# Legal Uncertainty and Municipal Bond Yields: Market Reactions to Puerto Rico

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**ABSTRACT**

There is a large degree of uncertainty regarding what would occur if a U.S. state government defaulted on its debt. The legal framework for state government default is non-existent, and there is no modern-day precedent for such an event. Recent events in the Puerto Rican debt crisis, however, may provide a blueprint for how a state default would play out. I find that state bond spreads over the Treasury rate react to various legal events and decisions related to the Puerto Rican bankruptcy. I also find that reactions are stronger in states with worse credit conditions. This suggests that markets may perceive these events and decisions as setting precedent for potential future state default events. Moreover, that precedent is likely more relevant for states that are closer to default. These findings provide unique evidence of the role legal uncertainty plays in asset markets.

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# I. Introduction

> Some of the legal precedents potentially being set, whether or not technically binding outside Puerto Rico or the 1st Circuit, erode the expectations and good order of the municipal bond marketplace that finances the activities of states and municipal instrumentalities nationwide.
>
> Len Weiser-Varon and William Kannel, *Bond Buyer*, March 21, 2018

Currently, there is no legal structure for how a U.S. state government would restructure its debt obligations in a default event. The lack of framework may lead to a great deal of legal uncertainty surrounding default events, and this uncertainty is more pronounced than for other municipal governments which have access to Chapter 9 of the U.S. bankruptcy code. Despite that uncertainty, when determining borrowing rates, investors in state debt markets need to make assumptions regarding both default probabilities and recovery rates in default. State and local governments spent over $119 billion in debt interest expenses in 2016.[1] Therefore, it is crucial for investors, policymakers, and their constituents to understand how legal uncertainty around default might affect state borrowing costs.

Recent legal decisions and legislation surrounding the Puerto Rican debt crisis are a fruitful laboratory in which to study the relationship between legal uncertainty and municipal bond prices. Chari, Leary, and Phan (2017) show that various legal events (e.g.,the passing of the Puerto Rico Oversight, Management, and Economic Stability Act (PROMESA)) have a material effect on Puerto Rican bond yields. As the quote above suggests, some market participants have seen these events as precedent setting and have implied that they may have effects in other municipal markets. I posit that events in Puerto Rico may provide signals to markets regarding the potential framework for future state government default. If this is the case, one would expect to observe price changes in other municipal bond markets around these decisions, even if the events are not legally binding in the other jurisdictions. I perform event study analyses around these decisions to test this hypothesis. I also explore whether or not there are cross-sectional differences in reactions to these events.

My empirical results show that legal events in Puerto Rico affect state debt markets. I find statistically significant movements in state bond spreads over U.S. treasuries around legal events

[1] "State and Local Expenditure," Urban Institute

pertaining to Puerto Rico. The magnitude of these effects are economically meaningful. For example, state bond spreads increased by an average of 16 basis points following the passage of PROMESA, a law which created a bankruptcy framework for Puerto Rico. A reaction of this size is equivalent to approximately ten percent of the average spread in my sample. The direction of the change in spreads varies depending on the event. These reactions suggest markets believe these legal events provide information about the structure of state default. The direction of the effect, however, depends on changes in investor perceptions about both default probabilities and recovery rates.

I also find significant cross-sectional differences in the effects. I find that states with lower credit quality have stronger reactions to legal events. For example, the effect of the PROMESA legislation on bond spreads in low credit quality states is 42 basis points, much larger than the effect for high credit quality states. Cross-sectional differences imply that legal signals may be more important for states that are closer to default, because investors in lower credit quality states are likely more concerned about default. Therefore, one would expect new information regarding the structure of default to have stronger price effects in states that are closer to such an event.

I do not, however, find significant effects of the events on trading behavior. I do not observe any significant changes in trading volume or the intensity of trading around these events. This suggests that the legal events may not precipitate major disruptions in municipal markets. State bond markets are relatively illiquid, as the majority of issues are held by retail investors. Therefore, it is not surprising to see little immediate change in trading behavior. Significant changes in spreads for bonds that do trade, however, show that price effects are meaningful.

My results suggest that markets look to these events for signals on what would occur in a state default, and they react to new information. Policymakers should consider these reactions when thinking about creating bankruptcy structures for state government. Ultimately the legal uncertainty channel in municipal bond yields requires more research. If that channel is real, however, it suggests that creating a legal framework for state government default (argued for by scholars such as Skeel (2013)), and therefore decreasing uncertainty, could lead to lower borrowing costs today for municipal governments. Overall, these results present empirical evidence of an understudied channel, legal uncertainty, that may affect asset prices.

### *A. Literature Review*

My paper is most closely related to the literature on political uncertainty and asset prices. Pastor and Veronesi (2013) develop a general equilibrium model in which stock prices react to political news. There model describes a channel, political uncertainty, which could have a significant effect on asset prices. Kelly, Pastor, and Veronesi (2016) provide empirical evidence that this uncertainty is priced in options markets. Meanwhile, Gao and Qi (2013) study municipal bond yields around gubernatorial elections. Consistent with the mechanism in Pastor and Veronesi (2013), they find an increase in spreads around elections, which they argue, are times of greater political uncertainty. In concurrent work (Boyer (2019)), I show that legal protections for pension liabilities have an effect on municipal bond yields. In this paper, I explore how legal uncertainty, distinct from political uncertainty, surrounding state government default and affects municipal bond prices. My results imply this may be a distinct channel that has a significant effect on asset prices more generally.

My paper also relates to the literature on the determinants of municipal bond yields. The majority of previous research on determinants of municipal bond yields focuses on either liquidity or the incorporation of tax exemptions into prices. However, recent work by Schwert (2017) shows default risk, not liquidity, is the main driver of municipal (including state) bond yields. An obvious question arising from this finding is: What drives cross-sectional and time-series variation in municipal default risk? My results suggest that legal uncertainty may have an important role in municipal debt markets.

Part of this literature on municipal bond determinants focuses on the effects of political factors on municipal bond prices. For example, Butler, Fauver, and Mortal (2009), Gao, Lee, and Murphy (2018), Gao, Lee, and Murphy (2019), and Poterba and Rueben (2001) explore how variables such as corruption, local newspaper presence, and balanced-budget amendments affect bond yields. Similar to Poterba and Rueben (2001), I explore how explicit legal factors may have an effect on municipal bond prices. My results suggest that legal frameworks may have an important role in municipal debt markets, distinct from the effects of political factors.

There also exists a legal literature discussing the framework for municipal and state bankruptcy. For example, Skeel (2013) argues in favor of a bankruptcy provision for state governments. Meanwhile, Gillette (2012a) explores how lessons from Chapter 9 bankruptcies could be applied to a

federal state bankruptcy law. Similarly, Gillette (2012b) argues that sovereign defaults may provide interesting lessons for state default. In general, this literature takes a normative approach. I, on the other hand, contribute to positive side of this literature by exploring how the lack of legal framework is already affecting state debt markets. But similar to this literature, I argue that state debt markets may learn about future default scenarios by observing other markets (e.g. municipal/sovereign bankruptcy, or Puerto Rico).

The rest of the paper is laid out as follows: I provide background on municipal debt markets, legal uncertainty around default, and the Puerto Rican debt crisis in Section II. In Section III, I explain my empirical methodology and describe the data I use in my analyses. Next, in Section IV I display and discuss the results from my event study exercises. Following that, I explore changes in trading behavior around legal events in Section V. Finally, Section VI concludes.

# II. Background on State Government Debt, Default, and the Puerto Rican Debt Crisis

In this section, I provide background information on state bonds, legal uncertainty around default, and the Puerto Rican Debt crisis. First, I describe basic characteristics of state debt markets. Next, I discuss the uncertainty surrounding state government default. Finally, I describe the Puerto Rican debt crisis and explain why it might be meaningful for other state debt markets. This background information is taken in part from Boyer (2019).

