds

The starting point to calculate the growth of the municipal bond market. We used 2017 full-year figures because the Tax Cuts and Job Act shocked the bond market in 2018 and sharply reduced issuance below the historical average.

California	New York	Small State
4.42	0.81	2.00

Units: Percent
Data Source: Authors calculations using the EMMA Database, Municipal Securities Rulemaking Board.

Municipal Bond Market Growth Rate

We calculated the 15-year average annual growth rate for each state, and applied this average starting with the Actual Cumulative Municipal Bond amount in 2017.

Yield

We calculated the average yield of the Bond Buyer 20-year GO municipal bond index over 15 years to determine future municipal yields. We assumed that the future yield would be constant at 4.23 percent.

4.2.1.2.B. Green Bond Market Forecast

California	New York	Small State
6.97	9.57	8.60

Units: Percent
Data Sources: Authors calculations using the EMMA Database, Municipal

Securities Rulemaking Board and Climate Bonds Initiative data.

Actual Green Municipal Bonds

The starting point to forecasting growth in the green municipal bond market is to determine the relative size of the market in each state. We assumed that green bonds will constitute a portion of the overall municipal bond market. We used Climate Bond Initiative data to calculate the percent of a state's 2017 municipal bond issuance were green.

Green Bond Market Growth Rate

To forecast the size of the green bond market, we polled 13 industry and academic experts to understand how the green bond issuance rates would change if a Greenium were present. The weighted average of their response was a growth rate of 6.85 percent per year. We assumed this growth rate was applied equally to each state.

4.2.1.2.C. Reduced Borrowing Costs

Reduced borrowing costs are the most important benefit of an MSTR program. Even small reductions in borrowing cost can add up to significant savings over 20 years. Volatility in the Greenium can drastically change the savings related to borrowing costs. We assumed that the future yield would be constant at 4.23 percent and the Greenium at 6 bps.

4.2.1.2.D. Taxes

Tax losses represent the single largest cost of an MSTR program, and calculating them relies on a supply forecast and a number of assumptions about tax levels and bond yields. Inadequate data on the portion of bond portfolios that are out of state drove us to make assumptions about out-of-state bond revenue. The 2018 tax rates in CA, NY and small states are 8.54%, 8.49% and 6.30% separately. We assume that the out-of-state proportion of bond issuances range between 5% and 15%.

4.2.1.2.E. Programmatic Costs

Certification by Climate Bonds Initiative

CBI charges a one-time fee of one-tenth of one basis point par value for each green bond formally certified by it.

Data Source: Expert Interview with CBI

Third-Party Verification

Green bond certification with CBI first requires third-party verification, which can be done by any organization approved by CBI to do so. These costs are a one-time expense and range from $30,000 to $100,000 per bond. We assumed a median value of $65,000, which equates to a par value of about one one-hundredth of a basis point.

Data Source: Authors calculations and Expert Interview with CBI

Category	Cost
Staff Costs	0.74
Monitoring	0.19
Evaluation	0.44

Units: Million USD
Source: RGGI[29]

Monitoring and Evaluation Costs

We used the Regional Greenhouse Gas Initiative costs as a proxy for monitoring and evaluation costs for an MSTR program. In addition, we assumed the costs are shared evenly between two states and escalate at the same growth rate as the green bond market.

4.2.1.2.F. Basic Inputs

California	New York	Small State
8.54	8.49	6.30

Units: Percent
Date Source: Tax Policy Institute[30]

Tax Rates

We assumed that states personal income taxes for the duration of the model would remain constant at 2018 levels.

Proportion of Green Bonds Out of State

After an exhaustive review of literature and databases, we concluded that there are no accessible data sources that indicate the number of out-of-state municipal bonds held by investors within a given state. Therefore, we assumed that this volume is 5 percent for large states and 15 percent for small states because large, high-tax states would have more in-state offerings for investors and therefore lead them to purchase fewer out-of-state bonds.

Data Source: Assumption

Small State Calculations

To generate municipal bond estimates reasonably commensurate with an average small state, we took the simple average for Massachusetts and Connecticut for each relevant variable.

Data Sources: Varied

4.2.2. Instructions: How to use the model

Within the CBA model there exist six different tabs. From left to right, the first tab, titled 'overview' is a highly stylized display page of multiple graphs, charts, and tables. The display in this page will change as different scenarios are chosen in the third tab titled, "Scenarios." The second tab, titled "Inputs" shows the main assumptions that feed the model for California, New York, and the 'small state' hybrid based on averages of both

[29] RGGI, "Program Design."

