IMES DISCUSSION PAPER SERIES

# What Went Wrong?
# The Puerto Rican Debt Crisis, the "Treasury Put," and the Failure of Market Discipline

Robert S. Chirinko
Assisted by Ryan Chiu and Shaina Henderson

**Discussion Paper No. 2022-E-3**

IMES

INSTITUTE FOR MONETARY AND ECONOMIC STUDIES

BANK OF JAPAN

2-1-1 NIHONBASHI-HONGOKUCHO
CHUO-KU, TOKYO 103-8660
JAPAN

You can download this and other papers at the IMES Web site:
https://www.imes.boj.or.jp

**IMES Discussion Paper Series 2022-E-3**
**March 2022**

# What Went Wrong?
# The Puerto Rican Debt Crisis, the "Treasury Put," and the Failure of Market Discipline

**Robert S. Chirinko***
**Assisted by Ryan Chiu** and Shaina Henderson*****

**Abstract**

What went wrong? Why did seemingly rational, forward-looking bond investors continue to purchase Puerto Rican debt with only a modest risk premium, even though the macroeconomic fundamentals were dismal? Why did financial markets fail to exercise market discipline and restrict capital flows to Puerto Rico? Given weak macroeconomic fundamentals and relatively low risk premia, investors were either stunningly myopic/misinformed or Puerto Rican debt was implicitly insured by the U.S. government.

This paper examines the latter hypothesis, which we label the "Treasury Put," by examining a rare situation where the put was extinguished. The expectation of a federal bailout was perfectly reasonable given past behavior by the federal government, starting with the prior bailout of the city of New York through the Global Financial Crisis. Evaluating the Treasury Put hypothesis with a minimal set of assumptions is possible given three unique features – the dire fiscal and economic conditions in Puerto Rico, a fortunate characteristic of Puerto Rican bond issuance, and an exogenous "seismic shock." The latter feature is the non-bailout of the city of Detroit in 2013 that effectively extinguished the Treasury Put. Puerto Rican risk premia were stable before the Detroit bankruptcy and bracketed by the risk premia on Corporate Aaa and Baa bonds. However, after the Detroit bankruptcy, risk premia rose dramatically, thus identifying a sizeable Treasury Put of at least 350 basis points and a significant misallocation of capital to Puerto Rico. In effect, the Treasury Put was a form of regulatory forbearance. Institutional reforms that would eliminate the Treasury Put are considered, but none are found satisfactory.

**Keywords:** Puerto Rican debt crisis; Implicit government guarantees; Failure of market discipline
**JEL classification:** H81, H74, G18, G01

* Professor, Department of Economics, University of Illinois at Chicago, CESifo (E-mail: chirinko@uic.edu)
** University of Illinois at Chicago
*** University of Illinois at Chicago

# What Went Wrong?
# The Puerto Rican Debt Crisis, The "Treasury Put," And The Failure Of Market Discipline

After years of propping up a struggling economy with
unsustainable borrowing, Puerto Rico's financial reckoning
was inevitable.

*New York Times* (January 24, 2018)

[Puerto Rico's] financial and economic woes
don't appear to be reflected in its bond yields.

*Barron's* (August 27, 2012)

Current general obligation credit spreads [on Puerto Rican debt],
with yields about 200 basis points above AAA benchmarks,
do not reflect bondholder risk.

Schankel (July 27, 2012)

## Introduction

What went wrong? Why did seemingly rational, forward-looking bond investors continue to purchase Puerto Rican debt with only a modest risk premium, even though the macroeconomic fundamentals were extremely weak? Why did financial markets fail to exercise market discipline and restrict capital flows to Puerto Rico? Since 2002, the Commonwealth of Puerto Rico (which is a territory of the United States, not a state per se) has run a budget deficit each year. Starting in 2006, population growth turned negative and the decline accelerated in recent years (Figure 1). Between 2005 and 2016, population fell by 11%. The employment-to-population ratio also declined sharply (Figure 2), and real GDP began to contract severely (Figure 3). Between 2005 and 2016, real GDP declined by 12%. In 2006, a very favorable tax credit for U.S. corporations operating in Puerto Rico was finally eliminated.[1] In its July 2012