Municipal governments issue bonds primarily to fund capital expenditures such as roads, schools, hospitals, and even sports stadiums. The types of governments that issue these bonds are numerous: States, counties, cities, towns, school districts, water districts, and other municipal entities issue municipal debt. A primary advantage of holding municipal bonds is that the income received from interest payments is usually tax exempt at the federal, state, and local level. Bonds are therefore generally held by high-net-worth individuals who can benefit most from this exemption. Bergstresser and Cohen (2015) show that 42% of municipal debt is held by the top 0.5% of individuals by wealth. [2] Over 50% of municipal debt is held by retail investors.[3] The yields on municipal

[2]The tax-exemption is only valid if an owner is a resident of the state where the bond was issued. Therefore, there is a natural market segmentation in municipal markets.

[3]"Trends in Municipal Bonds," MSRB. 2019

bonds are generally lower than a corporate bond with similar credit risk because investors require a lower return due to this exemption. Indeed, the purpose of these exemptions is to give access to cheaper credit for municipal governments.

In general, two types of bonds are issued by state and local governments: general obligation (GO) bonds, and revenue bonds. GO bonds are backed by the full faith and credit of the underlying government, and the municipalities' ability to raise tax revenue serves as collateral for the bond. Meanwhile, revenue bonds are tied to specific capital projects, and proceeds from these projects (e.g., tolls from a road) are used to make interest payments. I focus on state bonds as opposed to a broader set of municipalities because of the uncertainty around default. I also focus on general obligation bonds as they provide the cleanest measure of state government level credit risk. As I discuss below, the legal and practical structure for state default is almost non-existent. Other municipalities face less uncertainty, because they have access to Chapter 9 bankruptcy. This paper investigates whether or not investors view bankruptcy events in Puerto Rico as relevant for predicting outcomes in future state defaults.

Current observed spreads suggest current default probabilities may be higher than historical figures, despite the fact that state government default is extremely rare in the U.S.[4] No state has defaulted since Arkansas during the Great Depression. Other than a handful of defaults during the Civil War, state government default is almost nonexistent. Even in the case of Arkansas, debtholders were eventually made whole. Given that ratios of state government debt to GDP are much lower than most sovereigns (even when including pension liabilities), along with the wide taxing authority of states, the likelihood of actual default may appear unlikely. However, fiscal issues, particularly with unfunded pension liabilities, may change this perception and contribute to higher borrowing costs.

Even in the case of an insolvency, state default currently has no legal framework. States are sovereign under the U.S. Constitution and therefore cannot be sued, which rules out the possibility of bankruptcy hearings. Although, some legal scholars have argued for the need for such a structure (see, e.g., Skeel (2013)). Despite a lack of legal default framework, sovereigns (e.g., Argentina) have defaulted in the past and not been shut out of markets indefinitely. Recent events in Puerto Rico suggest that given a dire enough fiscal crisis, the federal government may be willing to create legal

[4]See Schwert (2017) for a discussion of physical and risk-neutral default probabilities implied by state bond yields.

structures to facilitate a state default. Sovereign defaults likely provide less information to state bond markets for a number of reasons, including the fact that sovereigns can use monetary policy to control debt issues. Puerto Rico has no such monetary policy lever.

While state government defaults are extremely rare, municipal defaults do occur. Although no legal structure for state bankruptcy exists, Chapter 9 of the bankruptcy code deals explicitly with municipal bankruptcy.[5] The majority of recent default crises have been triggered by idiosyncratic issues, which makes generalizing their structure to a potential state default difficult.[6] In the majority of these defaults, conflicts have arisen between debtholders and pensioners. In most cases, pension liabilities have been protected relative to bondholder claims, although full recovery has not been universal. Negotiations, such as those in the Detroit bankruptcy, may set a blueprint for how different claims may be handled in a state default. In Boyer (2019), I show that pension liabilities have a significant effect on municipal bond spreads, and the magnitude of those effects vary based on political and legal factors in each state.

Recent events in Puerto Rico, which is legally similar to U.S. states, have led to a number of unique pieces of legislation and court rulings regarding bankruptcy and default. Many politicians and market participants have suggested that these legal decisions may be setting a precedent for how a state in a fiscal crisis would handle a default event. Senator Bernie Sanders, upon passage of PROMESA, argued strongly that, "I rise in very strong opposition to the Puerto Rico Oversight, Management, and Economic Stability Act, the so-called PROMESA Act. This is a terrible piece of legislation, setting horrific precedent, and it must not be passed..." If this is true, investors in state bond markets may learn about legal frameworks for future defaults through these events. This could cause them to update their beliefs regarding default probabilities and recovery rates and therefore, one would expect to see existing state bond markets react to these changes in beliefs.

For context, I briefly describe the history of the Puerto Rican debt crisis. Any events I study explicitly will be discussed in more detail in Section IV. For a more detailed description of the Puerto Rican debt crisis, see Chari et al. (2017). Prior to 1996, Puerto Rico benefited from favorable tax laws as part of the Jones Act of 1920. Although, these benefits were generally phased out from

[5]Gao, Lee, and Murphy (2017) discuss the role of Chapter 9 protections at the state level on local municipal bond yields.

[6]In recent years we've seen municipal bankruptcies in the municipalities of Bridgeport, CT, Central Falls, RI, Detroit, MI and Jefferson County, AL. For more discussion of municipal bankruptcy, see Spiotto (2008).

1996 to 2006. As part of the Jones Act, U.S. investors were able to invest in Puerto Rico bonds tax-free, which lowered the required rate of return on Puerto Rican debt. Therefore, the Puerto Rican government could borrow at relatively low rates, which they did prodigiously. This, along with the financial crisis, led to poor results for the Puerto Rican economy which were exacerbated by attempts to shore up tax shortfalls with increases in debt.

In 2014 Puerto Rican bonds were downgraded to "junk" status, which led to concerns about default. Puerto Rico was explicitly barred from Chapter 9 bankruptcy and therefore looked towards other means of restructuring. This included multiple laws passed by the Puerto Rican government to create Chapter 9 like frameworks for restructuring. Finally, in June 2016 the U.S. Congress passed the Puerto Rico Oversight, Management, and Economic Stability Act (PROMESA) which created a federal framework for the restructuring of Puerto Rico's debt. This event in particular drew ire from politicians and debtholders, who argued that the law created a legal precedent for state default given that states also do not have access to Chapter 9. Despite the concerns, the PROMESA legislation is not legally binding in any jurisdiction outside Puerto Rico. A number of legal decisions have also taken place since PROMESA, including the January 2018 decision by Judge Swain that permitted Puerto Rico to not make payments on special revenue bonds while in bankruptcy. In the remainder of the paper I explore how state bond markets reacted to these events.

## III. Municipal Bond Data and Event Study Methodology

In this section I describe my empirical methodology. First I present a framework for thinking about how legal uncertainty and legal events may effect spreads. Following this, I present the event study methodology I use to quantify the reactions of state bond spreads to legal events in Puerto Rico. Next, I briefly describe the data I use in the paper. Finally, I discuss the specific events around which I perform event studies.

*A. Framework*

A credit spread (or the difference between the yield on a bond and a benchmark rate) can be approximated by the following formula:

$$s \approx E_Q\left[P(Default)\right] \times E_Q\left[(1-R)\right] \tag{1}$$

That is, the spread is roughly equal to the expected probability of default times one minus the recovery rate in default.[7] Therefore, if an event leads to an increase in the expected likelihood of default, it will result in a higher credit spread, and vice versa. Similarly, if an event leads to an increase in the expected recovery rate, one would expect to see a decrease in spread as the expected payout to debtholders is now higher. The legal events in Puerto Rico are most likely to effect expectations about recovery rates, as opposed to default. The ability of a U.S. state to make payments is based on the fiscal health of a state which can generally be seen as independent of the legal framework for default. These events are more likely to affect the amount debtholders would recover in an actual default as future bankruptcy laws could be more or less favorable to creditors. Therefore, a legal precedent that raises the expected recovery rates for state default may lead to a decrease in spreads. The direction of the coefficients in my event study will help discern how investors interpret legal events in these terms.