[30] Jared Walczak and Scott Drenkaard, "State and Local Tax Rates 2018" (Washington, D.C.: Tax Foundation, February 13, 2018), https://taxfoundation.org/state-and-local-sales-tax-rates-2018/.

Massachusetts and Connecticut. These assumptions were based on expert interviews, the literature review, industry studies, and extensive market research.

The Scenarios tab displays how 11 different scenarios could play out by affecting the future growth of the green municipal bond industry. Individual cases can be chosen by clicking the shaded cell E8. Of note, cases 13-22 represent a 10 percent +/- change in several variables to calculate inputs for tornado charts, and are therefore not true scenarios.

In the area below these elements is a data table that displays all such results for the 11 scenarios in one location, such as the Net Present Value (NPV) and Benefit-Cost Ratio (BCR). This Scenario Manager, enables the user to efficiently and elegantly compare different sensitivities against the model to better understand at what point does MSTR become net negative to states. As it turns out it takes quite an excessive amount of negative assumptions to occur for MSTR to turn out to be a bad investment for a state.

The CBA tab starts with a large overview of all the costs and benefits and is where most of the operational calculations are located. The first part of the model is understanding the size of the issuances for normal municipal bonds and green municipal bonds over time. As our starting point for estimating future growth, using a standard set of assumptions, such as the historic growth rate for municipal bonds, we determined the current market size that exists for municipal bonds in the states of California, New York, and the generic small state. Combining these multiple variables together, results in a projection for the green municipal bonds, resulting in issuances per year and cumulative issuances per year. Cumulative issuances per year provides a sense for how much interest is being generated for any given period. The individual issuances per year helps better understand the programmatic costs associated with MSTR.

The next section is the benefits section. The two main benefits include, the Reduced Borrowing Costs associated with a lower yield due to the greenium and the Reduced Subsidy Costs from Tax Exemption. Combining the two main benefits, the Reduced Interest Expenses and the Reduction in Subsidy Costs, is where the bulk of the benefits are found. We combined the two benefits to determine the Total Benefits in any given period, found at the top of the CBA tab: Total Costs, Total Benefits, and combined together is effectively the Net Benefits, which is discounted back to the present at the standardized industry discount rate. The “L” (Legend) tab and the “N” (Name) tab are used for standardized formatting and naming purposes.

4.2.3. Scenarios Analysis

Apart from our base case, the model includes a number of scenarios to better understand how the NPV and benefit-cost ratio change in different situations:

Case 1: Greener Market: In this scenario, we assume that the growth rate of green bond doubles the increase of 10% in base case. The result NPV triples in CA and NY and doubles in small states, while benefit-cost ratio barely moves.

Case 2: Bigger, Greener Market: Given the condition of greener market in case 1, we assume that the municipal bond issuance growth rate increase by 5%. The result is similar as the case 1 with a little bit more NPV in CA and NY and a little bit less NPV in small states.

Case 3: Smaller, Greener Market: Given the condition of greener market in case 1, we assume that the municipal bond issuance growth rate decrease by 5%. The result is also similar as the case 1 with a little bit less NPV in CA and NY and a little bit less NPV in small states.

Case 4: High Greenium: In this scenario, we assume that the greenium is 22 bps--the largest Greenium reported in the academic literature--instead of 6 bps in base case. The result NPV increases nearly five times while benefit-cost ratio nearly four times.

Case 5: Low Greenium: In this scenario, we assume that the greenium is 3 bps instead of 6 bps in base case. The result NPV decreases more than three times while benefit-cost ratio drops by nearly half.

Case 6: Increasing Greenium: In this scenario, we assume that the greenium increases by 1 bp per year, representing the increasing importance of the Greenium in the eyes of investors. The NPV increases by nearly five times for CA and NY and 17 times for small states.

Case 7: High yield: In this scenario, we assume that the muni bond yield is 5.23% instead of 4.23% in the base case. The result NPV is slightly lower than the base case.

Case 8: Low yield: In this scenario, we assume that the muni bond yield is 3% instead of 4.23% in the base case. The result NPV is slightly higher than the base case.

Case 9: Higher out-of-state tax losses: We assume that out-of-state bond revenue will be 5% for large state and 15% for small state, because the demand for green municipal bonds for the residents in small states will be less than the supply. If this factor increases, it will have negative effect on NPV because more out-of-state investors result in more out-of-state tax losses.

Case 10: Lower out-of-state tax losses: If this factor decreases, it will have a positive effect on NPV because less out-of-state investors result in less out-of-state tax losses.