[1] Section 936 of the Internal Revenue Code allowed for a tax credit for U.S. corporations operating in Puerto Rico. This tax credit was repealed by the Small Business Job Protection Act of 1996. However transition rules allowed firms, which had been credit claimants in 1996, to continue to receive the credit for income generated in Puerto Rico through the end of 2005. From 2006 onward, the tax credit was completely eliminated. The extent to which this elimination contributed to the reduction in economic activity is not clear. In 1995 (the year before repeal), there were 440 companies claiming the tax credit with gross income over $40 billion. In the final year of the 10 year transition interval, the comparable figures are 157 companies and $18 billion (GAO, 2018, p. 32). (Note that the Puerto Rican price level was approximately constant between 1995 and 2005.) Additional factors that might explain the economic

report on the Puerto Rican economy, the Federal Reserve Bank of New York (2012) concluded that "[t]he task of putting the Island on a path of robust, sustainable, and inclusive growth remains a work in progress."[2] Per the above quotation from the *New York Times*, the outcome "was inevitable." On August 3, 2015, Puerto Rico began to default on some of its bond commitments; bankruptcy was effectively declared (under Title III) on May 2, 2017.[3]

The fiscal situation has been precarious for many years. As shown in Figure 4 (see Appendix A for details) the ratio of government liabilities -- debt plus unfunded pension liabilities -- to nominal GDP has grown dramatically over the past 15 years. (Unless otherwise stated, GDP and GNP are in nominal terms.) In 2000, it was 70%; by 2015, this ratio had increased by more than half to 109%. Figure 5 shows that budget deficits were persistent and growing. The 2013 figure of 6.3% exceeds the comparable figure of 4.1% for the U.S. federal government. This graph is on a budgetary (or cash) basis. Krueger, Teja, and Wolfe (2015, p. 11) have noted several concerns with these figures: not stated on an accrual basis; omitting capital expenditures and the deficit-creating activities of several government agencies. When

---

decline beginning in 2006 are the imposition of a 7% sales tax, the slowdown in the U.S. mainland economy, and the rise in oil prices.

[2] As far back as the 1830's, there have been numerous reports documenting the problems and opportunities facing the Puerto Rican economy. See the preface and essays collected in Collins, Bosworth, and Soto-Class (2006) and the report by Krueger, Teja, and Wolfe (2015).

[3] It is important to distinguish between default -- failing to honor contractually mandated payments – and bankruptcy -- a legal status determined by a court of law usually after a creditor or debtor initiates a legal proceeding. For a complicated set of reasons related to the Commerce Clause in the U.S. Constitution, states and territories (such as Puerto Rico) cannot file for bankruptcy and a possible reconfiguration of their contractual obligations and other liabilities. (However, municipalities (e.g., Detroit, New York City) can seek protection under Chapter 9 of the bankruptcy code.) In light of this restriction, the Puerto Rico Oversight, Management and Economic Stability Act (PROMESA) was enacted by the U.S. Congress on July 1, 2016, and the PROMESA board was empowered to suspend debt payments and renegotiate debt contracts on behalf of Puerto Rico, thus mimicking traditional bankruptcy procedures that facilitate reorganization. PROMESA was not created to provide any direct fiscal assistance to Puerto Rico, but rather "The purpose of the Oversight Board is to provide a method for a covered territory to achieve fiscal responsibility and access to the capital markets" (U.S. Congress, 2016, p. 5).

(As an interesting historical aside, Puerto Rico and the District of Columbia could access Chapter 9 prior to 1984. In that year, federal legislation (HR 5174) removed that option. The reasons for the change remain unclear. One interpretation is that, since Puerto Rico's size and multi-jurisdictional structure are similar to those for U.S. states, Congress wished to place Puerto Rico on the same legal footing as U.S. states. However, this reasoning does not apply to the restriction on the District of Columbia, which seems similar to a municipality.)

some of these concerns are addressed, the adjusted deficit rises by about 84% in recent years (calculations are presented in Appendix B). This figure includes debt service. To present data closer to an operating deficit, which is a standard measure for assessing fiscal health,[4] we remove the expenditures associated with debt service. This downward adjustment nearly cancels the upward adjustments to the deficit noted above. Thus, at least for the latter years, Figure 5 approximates the operating deficit (though it may be somewhat overstated because, based on publicly available sources, it is difficult to remove all debt payments). A more important omission that severely understates the reported deficit is the failure to account for financing gaps in legacy liabilities stemming from, among other sources, employee retirement plans. By any measure, the fiscal picture has been dismal and deteriorating for many years.