Level expectations, however, are not the only thing that may affect spreads. The uncertainty (e.g., standard deviation) around expected probabilities and recovery rates can also affect spreads. Investors must also make assumptions about the uncertainty of expectations, and risk averse investors dislike uncertainty. Therefore, greater uncertainty about recovery rate estimates could lead to a higher credit spread and vice versa. A legal precedent that reduces the legal uncertainty around state default may lead to a decrease in spreads. This channel, however, could be at odds with the level expectations channel discussed above. For example, a legal precedent which reduces the uncertainty around recovery rates and also decreases the likely recovery rate will have conflicting effects. In this scenario the reduction in uncertainty would lead to a decrease in spreads while an decrease in the expected recovery rate will lead to an increase in spreads. My event studies

[7] This approximation is under the risk-neutral measure as it abstracts from risk-premia. All the logic follows when using the physical measure.

cannot completely separate these two channels. However, by looking at multiple events which *a priori* we may expect to have certain effects on expectations and uncertainty, I may be able to discern some patterns in which channel is likely to be driving reactions.

### *B. Event Study Methodology*

Event studies are designed to measure the reaction of a given security to a certain event. They are most commonly used with equities to explore stock price reactions to events such as merger announcements, earnings releases, etc. Given the high liquidity of equities, event studies for stocks are fairly straightforward. However, for less liquid fixed-income securities there are fewer well defined methods. I use an event study methodology similar to that of Chari et al. (2017), Gao et al. (2018), and Boyer (2019). I regress daily bond spreads on an indicator variable for whether the date $t$ is after the event in question and therefore the coefficient of interest measures the change in the average bond spread following an event. My main specification is as follows:

$$s_{i,t} = \alpha + \beta I_t + \gamma^{'} X_{i,t} + \epsilon_{i,t} \tag{2}$$

$s_{i,t}$ is the spread of bond $i$ at date $t$. $I_t$ is an indicator for whether or not date $t$ is after the event in question. The main coefficient of interest is $\beta$ which represents the average increase/decrease in bond spreads after the event. $X_{i,t}$ represents a set of bond-level controls which I briefly describe below. I perform this regression separately for each event and test the significance of $\beta$ to explore whether or not the given legal event in Puerto Rico has a material effects on state spreads.

Ideally, one would want to measure the instantaneous (e.g. within a day or hour) impact of a given event. This is crucial to discerning the causal effect of a given piece of news as it ensures one is not measuring the effects of a confounding event. Event studies are more feasible in equity markets, given the presence of high-frequency trading data. They are much trickier, however, with fixed-income data. In this paper I use various window sizes around a given event, and measure the change in average spread within that window of the event. That is, for an event on day t a window of x days indicates that the regression only uses data in the $[t - x, t + x]$ trading day window. I use window sizes varying from 30 to 3 days for robustness.

Even a three day window has two potential issues. First, it could include other events which

bias my findings. For example, if a given event of interest actually has zero impact on spreads, but another event within that window has a positive impact I may incorrectly attribute a positive reaction to the event of interest (or vice versa). Second, this could simply introduce noise in my estimates which will bias them towards zero. In this situation, I may measure no effect (or a lesser effect) of a given event, even if there is in fact a positive/negative reaction. This is necessarily a limitation of the data, and makes true causal inference difficult. However, the number of events I study can help show the general presence of market reactions to legal events.

Another concern with these specifications is the correlation of errors across both CUSIPs and the pre- and post-periods. Both issues could contaminate my statistical tests. If I am not capturing all the relevant bond features in my controls, regression errors could be correlated within CUSIPs. More concerning, changes in the overall municipal markets could lead to correlation among errors in the pre- and post-periods. To correct for these concerns, I perform specifications that cluster standard errors at both the CUSIP and event level to help alleviate these concerns.

Following this analysis, I explore whether there are cross-sectional differences in the reactions to Puerto Rican legal events. To do this, I add an interaction term to capture the credit quality/fiscal health of a state. My hypothesis is that these legal events may be more relevant for states that are closer to default. If they are setting a precedent for what may happen in a state default, that will be more germane to states where that is a possibility in the near future. To proxy for credit health I use the credit rating of a state. I define states that are relatively closer to default with an indicator for "low" rating states (see below for more detail). The specification is as follows:

$$s_{i,t} = \alpha + \beta I_t + \nu \left(LOWRAT\right)_{i,t} + \phi I_t \times \left(LOWRAT\right)_{i,t} + \gamma^{'} X_{i,t} + \epsilon_{i,t} \tag{3}$$

The additional coefficient of interest in this specification is $\phi$, which measures whether the average spread after an event is different for states with low ratings, as opposed to those with higher ratings. I expect to see a magnification of effects for the states with lower credit ratings as any precedents set are more salient for states which are closer to default. In Appendix A I use pension funding as a proxy for credit health and find similar results.

### C. Data

For bond spread data, I rely on two databases: the Mergent Municipal Bond Securities Database (Mergent) and the Municipal Securities Rulemaking Board's (MSRB) Electronic Municipal Market Access Database (EMMA). Mergent provides issue level information such as CUSIP, offering date, maturity date, offering amount, bond type and other characteristics such as option flags. EMMA is a transaction database, which tracks trades of municipal bonds and contains information on trade date, traded yield, and amount. I link the two datasets by CUSIP to obtain both original issue characteristics and updated pricing (yield) information.

I filter trades for only bonds issued by the state government itself (i.e. I exclude lower municipalities). Each trade yield is then adjusted to arrive at a pre-tax yield. Municipal bonds are generally tax-exempt at the federal, state, and local levels. Therefore, the yield of two bonds with equal credit worthiness could vary due to difference in taxes across states. In my analysis, I want to focus on credit risk, so I adjust for these cross-sectional differences by adjusting for the top marginal income tax rate (combination of state and federal) in each state.[8] The adjustment is:

$$y_{i,s,t}^{Pre-Tax} = \frac{y_{i,s,t}}{1 - \tau_{s,t}} \tag{4}$$

For each bond, I calculate the difference between the pre-tax yield and a maturity-matched treasury to obtain the bond spread. To obtain the maturity matched treasury, I interpolate between points on the treasury yield curve to correspond to the current time-to-maturity (TTM) of an issue.[9] I use these pre-tax spreads as the dependent variable in my analyses. I control for a number of issue characteristics for each observed spread, including TTM, issue amount, and flags for callability, putability, and whether the bond is insured. I also limit the sample to tax-exempt general obligation bonds, because GO bonds are backed by the "full faith and credit" of the government and likely represent the purest measure of state's default risk/borrowing costs

It is difficult to present meaningful summary stats on the data given that a different sample is used in each event study. In Figure 1, I present the average weekly spread in my sample. Red dots indicate the legal events. Spreads were at a moderate level of approximately 160 bp for across

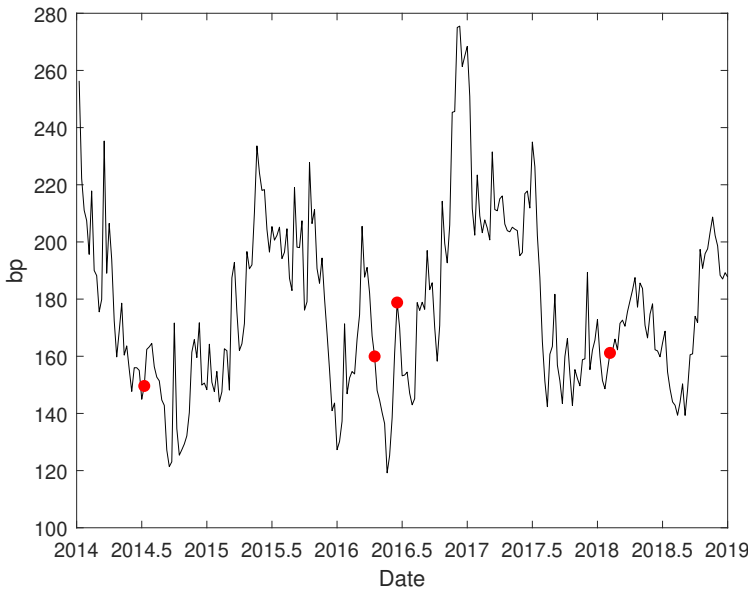
[8] This is the same tax-rate methodology used in Schwert (2017) Top marginal rates are from the NBER.