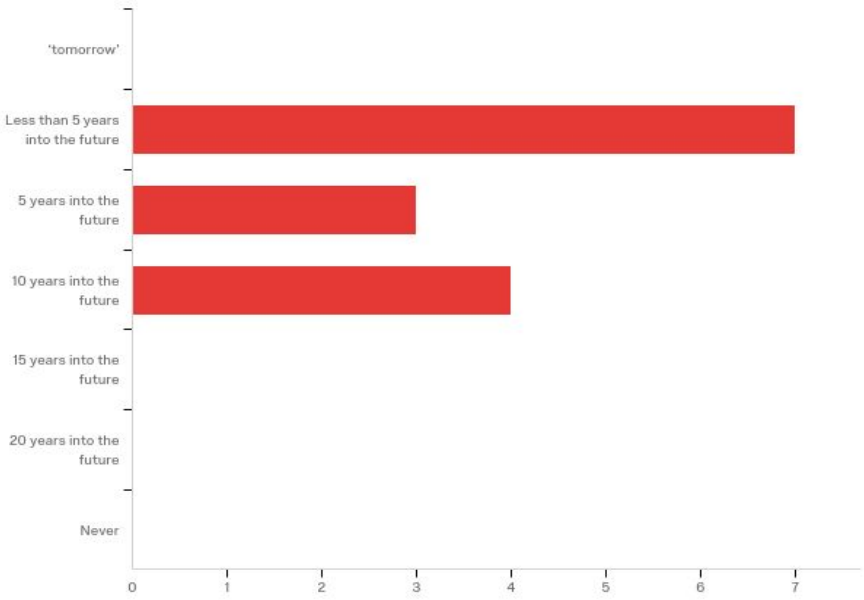
Case 11: Program costs: Higher program costs will result in lower NPV. For small states, they are much more sensitive to the change in program costs than NY and CA.

4.3. Survey Results

To quantify various components of the model, we conducted an expert survey. The survey was a multiple choice, five question survey that takes place on a Qualtrics-administered online platform. We constructed the survey as a means to create assumptions for our Cost Benefit Analysis (CBA) that are in-line with industry views. A total of 14 academics and industry experts responded to our survey, with participants taken from our pool of interviewees. The following is a brief overview of the questionnaire, including reasoning why we choose to frame our questions in such a manner.

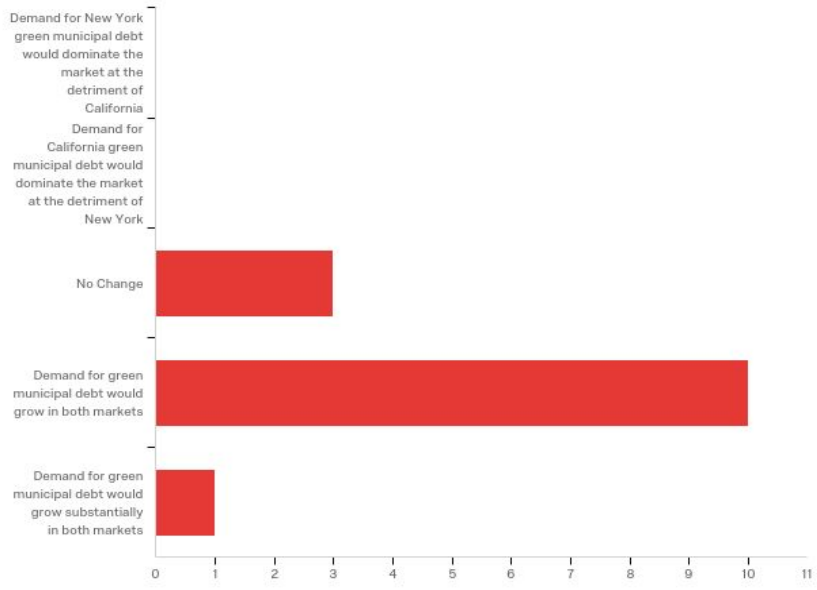
Question 1 addressed the rate MSTR is to grow into the future, which would provide ideas as to how we should gauge our growth model going into the future. The clear trend in results is that states could, within the next five years, develop MSTR agreements with each other.

Question 1) "Multi-State Tax Reciprocity (MSTR) is the idea that non-state-residents could buy municipal 'green' debt from another state without bearing an additional tax-burden. What is the likely timeline for multiple states (at least two states) to enter into a tax reciprocity program based on the underlying assumption that a 'green municipal' bond market would facilitate such an endeavor?"



Question 2 examined the potential green municipal bond market growth under MSTR between two states: New York and California. The clear trend in results is that once MSTR is enacted, overall demand for green municipal bonds would grow in both markets.