These persistent deficits reflect a limited fiscal capacity. In 2016, the Puerto Rican median household income was $19,606. Comparable figures for the United States and its poorest state (Mississippi) are $55,322 and $40,528, respectively. Moreover, the demographics are very unfavorable, owing in part to the absence of restrictions for migrating to and working in the United States (Puerto Ricans are U.S. citizens). As shown in Table 1 for 2015, the median age of 36.4 years in Puerto Rico is well above the median age for the Caribbean region and only slightly below that for the United States. The projected growth rate over the next 25 years is also relatively unfavorable. By 2040, the Puerto Rican population will be older than those for the Caribbean region, the United States, and the more developed and less developed groups of countries. With falling real GDP, ongoing government operating deficits, and an aging population, the debt level was clearly unsustainable and default inevitable.

The risk premium on Puerto Rican government debt did not reflect these economic realities, per the other two quotations above. For example, based on a matched pair of uninsured and insured bonds issued in April 2012 with the exact same maturity of 10 years (match #37 in Appendix C), the Puerto Rican risk premium of 146 basis points was greater than that on Corporate Aaa bonds by 41 basis points and less than that on Corporate Baa bonds by 85 basis points. Baa bonds are reasonably creditworthy; "[o]bligations rated Baa are subject to moderate credit risk; they are considered medium-grade and as such may possess speculative characteristics" (see Appendix D for further information on Moody's ratings). The Puerto Rican

[4] See the extended discussion of predictors of municipal fiscal distress in Gordon (2018, especially p. 28 and the cited references).

risk premium was much lower than that for Non-Investment grade ("junk") bonds, 428 basis points, though this comparison should be done with caution due to the substantial liquidity premium for junk bonds. The official statement associated with April 2012 bond issue was pessimistic, reporting that growth in employment and an economic activity index were both negative in 2011 and 2012. Notwithstanding this latter pessimism, the risk premium for Puerto Rican bonds remained surprisingly low in the face of continuing doubts about Puerto Rico's ability to honor its financial obligations.

Given these weak macroeconomic fundamentals and relatively low risk premium, either investors were extremely myopic/misinformed or Puerto Rican debt was implicitly insured by the U.S. government. While some myopia and misjudgments are surely possible, the widely reported weakness of the Puerto Rican economy rules out the former explanation. This paper studies the latter possibility, which we label the "Treasury Put." Three unique features allow us to identify and measure the implicit guarantee from the U.S. government as perceived by investors:

1. The very weak fiscal and economic conditions of Puerto Rico that make the Treasury Put a live option,
2. The simultaneous issuance of insured and uninsured bonds that facilitates the computation of the risk premium,
3. An exogenous seismic event – the absence of federal assistance to Detroit in the face of its bankruptcy – that extinguished the Treasury Put in July 2013 and allows us to estimate its magnitude.

In effect, we are estimating a difference-in-difference model on uninsured vs. insured bonds based on the "Detroit treatment," which is independent of events in Puerto Rico. Given the three very favorable circumstances listed above, the analysis can be successfully executed with simple statistics and in a narrative format.[5] The case study (or clinical) approach taken in this paper is no less powerful than econometric techniques needed to separate signal from noise in less favorable empirical environments. Studies using econometric techniques and large datasets have wide scope and a direct link to external validity. However, not infrequently, the statistical models have limited explanatory power, thus relegating many unknown factors to portmanteau error terms and time-invariant fixed effects. By contrast, case studies offer a precise understanding of a specific situation. Given the low $R^2$'s in many large-dataset studies that raise

[5] Narratives have proven very useful in a variety of applications; see, among other studies, Hamilton (1985), Romer and Romer (1989, 2017), and Ramey and Shapiro (1998).

concerns about omitted variables biasing the coefficients of interest, the more focused approach in a case study may have advantages. Neither large-dataset studies nor case studies dominate; both add unique value (Jensen, Fama, Long, Ruback, Schwert, Smith, and Warner, 1989).