[9] Results are insensitive to the use of a linear interpolation or a cubic spline. Reported results use the linear interpolation.

the sample. There is a large spike in spreads in late 2016 around the U.S. Presidential Election. The beginning of the sample shows a decrease in spreads as yields continued to fall following the financial crisis. Summary stats on trading behavior can be seen in Section V.

**Figure 1: Average Weekly State Bond Spread: 2013-2019**

Figure 1 displays the average weekly spread over Treasuries for state-level tax-exempt general obligation bonds. Red bonds indicate legal events surrounding the Puerto Rican debt crisis as described in Section III.




For my cross-sectional analysis I use credit ratings data from Moody's which I obtain from Bloomberg. I use the long-term rating for each state, and a state is classified as "low rating" if it has a rating below Aa, which is about 25% of the sample. I have also performed the analysis using public pension funding ratios as a proxy for the fiscal health of a state. Results are similar using this data (see Appendix A).

There exist many municipal bond mutual funds and exchange traded funds (ETFs). With daily prices, these instruments could be a useful tool for performing event studies. Unfortunately, I cannot use these prices for two reasons. First, the majority of these funds also include Puerto Rican bonds as part of their holdings. Puerto Rican bonds are unique in that they are tax-exempt for any U.S. resident (not only residents of Puerto Rico). Therefore, almost all funds include some Puerto Rican bonds in their holdings. Including these bonds could bias my results because Chari et al. (2017) show that there are significant changes in Puerto Rican bond prices around legal decisions. Second, municipal bond funds include state bonds as well as bonds of other municipalities such as

cities and counties. As discussed above, I focus on state bonds in this paper due to the uncertainty around state default. To my knowledge there are no municipal bond mutual funds or ETFs that contain only state-level debt. Therefore, including lower-level municipal bond prices in my event study could bias the interpretation of my results.

### *D. Events*

Below I list each of the events I include in my event study analysis. I very briefly describe the event and why it might set a precedent for other municipal markets. For more details on each event, see Chari et al. (2017).

- Puerto Rico Public Corporation Debt Enforcement and Recovery Act (Recovery Act - June 30, 2014): PR courts create legal structure for agencies (state owned corporations) of PR to restructure debt. Creates precedent through which states could enact laws allowing themselves to restructure debts. This act was eventually found to be unconstitutional. To the extent that markets realized it would not hold up legally, there may not be a reaction to the passage. Additionally, the Act applies to sub-sovereign corporations, and thus would not apply to state GO bonds directly. Again, this factor might dampen any spillover effects.
- Debt Moratorium and Financial Recovery Act (Debt Act - April 6, 2016): Law attempted to allow PR to stop making debt payments. Creates legal framework by which states could halt debt payments. Unlike the Recovery Act, applies to government debt itself, and therefore may be more of a "precedent" for states.
- PR Oversight, Management, and Economic Stability Act (PROMESA - Passed by House on June 9, 2016; Passed by Senate on June 30, 2016): Enacted by US Congress; creates bankruptcy framework under which PR could restructure debts. I focus on the House passing of the law, as this was seen as the bigger hurdle to passage. As part of the law, an oversight board was created to guide the restructuring of Puerto Rico's debt. Debt payments were halted the day after passage. It was generally seen as more favorable than Chapter 9 toward creditors. Creates precedent for federal laws which would allow states to default on debt and go through bankruptcy. Given that it is an act of the federal government it is more likely that this event (as opposed to the two previous) may be seen as precedent setting for future

state default events.

- Judge Swain Revenue Bond Decision (Swan - January 30, 2018): Judge Swain rules that special revenue bond payments are not required by Puerto Rico during bankruptcy proceedings. This event was/is seen by many as at odds with the language in the Chapter 9 bankruptcy code. Therefore, this event is likely the largest "surprise" of the events I have measured. It sets precedent for U.S. states that they can halt special revenue payments during general default. This event is unique in that it sets **actual** precedent for all municipal markets.

For the majority of these events it is not clear *a priori* what directional effect they should have on other markets. In general, I believe they appear to decrease market uncertainty as they have begun to create some precedent for a framework for state government default. However, one could also argue the events increase uncertainty if markets had previously thought there was no possibility of a federal framework for state default. The effects on expectations of recovery rates are less clear from event to event. My event studies shed light on which effects dominate in each case.

Another issue that adds noise to my estimates is the degree to which any of these events are "surprises". In an efficient market, any reactions should only arise due to unexpected news. If a piece of legislation was already anticipated, its final passage should not constitute news and therefore I should not expect to see a reaction. This situation would bias my estimates towards zero (i.e. no effect). My larger windows, along with the fast moving pace of much of this legislation helps mitigate this concern a bit.

The PROMESA event is likely the most relevant for future state default, because the legislation mostly clearly created a federal framework for Puerto Rican bankruptcy. The two previous events were enacted by the local Puerto Rican government, which makes them less likely to be seen as a blueprint for states. PROMESA, however, was the cornerstone legislation that led various politicians to worry about the precedent being set. The law specifically created a Chapter 9 like bankruptcy for Puerto Rico, and therefore it is likely the clearest blueprint for any future federal laws extending bankruptcy to state governments. In the following section I will empirically test whether market reactions are consistent with the perceived gravity of this legislation.

The Swain decision likely has the clearest expected directional effect on spreads. First, this

event was seen by many as a surprise and therefore constitutes "news" after which one would see a change in expectations. Revenue bonds have now become relatively less secure as governments are no longer required to make payments on them in bankruptcy. If anything, the Swain Decision likely increases uncertainty as to recovery rates because decision was unexpected and seemed to run contrary to the general understanding of Chapter 9 prior to the decision. Together, these two effects should unambiguously lead to an increase in spreads as discussed above.

# IV. State Bond Spread Reactions to Legal Events

In this section I present the results from my event study analyses. I first present my main tests exploring how municipal markets reacted to legal events in Puerto Rico. Next, I present results exploring the cross-sectional differences in those tests. Finally, I briefly discuss implications and interpretations of my results.

## *A. Main Results*

In Tables I, II, III, and IV I present the results from my main event studies based on the specification in Equation 2. "Post-Ruling" represents the $\beta$ coefficient representing the average increase/decrease in spreads after the given event. From left to right, the window for the event study decreases from 30 to 3 days. All specifications include the control variables discussed above. Specifications 2, 5, and 8 cluster standard errors at the CUSIP level while specifications 3, 6 and 9 specification at the date level.