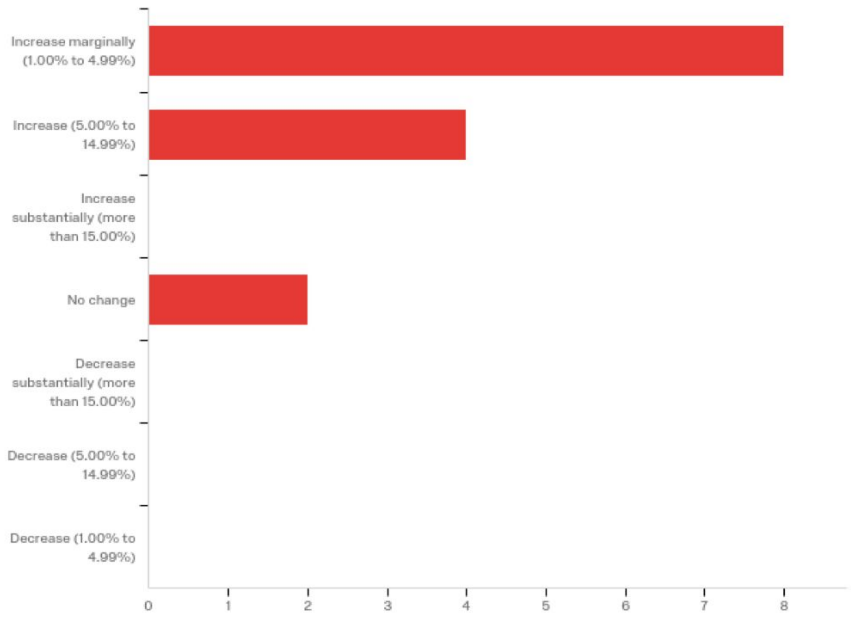
Question 2) "Assuming New York and California (the two largest green municipal markets) were to enter into a Multi-State Tax Reciprocity (MSTR) agreement for green municipal debt only, how might that affect the rate or size of municipal green bond issuances (assuming a strong need to issue in the first place)?"



Question 3 examined the effect that MSTR may have on green municipal issuances, generally. A specific figure as to the rate of issuances between two large, high-tax rate states is valuable as this adds parameters to our CBA model. Similar in both substance and results to our more broadly defined question on market growth, there is a

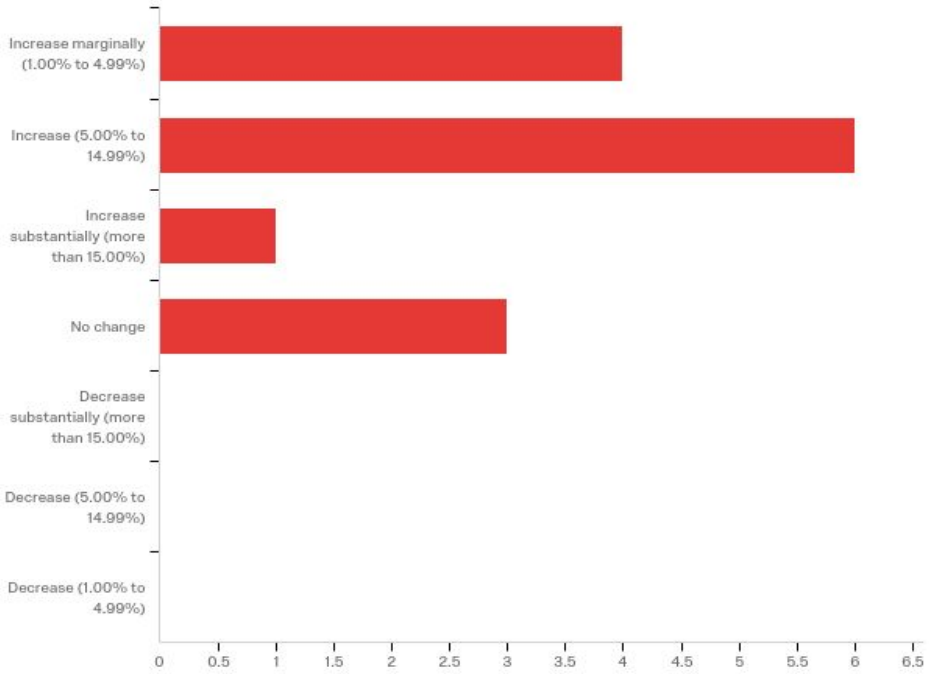
trend and it is that the issuance growth rate is to increase around 5%, with the weighted average response reaching 6.85%.

Question 3) "If a municipal bond in a large, high-tax state (such as New York and California) were granted tax exempt status in another large, high-tax state (and vice versa), how might that affect the rate or size of issuances (assuming a strong need to issue in the first place)?"