A further benefit of studying Puerto Rican bonds is that this debt is not held to any great extent by Puerto Rican banks, and hence we do not need to control for strategic complementarities (the "diabolic loop" or "too interconnected to fail") between sovereign and bank debt (Brunnermeier, Garicano, Lane, Pagano, Reis, Santos, Thesmar, van Nieuwerburgh, and Vayanos, 2016; Esposito, 2018; Capponi, Corell, and Stiglitz, 2020). Moreover, since Puerto Rico uses the U.S. dollar to value all transactions, exchange rate movements are not a confounding factor.

The Puerto Rican experience is rare in that the vast majority of studies of government guarantees focus on their creation,[6] not their removal; the latter may allow in some cases for an analysis with fewer confounding factors. Only three exceptions are known to the author. First, two papers exploit the information from the first default of a Chinese state-owned enterprise (SOE), which were presumably backed by the full faith and credit of the Chinese government. Dong, Hou, and Ni (2021) find that, after the SOE default, credit ratings are now less sensitive to the degree of state ownership and firm size (a "too-big-to-fail" effect), and credit ratings become more important in pricing debt. Jin, Wang, and Zhang (2020) document that real investment falls after the SOE default, especially for firms that were finance constrained. Second, in 2005, guarantees provided by the German states (*länder*) to the German state banks (*landesbanken*) on their liabilities and equity were terminated (based on a 2001 agreement) and the debt ratings of the 10 state banks in existence at that time fall sharply (Körner and Schnabel, 2013). Third, when a ruling by a Swiss court removed the explicit liability of cantons for the debt of its municipalities, the risk premium on cantonal debt falls modestly (Feld, Kalb, Moessinger, and Osterloh, 2017; see fn. 16 for further discussion).

Our quantitative evaluation of the Treasury Put hypothesis proceeds as follows. Section 1 documents the existence of a Treasury Put. Starting with the 1975 bailout of New York City, a

[6] The literature examining the impact of newly-created government guarantees on asset prices is very large. As an example of this literature, see the study of ECB government guarantees by Krishnamurthy, Nagel, and Vissing-Jorgensen (2018), which also highlights the challenges in estimating the impact of government policies on bond yields and default premia.

long list of government rescue plans of distressed borrowers led investors to the expectation of a bailout in the event of a Puerto Rican default. (In this paper, "bailout" describes any government action that commits taxpayer resources to support a financially distressed entity whether or not this commitment proves to be profitable.) We carefully examine the historical record to construct the information set for Puerto Rican bond investors before the Detroit bankruptcy.

Section 2 describes the model for estimating the risk premium, a task made relatively easy because Puerto Rico issued both uninsured and insured general obligation bonds. These bonds were issued on the same day and, in many cases, with the exact same maturity. These characteristics allow us to compute accurately the risk premium on Puerto Rican bonds and to avoid several potential biases: an estimate of the marginal income tax rate for the marginal municipal bond investor, the "municipal puzzle" of an excessively upward sloping yield curve, differential liquidity between uninsured and insured bonds, the creditworthiness of insurers, and general shocks to the municipal market. Our procedure for estimating the risk premium is then compared to several other more parametric approaches.

Section 3 discusses data requirements. Only five series are needed to estimate the risk premium: the yield to maturity for uninsured and insured Puerto Rican bonds, the yield curve for U.S. Treasury securities, the Corporate Aaa yield, and the marginal income tax rate for the marginal municipal bond household investor.

Section 4 presents results based on the risk premium for Puerto Rican bonds both before and after the seismic shock of the Detroit bankruptcy. The risk premium is relatively low before Detroit, but it increases sharply thereafter. This 350 basis point increase is our estimate of the Treasury Put. The increase in borrowing costs following the elimination of the Treasury Put quantifies the resource misallocation associated with this implicit government guarantee.

Section 5 summarizes our results and relates them to ongoing discussions about the role of government guarantees in financial markets. The Treasury Put is implicit insurance that explains the puzzling behavior of the Puerto Rican risk premium and, in effect, is a form of regulatory forbearance. Institutional reforms that would extinguish the Treasury Put are considered, but none are found satisfactory. How to extinguish the Treasury Put on an ongoing basis in a democratic society remains an open question.