In Table I I examine state bond reactions to the passage of the Recovery Act. The 30 day window, and 3 day window results show a decrease in spreads following the passage of the law. For the 10 day window the coefficient is approximately zero and not statistically significant. For specifications 1, 3, and 9, this effect is statistically significant. The 3 basis point coefficient in specification 9 indicates that spreads decreased on average by 3 bp in the three days following the passage of the Recovery Act. This table provides weak evidence of spillovers from the Recovery Act to other municipal markets. The negative coefficient suggests that this could be resulting from an increase in expected recovery rates or a decrease in uncertainty about that expectation. As discussed above, the dubious legality of this decision may lead to a dampened reaction as markets

**Table I: Recovery Act Event Study Results**

Table I presents results from an event study around passage of the 6/30/14 Puerto Rico Public Corporation Debt Enforcement and Recovery Act in Puerto Rico. The event study is performed by regressing tax-exempt general obligation U.S. state bond spreads over U.S. treasuries on an indicator variable for whether or not the day is after the ruling. Controls include issue size, trade size, time to maturity and indicators for bond insurance, and optionality. Window describes the number of days before and after the event day that are included in the regression. $R^2$ is adjusted $R^2$. Estimated coefficients are presented in basis points.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| Post-Ruling | -4.137*** | -4.137 | -4.137* | 0.0995 | 0.0995 | 0.0995 | -3.047 | -3.047 | -3.047** |
| | (0.000) | (0.121) | (0.066) | (0.946) | (0.978) | (0.650) | (0.201) | (0.417) | (0.033) |
| N | 101145 | 101145 | 101145 | 34573 | 34573 | 34573 | 10926 | 10926 | 10926 |
| $R^2$ | 0.367 | 0.367 | 0.367 | 0.374 | 0.374 | 0.374 | 0.389 | 0.389 | 0.389 |
| Cluster | None | CUSIP | Pre/Post | None | CUSIP | Pre/Post | None | CUSIP | Pre/Post |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Window | 30 days | 30 days | 30 days | 10 days | 10 days | 10 days | 3 days | 3 days | 3 days |

$p$-values in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

perceived the legislation as unlikely to be upheld.

**Table II: Debt Act Event Study Results**

Table II presents results from an event study around passage of the 4/6/2016 Debt Moratorium and Financial Recovery Act in Puerto Rico. The event study is performed by regressing tax-exempt general obligation U.S. state bond spreads over U.S. treasuries on an indicator variable for whether or not the day is after the ruling. Controls include issue size, trade size, time to maturity and indicators for bond insurance, and optionality. Window describes the number of days before and after the event day that are included in the regression. $R^2$ is adjusted $R^2$. Estimated coefficients are presented in basis points.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| Post-Ruling | -30.82*** | -30.82*** | -30.82** | -18.94*** | -18.94*** | -18.94** | -6.285*** | -6.285 | -6.285** |
| | (0.000) | (0.000) | (0.049) | (0.000) | (0.000) | (0.025) | (0.002) | (0.163) | (0.016) |
| N | 129468 | 129468 | 129468 | 44171 | 44171 | 44171 | 13824 | 13824 | 13824 |
| $R^2$ | 0.302 | 0.302 | 0.302 | 0.254 | 0.254 | 0.254 | 0.272 | 0.272 | 0.272 |
| Cluster | None | CUSIP | Pre/Post | None | CUSIP | Pre/Post | None | CUSIP | Pre/Post |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Window | 30 days | 30 days | 30 days | 10 days | 10 days | 10 days | 3 days | 3 days | 3 days |

$p$-values in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

All specifications for the Debt Act in Table II show a decrease in spreads following the passage of the law. This effect is statistically significant at the five percent level for all specifications except 8. These coefficients provide much stronger evidence of state bond reactions to the Debt Act. The 6 basis point decrease in specification 9 indicates that state-level bond spreads decreased on average by 6 basis points following the passage of the Debt Act. The negative effect is stronger for larger

window sizes. The coefficient is 19 and 31 basis points for the 10 and 30 day windows respectively. As with the Recovery Act, the negative coefficient suggests that this could be resulting from an increase in expected recovery rates or a decrease in uncertainty about that expectation.

**Table III: PROMESA Event Study Results**

Table III presents results from an event study around the 6/9/2016 House passage of the PROMESA legislation.The event study is performed by regressing tax-exempt general obligation U.S. state bond spreads over U.S. treasuries on an indicator variable for whether or not the day is after the ruling. Controls include issue size, trade size, time to maturity and indicators for bond insurance, and optionality. Window describes the number of days before and after the event day that are included in the regression. $R^2$ is adjusted $R^2$. Estimated coefficients are presented in basis points.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| Post-Ruling | 14.72*** | 14.72*** | 14.72*** | 18.37*** | 18.37*** | 18.37*** | 16.25*** | 16.25*** | 16.25** |
| | (0.000) | (0.000) | (0.010) | (0.000) | (0.000) | (0.006) | (0.000) | (0.001) | (0.016) |
| N | 110902 | 110902 | 110902 | 41028 | 41028 | 41028 | 14251 | 14251 | 14251 |
| $R^2$ | 0.205 | 0.205 | 0.205 | 0.208 | 0.208 | 0.208 | 0.218 | 0.218 | 0.218 |
| Cluster | None | CUSIP | Pre/Post | None | CUSIP | Pre/Post | None | CUSIP | Pre/Post |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Window | 30 days | 30 days | 30 days | 10 days | 10 days | 10 days | 3 days | 3 days | 3 days |

$p$-values in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

I present event study results for the PROMESA legislation in Table III. The table presents the strongest evidence of market reactions to legal events in Puerto Rico. The post-ruling average spread is positive and statistically significant for all specifications. The 16 basis point coefficient in specification 9 indicates that state-level GO bond spreads were on average 16 basis points higher following passage of PROMESA by the House on June 9, 2016.[10] A spread change of that size is economically meaningful as it represents ten percent of the average spread in the sample at that time. The magnitude is similar for other window sizes. This implies that the effects were concentrated in the short window around the event. That fact is strong evidence that markets were reacting to this event in particular. As I discussed, PROMESA likely provides the clearest blueprint for how Congress might legislate in a state default crisis. The results in Table III indicate that markets also believe this to be the case.

Along with being statistically significant, the change in spreads is positive. This could happen for a number of reasons. First, it may be that PROMESA set a precedent for state bankruptcy that was relatively unfriendly for bondholders, compared to expectations. In that scenario, expected recovery rates for a state default may have decreased, leading to an increase spreads. Second,

[10] I find little evidence of spread reactions in the small window around Senate passage of PROMESA on June 30.

it may be that PROMESA actually increased uncertainty around state government default. If investors previously thought the federal government would never allow for state bankruptcy, this legislation could have changed that perception. In that case, uncertainty around state default may have actually increased, leading to an increase in spreads. Finally, PROMESA may have also changed expectations around default probabilities. It is possible that prior the Puerto Rican crisis, investors assumed states would never default on their debt. PROMESA may have made investors aware that state bankruptcy is a real possibility down the road, which led them to increase default probability expectations, leading to an increase in spreads.

**Table IV: Swain Decision Event Study Results**

Table IV presents results from an event study around the decision of Judge Swain regarding special revenue bonds on 1/30/2018. The event study is performed by regressing tax-exempt general obligation U.S. state bond spreads over U.S. treasuries on an indicator variable for whether or not the day is after the ruling. Controls include issue size, trade size, time to maturity and indicators for bond insurance, and optionality. Window describes the number of days before and after the event day that are included in the regression. $R^2$ is adjusted $R^2$. Estimated coefficients are presented in basis points.

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Post-Ruling | 8.603*** | 8.603*** | 8.603*** | 5.258*** | 5.258* | 5.258* |
| | (0.000) | (0.000) | (0.006) | (0.001) | (0.094) | (0.053) |
| N | 147969 | 147969 | 147969 | 18132 | 18132 | 18132 |
| $R^2$ | 0.207 | 0.207 | 0.207 | 0.260 | 0.260 | 0.260 |
| Cluster | None | CUSIP | Pre/Post | None | CUSIP | Pre/Post |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Window | 30 days | 30 days | 30 days | 3 days | 3 days | 3 days |

$p$-values in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Finally, results from the Swain decision event study are in Table IV. We again see a consistent statistically significant increase in spreads after the decision. The magnitude of the effect is similar to that in the previous event studies with a coefficient of 5.3 basis points. Once again this could be due to multiple channels. First, the decision may have increased uncertainty around state government default. As I discussed above, the decision was seen as surprising to many observers, as Swain's ruling was believed to contradict current statues of Chapter 9 bankruptcy. Such an unexpected legal change could increase legal uncertainty around state default, leading to an increase in spreads. Second, the decision may have decreased market expectations of recovery rates in a default, leading to an increase in spreads.