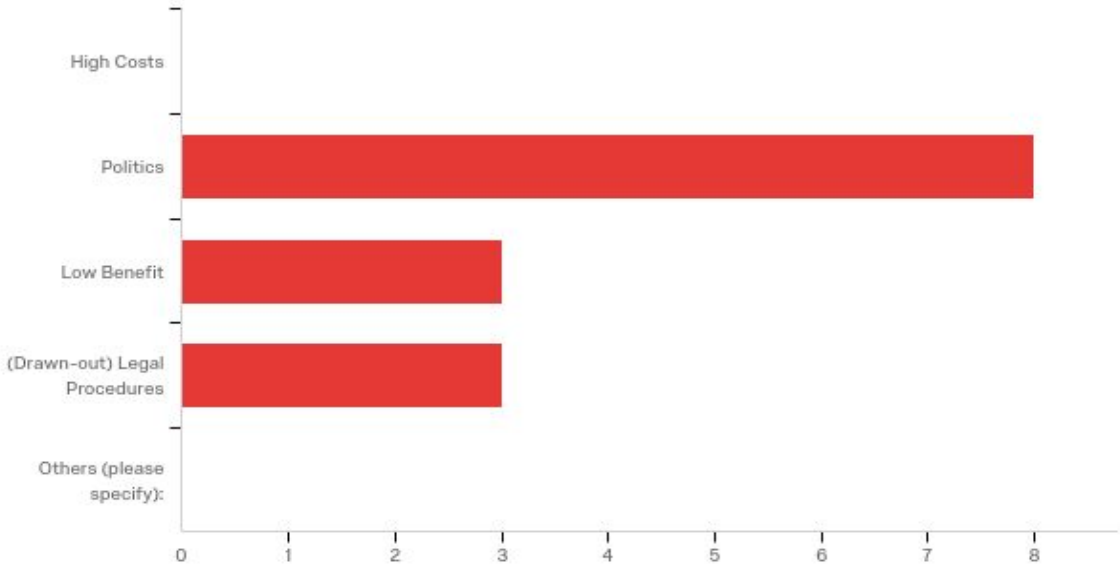
Question 4 addressed the impact of a green premium on issuance growth. The trend is less clear for this question, although a plurality of respondents believe that coupon rates would increase green bond issuances between 5% and 15%.

Question 4) "If an issuer were able to issue municipal bonds with reduced coupon rates of between 6 and 20 bps, how would that affect the number or size of bonds issued (assuming a strong need to issue in the first place)?



Question 5 helped us understand the greatest potential roadblocks for MSTR. The clear trend here is that politics and legal challenges are large threats to the program.

Question 5) "Which of the following do you think is the biggest roadblock for the implementation of a Multi-State Tax Reciprocity (MSTR) program?"



5. Conclusion

The United States needs to increase its financing of green infrastructure to reach a low-carbon future. Existing instruments, such as the green municipal bond, have been growing quickly but need additional action to scale up issuance further. Multi-state tax reciprocity is a viable solution to boost the U.S. green municipal bond market. We identified numerous risks to MSTR after interviewing more than 20 experts and conducting extensive market and industry research, which helped us build a comprehensive cost-benefit analysis model to assess a potential MSTR program.

Our cost-benefit analysis model indicated that MSTR would generate hundreds of millions of dollars in value for participating states and create more than 3 dollars for every dollar spent over a 20-year horizon. The program would also increase the overall size of the green municipal bond market by nearly 20-fold by 2037, where it would represent about 25 percent of all municipal issuances for California, New York, and participating small states. Ultimately, we assess that an MSTR program is a valuable program to scale up green municipal bond issuance in the United States.

6. Literature Review

Table of Contents

Sources: Industry and Academic Reports[31,32,33,34,35,36]

[31] Baker et al., "Financing the Response to Climate Change."

[32] Martin J. Luby, "Federal Intervention in the Municipal Bond Market: The Effectiveness of the Build America Bond Program and Its Implications on Federal and Subnational Budgeting," *Public Budgeting & Finance* 32, no. 4 (2012): 46–70, https://doi.org/10.1111/j.1540-5850.2012.01023.x.

[33] Mark Kim, "Going Green: Considerations for Green Bond Issuers" (Government Finance Officers Association, December 2015), https://www.gfoa.org/sites/default/files/1215GFR14.pdf.

[34] Mary E. Lovely and Michael J. Wasylenko, "State Taxation of Interest Income and Municipal Borrowing Costs," *National Tax Journal* 45, no. 1 (1992): 37–52, https://www.jstor.org/stable/41788945.

[35] Karpf and Mandel, "The Changing Value of the 'Green' Label on the US Municipal Bond Market."