## 1. The "Treasury Put"

The "Treasury Put" is the implicit guarantee -- as perceived by investors -- from a government agency to provide support in the event of financial distress by the issuer of Puerto Rican bonds.[7] In the event of a default by Puerto Rico, investors would, in effect, "place" their debt with the federal government, which would then return to investors the value of the securities at near face value through a bailout, either a direct payment or government guarantee. Measuring perceptions at a point in time is a difficult matter. In this section, we review a set of historical circumstances that allow us to infer the perceptions of a "representative investor." In effect, we are reconstructing investors' information sets during the years prior to the Puerto Rican default.

The expectation of a federal bailout was sensible given past behavior. In 1975, New York City was on the verge of bankruptcy.[8] Initially, the federal government explicitly refused to offer any financial assistance. Republican president Gerald Ford stated on October 29, 1975 that "[t]he people of this country will not be stampeded. They will not panic when a few desperate New York officials and bankers try to scare New York's mortgage payments out of them" (*New York* Times, December 28, 2006). President Ford's position was encapsulated in a famous (though perhaps apocryphal) headline in the *New York Daily News* the next day: "Ford to City: Drop Dead. Vows He'll Veto Any Bail-Out." However, the federal government relented, and financial assistance was authorized on December 10, 1975 in the form of $2.3 billion in loans. This bailout is equivalent to between $15.5 and $7.8 billion in 2013 if adjusted for growth in current dollar GDP per capita or in the GDP price deflator, respectively).[9] What is particularly

[7] This phrase is in the spirit of the "Greenspan Put" of Miller, Weller, and Zhang (2002). As a technical matter, contractual obligations for bond payments reside with the "obliger," who is frequently, but not always, the issuer.

[8] Municipalities like New York City can file for bankruptcy. This protection is not available to U.S. states and territories; cf. fn. 3.

[9] Washington D.C. also received substantial financial assistance from the Treasury in 1997. This bailout included the assumption of $5 billion in pension liabilities and a complicated set of financial flows involving increases and decreases in payments to the District and Treasury-backed loans (Brookings, n.d., pp. 89-98). However, given the special legal relationship of Washington D.C. to the federal government, it is not clear that a reasonable investor would have seen these actions as a precedent for other municipalities and Puerto Rico.

noteworthy about that bailout is that New York City was led by a liberal Democratic mayor, while President Ford was a fiscally conservative Republican.

In the face of financial distress, federal financial assistance has been the norm:

1. Lockheed, 1971: federal guarantee of $0.25 billion of Lockheed debt (*New York Times*, 1979). [$2.4 : $1.1]. Figures in brackets are the nominal figure adjusted to 2013 dollars by the growth rate in nominal GDP per capita : growth rate in the implicit GDP price deflator, respectively.

2. Chrysler, 1980: federal guarantee of $1.5 billion of Chrysler debt (*Washington Post*, 1984). [$6.3 : $3.6].

3. Savings and Loan Crisis, 1986 to 1995: resolution costs to taxpayers of $124 billion (Curry and Shibut, 2000,Table 4). [$273 : $199; computations based on 1990 values].

4. Mexican Peso Crisis, 1995: federal guarantee of $20 billion of Mexican government debt, part of a total aid package exceeding $50 billion with additional contributions from the IMF, the BIS, Canada, and several Latin American countries (Lustig, 1995, p. 20). [$37 : $28].

5. Bear Stearns, 2008: loan from the Federal Reserve System of $29 billion for the purchase of toxic mortgage-related assets (Blinder, 2013, p. 107). [$32 : $31].

6. Fannie Mae + Freddie Mac, 2008 to 2012: capital injections from the U.S. Treasury of $140 billion (Blinder, 2013, pp. 118-119). [$155 : $150; computations based on an average of 2008 and 2009 values].

7. American International Group (AIG), 2008 to 2009: combination of loans from the Federal Reserve System and funding from TARP of $182 billion (Blinder, 2013, pp. 136-137). [$201 : $195; computations based on an average of 2008 and 2009 values].