In the above event studies, I provide evidence that U.S. state bond prices reacted to legal events in Puerto Rico. Each of the four event studies show some evidence of state-level bond spread reactions. Bond spreads decreased around passage of the Recovery and Debt Acts. Meanwhile, I show strong evidence that bond spreads increased following the passage of PROMESA, and the Swain decision. Overall, the results suggest that legal uncertainty may play an important role in state-level bond markets. In the next subsection I explore whether the effect of these events varies from state to state. While the channels are not perfectly clear, I see these results as in important piece of evidence that markets are learning about potential legal frameworks for state default and are incorporating that information into municipal bond prices.

### *B. Cross-Sectional Results*

In Tables V, VI, and VII, I present the results from my cross-sectional event studies based on Equation 3. "Post-Ruling" represents the $\beta$ coefficient which measures the average increase/decrease in spreads after the given event. "Post x Low Rat" represents the interaction coefficient ($\phi$) between the post-ruling indicator and an indicator for a state with a low credit rating. This coefficient measures the average change in post-event spreads in low credit quality states, as opposed to high quality states. Appendix A presents results when using pension funding as a proxy for credit quality.

Results from the Recovery Act in Table V paint a stronger picture than the results in Table I. Here, there is a strong evidence of market reactions to the legislation in lower credit quality states. States with lower credit ratings have much larger positive reactions to the legislation. These large coefficients are statistically significant across all specifications, except specification 5. The magnitude in the 10 day window is large at 100 bp (over half the average spread in the sample). However, the magnitude is much smaller (9 bp) in the three day window around the event. These results are consistent with the act decreasing recovery rate expectations, or increasing uncertainty.

Including the low-rating variable leaves the post-ruling coefficient insignificant for the majority of specifications. Although, I do find moderate evidence of a negative post-ruling change in average bond spreads for high rated states in specifications 5 and 6. The low rating indicator itself is unsurprisingly positive and statistically significant across specifications. Overall, these results suggest the lack of reaction in Table I may be biased due to high credit quality states. As I mentioned

**Table V: Recovery Act Event Study Results: Cross-Sectional**

Table V presents results from an event study around passage of the 6/30/14 Puerto Rico Public Corporation Debt Enforcement and Recovery Act in Puerto Rico. The event study is performed by regressing tax-exempt general obligation U.S. state bond spreads on an indicator variable for whether or not the day is after the ruling. Low Rating is and indicator for whether or not the state has a below Aa credit rating from Moody's. Controls include issue size, trade size, time to maturity and indicators for bond insurance, and optionality. Window describes the number of days before and after the event day that are included in the regression. $R^2$ is adjusted $R^2$. Estimated coefficients are presented in basis points.

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Post-Ruling | 2.133 | 2.133 | 3.535 | 3.535 | -6.101* | -6.101*** |
| | (0.419) | (0.486) | (0.226) | (0.123) | (0.100) | (0.006) |
| Low Rating | 64.49*** | 64.49** | 62.53*** | 62.53*** | 136.7*** | 136.7** |
| | (0.000) | (0.017) | (0.000) | (0.005) | (0.000) | (0.020) |
| Post x Low. Rat. | 106.5*** | 106.5* | 101.1*** | 101.1* | 9.664 | 9.664** |
| | (0.000) | (0.055) | (0.000) | (0.054) | (0.498) | (0.039) |
| N | 101145 | 101145 | 34573 | 34573 | 10926 | 10926 |
| $R^2$ | 0.424 | 0.424 | 0.423 | 0.423 | 0.437 | 0.437 |
| Cluster | CUSIP | Pre/Post | CUSIP | Pre/Post | CUSIP | Pre/Post |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Window | 30 days | 30 days | 10 days | 10 days | 3 days | 3 days |

$p$-values in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

previously, there is good reason we would expect to see stronger reactions in states with lower credit quality. As these states are closer to default, changes in legal uncertainty or expectations are more pertinent for market prices today. Cross-sectional differences in bond spread reactions to the Recovery Act imply this mechanism is at play.

In Table VI I present the interaction results for the Debt Act. I show a consistent statistically significant and positive change in state-level spreads following the legislation. Specification 6 indicates that state-level spreads increased by 32 bp in the three days following the legislation. As with the Recovery Act, spreads are on average higher in low rating states over the entire sample. The Post-Ruling coefficient is negative and statistically significant across all specifications. The coefficient in specification 6 implies that spreads in high credit rating states decreased on average by 9 bp in the three days following the passage of the Debt Act. That effect and magnitude is consistent with the full-sample result in Table II.

The positive interaction effect is opposite of the overall average effect I find in Table II. In that

**Table VI: Debt Act Event Study Results: Cross-Sectional**

Table VI presents results from an event study around passage of the 4/6/2016 Debt Moratorium and Financial Recovery Act in Puerto Rico. The event study is performed by regressing tax-exempt general obligation U.S. state bond spreads on an indicator variable for whether or not the day is after the ruling. Low Rating is and indicator for whether or not the state has a below Aa credit rating from Moody's. Controls include issue size, trade size, time to maturity and indicators for bond insurance, and optionality. Window describes the number of days before and after the event day that are included in the regression. $R^2$ is adjusted $R^2$. Estimated coefficients are presented in basis points.

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Post-Ruling | -32.41*** | -32.41** | -23.53*** | -23.53** | -9.080** | -9.080** |
| | (0.000) | (0.044) | (0.000) | (0.022) | (0.041) | (0.013) |
| Low Rating | 178.8*** | 178.8*** | 147.2*** | 147.2** | 154.5*** | 154.5*** |
| | (0.000) | (0.007) | (0.000) | (0.015) | (0.000) | (0.008) |
| Post x Low. Rat. | 9.791 | 9.791* | 31.21*** | 31.21** | 32.08** | 32.08** |
| | (0.467) | (0.066) | (0.002) | (0.031) | (0.048) | (0.018) |
| N | 129468 | 129468 | 44171 | 44171 | 13824 | 13824 |
| $R^2$ | 0.404 | 0.404 | 0.333 | 0.333 | 0.384 | 0.384 |
| Cluster | CUSIP | Pre/Post | CUSIP | Pre/Post | CUSIP | Pre/Post |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Window | 30 days | 30 days | 10 days | 10 days | 3 days | 3 days |

$p$-values in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

table I show a consistent coefficient of −9 bp. Results in Table VI suggest those previous results are being driven by the high quality states, which presents an interesting dichotomy I have not previously raised. It is not the case that effects are magnified in low credit quality states, but instead the event has opposing effects in states based on credit quality. It could be the case that a decrease of uncertainty is more meaningful for high credit quality states, or a decrease in recovery expectations has a dominant effect for low credit quality states. That duality could produce the above results. Future work modeling the effects of legal uncertainty on state bond prices should explore channels through which these opposing forces can be at work.

In Table VII I present results from my cross-sectional event study around the House passage of PROMESA. I find a consistent positive and statistically significant increase in spreads around the event. Specification 6 indicates that state-level bond spreads in low credit rating states increased by an average of 42 bp in the three days following passage of the law by the House. The magnitude of the effect is consistent across windows, which indicates the effect is concentrated in the small

**Table VII: PROMESA Event Study Results: Cross-Sectional**

Table VII presents results from an event study around the 6/9/2016 House passage of the PROMESA legislation. The event study is performed by regressing tax-exempt general obligation U.S. state bond spreads on an indicator variable for whether or not the day is after the ruling. Low Rating is and indicator for whether or not the state has a below Aa credit rating from Moody's. Controls include issue size, trade size, time to maturity and indicators for bond insurance, and optionality. Window describes the number of days before and after the event day that are included in the regression. $R^2$ is adjusted $R^2$. Estimated coefficients are presented in basis points.