[36] Myron Franz, "Income Tax Reciprocity Benchmark Study" (Minnesota Department of Revenu, March 1, 2013), https://www.revenue.state.mn.us/research_stats/research_reports/2013/reciprocity_study_report_march_2013.pdf.

Financing the Response to Climate Change: The Pricing and Ownership of U.S. Green Bonds	
Malcolm Baker (Harvard Business School ((HBS)), Daniel Bergstresser (Brandeis), George Serafeim (HBS), and Jeffrey Wurgler (NYU Stern)	
October 2018	Publisher: National Bureau of Economic Research
Main Findings:	Green bonds are priced at a premium. After-tax yields at issue for green bonds are 6 basis points below yields paid by otherwise equivalent bonds. This value doubles or triples for bonds that are externally certified as green by a third party and publicly registered with the Climate Bonds Initiative. The authors also find that green bond ownership should be disproportionately weighted toward concerned investors willing to accept lower returns.
Methodology:	The authors reviewed a sample of 2,083 green U.S. municipal bonds issued between 2010 and 2016 with a goal of determining the presence of a green bond premium and to understand the dynamics of bond ownership. They used an investment assessment framework that included a non-monetary component—such as a sense of social responsibility—of utility to augment expected returns from the typical CAPM beta. Their model controlled for ratings, maturity, the yield curve, tax status, and other characteristics.
Credibility:	The authors are all from highly regarded business schools and the paper benefited from a seminar held at The Brookings Institution. It does not seem that it was peer reviewed. It was also published by the National Bureau of Economic Research, a nearly 100-year-old private, non-profit that has been affiliated with 29 Nobel Prize winners in economics and 13 chairs of the President's Council of Economic Advisers.
General Assessment:	This is an excellent article because it is timely, relevant, and draws from a large sample size of green municipal bonds. The authors' theoretical framework is convincing because it relies on time-tested financial models and clearly indicates where, and how, it diverges.
Citation:	Baker et al., "Financing the Response to Climate Change: The Pricing and Ownership of U.S. Green Bonds" (Working Paper no. 25194, National Bureau of Economic Research, 12 October 2018): https://www.nber.org/papers/w25194.ack.

Federal Intervention in the Municipal Bond Market: The Effectiveness of the Build America Bond Program and Its Implications on Federal and Subnational Budgeting

Martin J. Luby

Winter 2012	Publisher: Public Financial Publications, Inc., Wiley
Main Findings:	Examined the effectiveness of the BAB program and the implications on federal and subnational budgeting by incorporating a direct federal subsidy approach ● BAB program was a success, measured by the amount of bonds sold, diversity of bond issuers and bond credit types ○ In 2009, state and local governments sold $64.1 billion of BABs out of a total of $410 billion in total municipal bond issuance. This represents 16% of the long-term municipal bond market. ○ In 2010, this increased to 27% ($64.1 billion of BABs sold out of $410 billion in total municipal bond issuance) ● The BAB yield after taking into account the 35% direct subsidy resulted in significantly lower borrowing costs at each maturity compared to the traditional tax-exempt bond alternative. This interest cost savings ranged from 36 to 90 basis points per maturity as measured by the yield to maturity. BAB program federal budget costs considering the growth in issuance and the length of the program is relatively moderate. ● If the federal government extended the length of the program and there was an increase in the annual bond volume growth the program would increase the annual federal budget cost for facilitating subnational borrowing by $1.32 billion each year for the next 10 years, assuming a 100% substitution effect of BABs for tax-exempt bonds.
Methodology:	1. First, the program costs for 2009 and 2010 were based on actual BAB issuance in 2009 ($64 billion) and 2010 ($117 billion). 2. The variables used in the sensitivity analysis include variables BAB issuance growth, BAB program length, BAB subsidy rate, and the substitution effect percentage. Program length levels included 0, 2,

	5, and 10 years while growth in issuance included 0-, 1-, 2-, 3-percent levels 3. Two groups of sensitivities are performed based on different levels of the substitution effect, 100 and 90 percent. ○ 100%: BAB issuance replaces a tax-exempt issuance ○ 90% BAB increases bond issuance over what would have been issued if tax-exempt debt was only available 4. The budgetary costing of the BAB program is net of the decrease in federal tax expenditures estimated from the replacement of tax-exempt debt with BAB debt 5. The scenario analysis includes two numbers that offer intermediate and long-term costing of the program ○ 10-year non-discounted cost of the program ○ 40-year non-discounted cost of the program
Credibility:	Public Budgeting & Finance is a quarterly peer-reviewed journal that was established in 1981. The author, Martin Luby, has 18 research works with 66 citations and 610 reads.
General Assessment:	The article was clear, logical and relevant to our tax-reciprocity cost benefit analysis. It presented many sensitivities and explained the logic behind the sensitives that were highlighted.
Citation:	Martin Luby, "Federal Intervention in the Municipal Bond Market: The Effectiveness of the Build America Bond Program and Its Implications on Federal and Subnational Budgeting Luby/Federal Intervention in the Municipal Bond Market" (*Public Budgeting & Finance* 32, no. 4, December 2012: 46-70), 10.1111/j.1540-5850.2012.01023.