8. Troubled Asset Relief Program (TARP), 2008 to 2009: authorization for the U.S. Treasury to spend $700 billion to support institutions and households affected by the Financial Crisis, though only $499 billion was dispersed or used for guarantees: $250 billion to banks, $80 billion to General Motors and Chrysler (again), $68 billion to AIG, $45 billion for the FHA Refinance Program, $37 billion to foreclosure prevention programs, and $19 billion to credit market programs (U.S. Treasury, 2017, Table 1, p. 19). [$552 : $535; computations based on an average of 2008 and 2009 values].

Mervyn King, former head of the Bank of England, noted that "[a]ll banks, and large ones in particular, benefited from an implicit taxpayer guarantee, enabling them to borrow cheaply to finance their lending" (King, 2016, p. 96). This view was confirmed formally by Kelly, Lustig, and van Nieuwerburgh (2016); using data on options, they document government

guarantees of the U.S banking industry as a whole, though not individual banks, during the financial crisis. The "Geithner Doctrine" – "no significant financial institution would be allowed to fail" (Kay, 2015, p. 256) – coupled with the calamitous events that followed the Lehmann Brothers bankruptcy when the Doctrine was disregarded, led rational investors to expect government support of the $100+ billion in Puerto Rican liabilities.

Apart from the above precedents, are there factors specific to Puerto Rico that would have led a reasonable investor to expect the Treasury (or any other government agency) to bailout Puerto Rico, even though it is not generally considered a systemically important financial institution (SIFI)? There are at least three reasons why a Treasury Put was live.

- **Financial market contagion**: Greece too represented a small percentage of overall EMU GDP. But fear of contagion and an ensuing economic catastrophe motivated German Chancellor Merkel and perhaps other European policymakers to provide extensive financial assistance.

- **Extensive immigration:** Since Puerto Rican citizens hold a U.S. passport, they can easily travel to and work in the United States. A collapsing Puerto Rican economy might trigger an extensive and disruptive mass migration into the United States. A similar situation existed during German re-unification. Before Reunification, East German demonstrators chanted the slogan "If the D-Mark does not come to us, we are coming to the D-mark." Concern about migration was one reason why Western Germans were keen on providing extensive and generous aid to Eastern Germans (Sinn and Sinn, 1994, p. 51).

- **Political influence:** **S**everal U.S. mutual funds were invested heavily in Puerto Rican bonds. They could be expected to lobby the U.S. Treasury for a bailout, similar to the ones received by U.S. financial institutions via Brady Bonds during the first Bush administration and by German and French banks during the Euro crisis.

Government willingness to use its resources to assist investors in recent times extends to other countries. When speaking about the fragility of the Euro, ECB President Mario Draghi (2012) offered the following famous remark (<u>emphasis added</u>),[10]

> But there is another message I want to tell you. Within our mandate, the ECB is ready to do <u>whatever it takes</u> to preserve the euro. And believe me, it will be enough.

[10] In a sophisticated econometric analysis, Delatte, Fouquau, and Portes (2016) document that Draghi's remark returned bond yield spreads to their pre-crisis levels within one year of his speech.

During the European debt crisis, several severely impaired economies received bailouts from the Eurosystem and the other two members of the Troika, the European Commission and the IMF. In September 2007, Northern Rock bank, a substantial presence in the British mortgage market, faced a liquidity crisis. Motivated by a desire to avoid setting a precedent and cultivating moral hazard, the Bank of England initially declined Northern Rock's request for assistance. This refusal of a bailout was immediately followed by a classic bank run. The Bank of England relented within 24 hours and provided funds (initially £10 billion, eventually rising to £37 billion) to Northern Rock, earning the Governor of the Bank of England the appellation "Swervin' Mervyn." This assistance was followed by bailouts from the Bank of England to Lloyd's of London and the Royal Bank of Scotland of £22 and £57 billion, respectively.

Government intervention on behalf of investors has a long tradition. In the aftermath of the debt default by eight U.S. states and one territory circa 1840,[11] British financial interests aggressively lobbied for intervention by the U.S. federal government (Jenks, 1938, pp. 105-106):

> Baring Brothers [a British merchant bank] began an agitation to persuade the federal government to assume the responsibility for the state debts. … London merchants easily gathered the impression that Whigs of the Webster school [a faction of a U.S. political party at the time] were likely to carry out this policy. And so the Whig cause in the campaign of 1840 received generous support from England.[12]

The British government was also actively involved in supporting British business interests, as described 82 years ago in Hobson (1938, p. 56, emphasis added) in his book on *Imperialism*,

---

[11] The only other state to default on its debt obligations has been Arkansas in 1933 (Ratchford, 1941, Chapter XV; Ergungor, 2016).