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Post-Ruling | 7.705** | 7.705** | 2.219 | 2.219* | 2.107 | 2.107 |
| | (0.024) | (0.026) | (0.618) | (0.080) | (0.688) | (0.299) |
| Low Rating | 183.4*** | 183.4*** | 171.7*** | 171.7** | 169.3*** | 169.3*** |
| | (0.000) | (0.005) | (0.000) | (0.010) | (0.000) | (0.009) |
| Post x Low. Rat. | 38.80*** | 38.80*** | 63.50*** | 63.50** | 42.00** | 42.00** |
| | (0.000) | (0.009) | (0.000) | (0.016) | (0.014) | (0.043) |
| N | 110902 | 110902 | 41028 | 41028 | 14251 | 14251 |
| $R^2$ | 0.371 | 0.371 | 0.391 | 0.391 | 0.397 | 0.397 |
| Cluster | CUSIP | Pre/Post | CUSIP | Pre/Post | CUSIP | Pre/Post |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Window | 30 days | 30 days | 10 days | 10 days | 3 days | 3 days |

$p$-values in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

window around the passage of PROMESA. Again, I show that spreads are consistently higher in low credit rating states both before and after the event. Finally, the Post-Ruling coefficient suggests that there was not a change in spreads in high credit quality states.

The insignificant coefficient on Post-Ruling indicates that results in Table III are driven by low credit quality states. State-level bonds do not appear to react to the PROMESA legislation in high credit quality states. Again, the changes in legal uncertainty brought about by the legislation may not be meangingful for states that are not close to default. As before, the increase in spreads could arise due to multiple channels. On the one hand, PROMESA may have decreased expected recovery rates for state default leading to an increase in spreads. On the other hand, PROMESA may have actually increased legal uncertainty leading to an increase in spreads. Finally, it may be that PROMESA raised investor concerns about the potential for state default, which could raise expectations for the probability of default which would lead to an increase in spreads.

The three tables above show consistent evidence of cross-sectional differences in the reaction of

state-level bonds to legal events surrounding the Puerto Rican debt crisis. I find all three events lead to a statistically significant, and economically meaningful increase in state-level bond spreads in low credit quality states. The results also show that effects are much lower, and often insignificant in high credit quality states. As hypothesized above, legal uncertainty surrounding state default may be most meaningful for low credit quality states. These are the states that are closest to default, and therefore, any changes to expectations around the legal structure of default would be more relevant for those states which are most likely to experience such an event.

Overall, the results in this section provide strong evidence that state-level bond markets have reacted to legal events surrounding the Puerto Rican debt crisis. This implies that markets do see these events as providing meaningful information, or legal precedent, regarding how a state default may play out. Moreover, the strength of these effects are consistently stronger in low credit quality states, although the direction and magnitude of the effects, however, vary based on the events. As I've discussed, multiple channels could lead to reactions in state bond markets around these events. Future theoretical work could help tease out which effects may dominate empirically. This could provide more guidance on which channels are driving the results I find here. While these results speak to price effects, they do not address quantity effects. Therefore, in the next section I explore whether or not these legal events led to changes in state-level bond trading behavior.

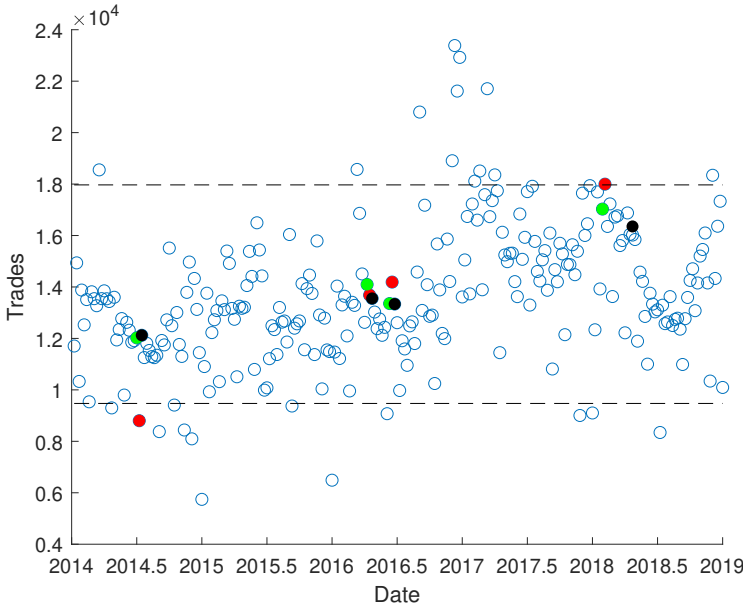
## V. Trading Activity

In this section I briefly investigate trading behavior in state debt markets around the Puerto Rican legal events. Figure 2 displays the weekly number of state general obligation bond trades in my sample. Meanwhile Figure 3 presents the total weekly trading volume of state general obligation bonds in my sample. Green dots indicate the week prior to a Puerto Rican legal event, as described in Section III. Red dots indicate the week of an event, while black dots indicate the week following. Dotted horizontal lines represent the fifth and ninety-fifth percentiles.

Figure 2 displays little evidence of increases in trading activity around the legal events I study. The red dot in 2014 actually indicates that the number of trades in the week of the Recovery Act was in the bottom fifth percentile. The number of trades during the passage of the Debt Act and PROMESA are right around the sample average. There is a slightly heightened level of trading

**Figure 2: Weekly Trading Activity: 2014-2019**

Figure 2 displays the weekly number of tax-exempt state general obligation bond trades. Green dots indicate the week prior to a Puerto Rican legal event, as described in Section III. Red dots indicate the week of an event, while black dots indicate the week following. Dotted horizontal lines represent the fifth and ninety-fifth percentiles.



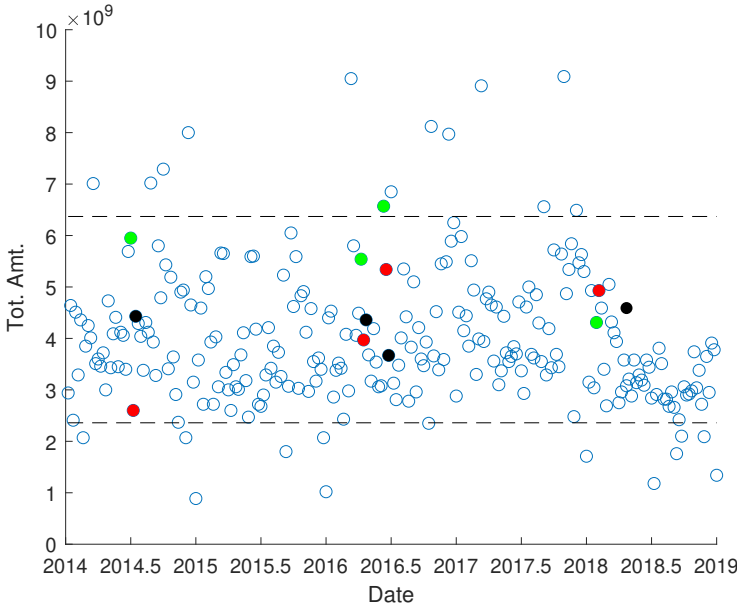

around the Swain decision, and the week of the ruling actually had trading activity in the top fifth percentile in the sample. Therefore, this figure provides some weak evidence that this event was associated with a spike in activity. There is little evidence, however, of changes in trading intensity for the other events.

The story is similar when looking at the weekly trading volume. Figure 3 shows little evidence of spikes (or decreases) in volume around legal events. The week prior to the passage of PROMESA has a total volume in the top fifth percentile of the sample. The week of the event and the week following also have higher than average volume. This is weak evidence that the passage of PROMESA may have been associated with an increase in volume. Otherwise, the other events have "normal" levels of volume.