Going Green: Considerations for Green Bond Issuers	
Mark T. Kim (District of Columbia Water and Sewer Authority and GFOA Committee on Governmental Debt Management)	
December 2015	Publisher: Government Finance Review
Main Findings:	There is no universally accepted definition of a green bond and in many aspects, green bonds are no different than the traditional bonds that many state and local governments and non-profits issue to fund their capital programs. Issuers should carefully consider the potential risks and rewards of issuing green bonds by undertaking a cost benefit analysis. The most commonly cited potential benefits of issuing green bonds are investor diversification, public relations, and the cost of funds. Issuers must weigh the potential benefits of issuing green bonds against the potential costs, which include costs of issuance, administrative burden, and reputational risk.
Methodology:	This article presents a brief history of the green bond market, followed by a cost-benefit analysis of issuing green bonds and a summary of current best practices. The author referred to papers, such as *Principles for Responsible Investment, Investors Are Paying Extra for Environmentally Friendly Bonds, Barclays Says, Green Bonds for a Parking Garage?, Voluntary Process Guidelines for Issuing Green Bonds,* among others. He looked at all the green bonds issued from 2007 to 2015 and used empirical evidence to support his arguments.
Credibility:	The author was a chief financial officer in DC Water, and a member of the Government Finance Officers Association. He has a very strong academic background with a PhD in public policy from Harvard University, a law degree from Cornell Law School, and a bachelor's degree from Northwestern University. Currently, he is the Executive Vice President and Chief Operating Officer of the Municipal Securities Rulemaking Board (MSRB). It seems that this paper was not peer reviewed. It was published in Government Finance Review, a bi-monthly membership magazine of the Government Finance Officers Associations, a professional association of approximately 19,000 state, provincial, and local government finance officers in the US and Canada.
General Assessment:	This article is well articulated because it summarizes the costs and benefits associated with the issuance of green bond in the market. It also brings up a real case study of DC Water's Green Bond, which weighs the pros and cons of issuance of this kind of securities. The final conclusion is also insightful and aspirational: the best practices continue to evolve, they will likely lead to lower transaction costs for issuers and

	greater demand by investors, which should result in a better price for green bonds over traditional bonds. Until that time, issuers should exercise caution and due diligence in labeling their bonds green and should take a rigorous approach to the use and management of proceeds and to the monitoring and reporting expectations of green bond investors.
Citation:	Mark T. Kim, "Going Green: Considerations for Green Bond Issuers" (Government Finance Review, December 2015): http://www.gfoa.org/going-green-considerations-green-bond-issuers.

State Taxation of Interest Income and Municipal Borrowing Costs

Mary E. Lovely (Syracuse) and Michael J. Wasylenko (Syracuse)

March 1992	Publisher: National Tax Journal (NTJ)
Main Findings:	Only if more than half of state municipal debt is held by nonresidents (out-of-state-residents) will an aggregate savings be achieved by a tax exemption policy. Tax exemption of in-state bond income also lowers the yield that public-sector borrowers within the state pay to finance their debt. More specifically, a one-percent reduction in the state income tax rate on in-state municipal bond interest translates to a 3.9 basis point reduction in the yield to maturity (YTM). Green municipal bonds are not part of this study.
Methodology:	With the ultimate goal of determining if individual states were to gain or lose money in a general tax reciprocity agreement, the authors seek to expand upon a surprisingly small sample of empirical literature. Reviewing a sample of 1,443 serial issues, the timeframe between January 1982 through June 1990 is dated. Sound econometric methods of regression analysis were computed using justified assumptions. As it is difficult to account for the transformative nature of tax law in econometric models, some assumptions may be void since publication in 1992.
Credibility:	Both authors are trained PhD trained economists from credible universities who now teach at Syracuse University's Maxwell School. Published in a peer reviewed journal, the NTJ includes economic, theoretical, and empirical analyses of tax and expenditure issues with an emphasis on policy implications. Published quarterly since 1948, the NTJ is sponsored by the National Tax Association. Dissemination of governmental tax and expenditure policies is the goal of NTJ.
General Assessment:	Although a sound academic article, as tax law is in constant flux, some of the underlying assumptions, such as which states participate in municipal tax reciprocity have since become dated. An example is that both Utah and Indiana are listed as states that honor tax reciprocity. Indiana no longer honors tax reciprocity between states for issuances occurring after 1992, which is the same year that this article was published.
Citation:	Mark E. Lovely and Michael J. Wasylenko, "State Taxation of Interest Income and Municipal Borrowing Costs" *National Tax Journal* 45, no. 1 (JSTOR, 1992), 37–52: www.jstor.org/stable/41788945.