[12] This impression of the Whigs' intentions was erroneous. The Whigs won the election but then enacted the Bankruptcy Act of 1841 (Warren, 1935, Part II). This Act was detrimental to the interests of British bondholders and other creditors because it allowed for the first-time debtors to initiate bankruptcy (labeled voluntary bankruptcy), resulting in over 33,000 bankruptcy filings in less than 17 months (Federal Judicial Center, n.d.) amounting to approximately 23% of GNP (Warren, 1935, p. 81 and author's calculations). (These bankruptcies were mostly filed by smaller businesses; larger firms with bondholders, primarily railroads, relied on a non-bankruptcy process called equity or railroad receivership (Skeel, 2001, p. 48).) This relief was temporary, and the 1841 Act was repealed two years later, a pattern of legislation that parallels a "tax holiday." U.S. states were not covered by the 1841 Act; somewhat over half their delinquent debts were repaid voluntarily, presumably to maintain future access to foreign capital markets (English, 1996).

> Investors who have put their money in foreign lands, upon terms which take full account of risks connected with the political conditions of the country, desire to use the resources of their Government to minimize these risks, and so to enhance the capital value and the interest of their private investments.[13]

Based on a plethora of past precedents, investors would have expected that, given the size of the outstanding Puerto Rican debt, it benefited from an implicit government guarantee that would, in turn, dampen risk premia. Puerto Rican bond investors held a Treasury Put.

[13] Hobson has rather harsh words for creditor-initiated arrangements: "But more frequently the insufficient guarantee of an international loan gives rise to the appointment of a financial commission by the creditor countries in order to protect their rights and guard the fate of their invested capital. The appointment of such a commission literally amounts in the end, however, to a veritable conquest" (p. 54, emphasis added). The PROMESA (cf. fn. 3) created by the U.S. Congress could be considered such a "creditor-initiated arrangement," one that was viewed harshly by many Puerto Ricans.

## 2. Computing The Risk Premium

This section presents the model for computing the risk premium on Puerto Rican general obligation bonds. Key to the derivation is the existence of both uninsured and insured bonds issued on the same day with maturities that are equal or nearly equal. Potential biases with our procedure are then examined. We conclude by comparing our procedure for estimating the risk premium to several others taking more parametric approaches.

### 2.1. Model

Municipal bonds generally enjoy a favorable tax status. All municipal bonds issued in the United States are exempt from federal income tax and, in most cases, they are also exempt from income taxes assessed in the state in which they are issued. Puerto Rican bonds enjoy the most favorable tax status of any municipal bond, as they are "triple tax-free" -- exempt from all federal, state, and local income taxes (though the latter exemption is of no practical importance). Given this favorable tax status, the taxable-equivalent-yield (TEY) on a bond issued by Puerto Rico (P), uninsured (uni), and with a maturity m years is modeled as the yield-to-maturity observed in the bond market, stated on a pre-tax basis by dividing by one minus the marginal income tax rate for the marginal municipal bond investor ($\tau$),

$$(1) \qquad \frac{r^{P,uni,m}}{(1-\tau)} \equiv r^{f} + s + l + \mu^{m} + \sigma \ .$$

The TEY depends on five factors: the risk-free rate ($r^{f}$), a municipal market-wide shock ($s$), and three premia for liquidity ($l$), maturity ($\mu^{m}$), and default risk ($\sigma$).[14] The object of the analysis in this section is to isolate the latter in terms of observables.