The two figures above suggest the legal events discussed above were not associated with any significant changes in trading behavior for state-level tax-exempt general obligation bonds. This is not inherently surprising for two reasons. First, municipal markets are very illiquid. Second, municipal bonds are generally held by individual retail investors. The fact is, there is not a lot of trading in these markets. And the investors may be slightly less sophisticated than in other

**Figure 3: Weekly Trading Volume: 2014-2019**

Figure 3 displays the weekly total trading volume for state tax-exempt general obligation bonds. Green dots indicate the week prior to a Puerto Rican legal event, as described in Section III. Red dots indicate the week of an event, while black dots indicate the week following. Dotted horizontal lines represent the fifth and ninety-fifth percentiles.




asset markets, such as those for equities. Therefore, these legal events may not be enough to push investors to trade. Although, the event study results in the previous section show that the events do have a significant effect on prices, given trading activity.

# VI. Conclusion

In this paper I study state bond market reactions to legal events in the Puerto Rican debt crisis. I find that U.S. state bond prices have statistically significant, and economically meaningful reactions to events in Puerto Rico. Although these reactions differ in size, and direction across events. I also find evidence of strong cross-sectional differences in these reactions based on credit worthiness. Bonds issued by states with lower credit quality have stronger price reactions to legal events. I do not, however, find evidence of changes in trading behavior around the legal events. These results imply that investors are learning about the structure of future state defaults by observing legal events around the Puerto Rican bankruptcy.

Overall, I see my work as an important first step in understanding the role of legal uncertainty

in municipal bond prices, and asset prices more generally. Future theoretical work on the role of legal uncertainty in municipal debt markets, and asset markets more generally, is warranted. As I have discussed, multiple channels could lead to legal "shocks" having an effect on asset prices. Theoretical work could help tease out which channels are likely to dominate. Nevertheless, results suggest that markets see legal decisions around Puerto Rican bankruptcy as informative for state government default. My findings suggest that creating a legal framework for state government default, and therefore decreasing uncertainty, could lead to lower borrowing costs today for municipal governments. More broadly, I highlight an understudied channel, legal uncertainty, in the asset pricing literature. Future research should explore what role legal uncertainty plays in other asset markets.

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# Appendix A. Pension Funding Interaction Results

In Tables VIII, IX, and X, I present the results from my cross-sectional event studies using pension funding. "Post-Ruling" represents the $\beta$ coefficient representing the average increase/decrease in spreads after the given event. "PL-PA x Post" represents the interaction coefficient ($\phi$) between the post-ruling indicator and the states unfunded pension liability to GDP ratio. The unfunded pension liability ratio is calculated using pension liability and asset data from the Boston College Center for Retirement Research Public Plans Database. State-level GDP is taken from the BEA. Data is at an annual frequency, so the ratio will be constant for each state in the sample for each event study. The ratio is scaled by one-standard deviation in the sample. For more information on the pension funding ratio and the effect of unfunded pension liabilities on state bond spreads, see Boyer (2019). Results are consistent with those in Section IV. I find a positive and statistically significant interaction effect for each event.

**Table VIII: Recovery Act Event Study Results: Cross-Sectional, Pension Funding**
Table VIII presents results from an event study around passage of the 6/30/14 Puerto Rico Public Corporation Debt Enforcement and Recovery Act in Puerto Rico. The event study is performed by regressing tax-exempt general obligation U.S. state bond spreads on an indicator variable for whether or not the day is after the ruling. PL-PA is the ratio of a state's unfunded public pension liability to GDP. Controls include issue size, trade size, time to maturity and indicators for bond insurance, and optionality. Window describes the number of trading days before and after the event day that are included in the regression. $R^2$ is adjusted $R^2$. Estimated coefficients are presented in basis points.

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Post-Ruling | -19.48*** | -19.48** | -14.59** | -14.59*** | -19.67*** | -19.67** |
| | (0.000) | (0.028) | (0.022) | (0.007) | (0.009) | (0.018) |
| PL-PA | 31.93*** | 31.93*** | 31.83*** | 31.83*** | 25.89*** | 25.89** |
| | (0.000) | (0.008) | (0.000) | (0.006) | (0.000) | (0.015) |
| PL-PA x Post | 9.214*** | 9.214** | 7.260* | 7.260** | 7.664** | 7.664** |
| | (0.000) | (0.018) | (0.076) | (0.010) | (0.048) | (0.030) |
| N | 101145 | 101145 | 34573 | 34573 | 10926 | 10926 |
| $R^2$ | 0.412 | 0.412 | 0.415 | 0.415 | 0.420 | 0.420 |
| Cluster | CUSIP | Pre/Post | CUSIP | Pre/Post | CUSIP | Pre/Post |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Window | 30 days | 30 days | 10 days | 10 days | 3 days | 3 days |

$p$-values in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

**Table IX: Debt Act Event Study Results: Cross-Sectional, Pension Funding**

Table IX presents results from an event study around passage of the 4/6/2016 Debt Moratorium and Financial Recovery Act in Puerto Rico. The event study is performed by regressing tax-exempt general obligation U.S. state bond spreads on an indicator variable for whether or not the day is after the ruling. PL-PA is the ratio of a state's unfunded public pension liability to GDP. Controls include issue size, trade size, time to maturity and indicators for bond insurance, and optionality. Window describes the number of trading days before and after the event day that are included in the regression. $R^2$ is adjusted $R^2$. Estimated coefficients are presented in basis points.

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Post-Ruling | -19.72*** | -19.72* | -16.49*** | -16.49** | -15.71** | -15.71** |
| | (0.005) | (0.057) | (0.009) | (0.022) | (0.027) | (0.035) |
| PL-PA | 41.92*** | 41.92** | 37.23*** | 37.23** | 34.70*** | 34.70*** |
| | (0.000) | (0.031) | (0.000) | (0.011) | (0.000) | (0.004) |
| PL-PA x Post | -5.377 | -5.377** | -0.388 | -0.388* | 4.964 | 4.964** |
| | (0.124) | (0.028) | (0.892) | (0.057) | (0.109) | (0.040) |
| N | 128467 | 128467 | 44008 | 44008 | 13779 | 13779 |
| $R^2$ | 0.368 | 0.368 | 0.316 | 0.316 | 0.357 | 0.357 |
| Cluster | CUSIP | Pre/Post | CUSIP | Pre/Post | CUSIP | Pre/Post |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Window | 30 days | 30 days | 10 days | 10 days | 3 days | 3 days |

$p$-values in parentheses

$^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

**Table X: PROMESA Event Study Results: Cross-Sectional, Pension Funding**

Table X presents results from an event study around the 6/9/2016 House passage of the PROMESA legislation. The event study is performed by regressing tax-exempt general obligation U.S. state bond spreads on an indicator variable for whether or not the day is after the ruling. PL-PA is the ratio of a state's unfunded public pension liability to GDP. Controls include issue size, trade size, time to maturity and indicators for bond insurance, and optionality. Window describes the number of days before and after the event day that are included in the regression. $R^2$ is adjusted $R^2$. Estimated coefficients are presented in basis points.

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Post-Ruling | 0.303 | 0.303 | -17.01* | -17.01** | -22.64** | -22.64* |
| | (0.965) | (0.586) | (0.062) | (0.025) | (0.019) | (0.067) |
| PL-PA | 39.74*** | 39.74** | 39.42*** | 39.42** | 38.88*** | 38.88*** |
| | (0.000) | (0.010) | (0.000) | (0.013) | (0.000) | (0.002) |
| PL-PA x Post | 7.322** | 7.322*** | 15.68*** | 15.68** | 16.09*** | 16.09** |
| | (0.011) | (0.006) | (0.000) | (0.011) | (0.000) | (0.032) |
| N | 110601 | 110601 | 40919 | 40919 | 14212 | 14212 |
| $R^2$ | 0.301 | 0.301 | 0.314 | 0.314 | 0.331 | 0.331 |
| Cluster | CUSIP | Pre/Post | CUSIP | Pre/Post | CUSIP | Pre/Post |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Window | 30 days | 30 days | 10 days | 10 days | 3 days | 3 days |

$p$-values in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$