The changing value of the 'green' label on the US municipal bond market

Andreas Karpf and Antoine Mandel (Paris School of Economics, Université Paris, Paris, France)

February 2018	Publisher: Nature Climate Change
Main Findings:	1) Although returns on conventional bonds are on average higher than for green bonds, the differences can largely be explained by the fundamental properties of the bonds. 2) Green bonds on average pay a lower interest rate and hence provide better financing conditions than conventional bonds. 3) Green bond yield increases with the benchmark market rate and with the risk, measured via days to maturity, the rating class of the bond or the outstanding debt in the state. It decreases with liquidity and with positive macroeconomic indicators. 4) If green bonds had been evaluated as conventional bonds, they would have yielded an, on average, 7.8 basis point lower return.
Methodology:	The authors made both qualitative and quantitative analysis of these assumptions. The data they use is issuance and transaction data from the US municipal bond market. The research compares the yield of green and conventional bonds with similar characteristics. The authors run a regression model and the Oaxaca–Blinder decomposition regression model to investigate the relationship between the yields of green and conventional bonds.
Credibility:	The authors are all from a university with a strong economics department and the research has both qualitative and quantitative analyses. It does not seem that it was peer reviewed, but the methodology gives it credibility because it shows that green bonds have the same characteristics as conventional bonds, just as they should.
General Assessment:	This is a good article because it is timely, relevant, and the conclusion is based on a large database and drawn from regression models. The reason why they used Oaxaca–Blinder decomposition regression model is convincing.
Citation:	Andreas Karpf and Antoine Mandel, "The changing value of the 'green' label on the US municipal bond market," *Nature Climate Change* 8 no. 2, (2018), 161-165: http://dx.doi.org.ezproxy.cul.columbia.edu /10.1038/s41558-017-0062-0

Income Tax Reciprocity Benchmark Study	
Myron Frans, Commissioner of Revenue (Minnesota Management and Budget)	
March 2013	Publisher: Minnesota Department of Revenue
Main Findings:	For tax year 2011, Minnesota would have a net revenue loss under reciprocity, which is equal to $73.7 million. Wisconsin would have a net revenue gain due to reciprocity, which is equal to $67.3 million. Combined impact of reciprocity is a net loss of $6.4 million revenue.
Methodology:	The Minnesota Department of Revenue reviewed 55,743 Minnesota income tax returns were filed by Wisconsin residents who earned personal service income of $2.434 billion in Minnesota. And it also identified 23,940 Minnesota returns were filed by Minnesota residents who earned personal service income of $718 million in Wisconsin. It found out that there are more than twice as many Wisconsin residents who work in Minnesota as Minnesota residents who work in Wisconsin. For this reason, Minnesota would have a revenue loss under reciprocity. The Wisconsin Department of Revenue reviewed 24,346 Wisconsin income tax returns were filed by Minnesota residents who earned personal service income of $717 million in Wisconsin. And it identified 50,577 Wisconsin returns were filed by Wisconsin residents who earned personal service income of $2.357 billion in Minnesota. Wisconsin's net revenue gain would be the net of two amounts: the loss of the Wisconsin tax on Minnesota residents working in Wisconsin and the gain from not providing to Wisconsin residents a credit for tax paid to Minnesota.
Credibility:	The author was appointed Commissioner of Minnesota Management and Budget (MMB by Governor Mark Dayton in January 2015. As Commissioner of MMB, he is the chief financial officer, the chief accounting officer, the state controller, and head of human resource management and employee insurance for over 50,000 state employees, and in charge of collective bargaining on behalf of the state. The credibility of this study is relatively high.
General Assessment:	This article clearly states the gains and losses each state faces due to tax reciprocity program in fiscal year 2011. Although it may not be that relevant to help us with our cost-benefit analysis in green muni bond market, it can still be a good reference with regarding to how to analyze tax reciprocity program.
Citation:	Myron Frans, "Income Tax Reciprocity Benchmark Study," https://www.revenue.state.mn.us/research_stats/research_reports/2013/reciprocity_study_report_march_2013.pdf.

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