The companion TEY on an insured (ins) Puerto Rican bond with maturity of n years is modeled in a similar manner,

$$(2) \qquad \frac{r^{P,ins,n}}{(1-\tau)} \equiv r^{f} + s + l + \mu^{n} + \phi \ .$$

[14] The liquidity premium is an important component of municipal debt. Longstaff (2011) documents that the liquidity premium is quantitatively important for short-term municipal securities; even in a rather liquid segment of the market, it averages 56 basis points for the period 2001-2009. Ang and Green (2011, citing Ang, Bhansali, and Xing (n.d.)) report that the liquidity premium on municipals averages 112 basis points. He and Milbradt (2014) and Passadore and Xu (2018) show that the liquidity premium varies substantially by default state, accounting for one-half of the sovereign spread during periods of financial distress but only a negligible amount otherwise.

Equation (2) differs from equation (1) by allowing the bond to have a different maturity ($n \neq m$) and replacing the default risk premium on the uninsured bond by a default risk premium for the bond insurer ($\phi$). Equations (1) and (2) do not include time subscripts because both bonds are matched exactly by issue day (also known as the dated date).

The risk premium on uninsured bonds is obtained in three steps. First, equation (2) is subtracted from equation (1), thus eliminating the risk-free rate, the liquidity premium and aggregate/market-wide shock,

$$(3) \qquad \left(\frac{r^{P,uni,m}}{(1-\tau)}\right) - \left(\frac{r^{P,ins,n}}{(1-\tau)}\right) = \left(\mu^m - \mu^n\right) - \phi + \sigma \ .$$

Second, a Treasury bond of maturity k ($r^{T,k}$) is modeled as the sum of the risk-free yield and a maturity premium ($\mu^k$, $k = \{m,n\}$), where k extends over the entire Treasury yield curve,

$$(4) \qquad r^{T,k} = r^f + \mu^k \ .$$

Subtracting equation (4) from equation (3) twice with k equal to m and n and rearranging, we eliminate the maturity premia,

$$(5) \qquad \left(\frac{r^{P,uni,m}}{(1-\tau)} - r^{T,m}\right) - \left(\frac{r^{P,ins,n}}{(1-\tau)} - r^{T,n}\right) = -\phi + \sigma$$

Third, the risk premium for insurers is modeled as the difference between the yields on a 20-year Corporate Aaa bond ($r^{C,Aaa,20}$) and a 20-year Treasury bond ($r^{T,20}$),

$$(6) \qquad \phi = r^{C,Aaa,20} - r^{T,20} .$$

Using equation (6) to eliminate $\phi$ in equation (5), we obtain the following final expression defining the risk premium on uninsured Puerto Rican bonds in terms of observables,

$$(7) \qquad \sigma = \left(\frac{r^{P,uni,m}}{(1-\tau)} - r^{T,m}\right) - \left(\frac{r^{P,ins,n}}{(1-\tau)} - r^{T,n}\right) + \left(r^{C,Aaa,20} - r^{T,20}\right) .$$

### 2.2. Potential Biases

This sub-section evaluates the impact of five potential biases with using equation (7) to estimate the risk premium. First, a bias will occur if the marginal income tax rate for the elusive "marginal investor" differs from the true tax rate. While $\tau$ is an important variable in computing the gross-of-tax return, it is of second-order importance in computing the risk premium on Puerto

Rican bonds because it enters the yields for both the uninsured and insured bonds. As we shall see in Section 4, the difference between the uninsured and insured yields is small, and hence so is the potential bias. Our calculations are based on the highest possible marginal income tax rate for a household investor. Using different methodologies on very different samples, Feenberg and Poterba (1991) and Longstaff (2011) both find that the marginal tax rate for the marginal municipal investor is close to the maximum statutory federal tax rate for households, though this issue remains unsettled (Longstaff, 2011, fn. 1). Notwithstanding this evidence, it is nonetheless useful to assess the bias if the appropriate marginal tax rate is lower than the one used in these baseline computations. From equation (7), $\sigma$ falls with lower values of $\tau$. If the "true" tax rate is less than the maximum rate used in our calculations, estimates of $\sigma$ reported below would be biased upward, a bias that would militate against our assertion that the risk premium on Puerto Rican bonds was too low.

Second, when studying municipal bonds, a bias may arise because of the well-documented "municipal puzzle" of an excessively upward sloping yield curve for municipals. A consensus solution to this puzzle does not exist. Kalotay and Dorigan (2008) claim it is due to the callability of municipals with maturities of 10 or more years, but Chalmers (1998) finds no support for this hypothesis when comparing Treasuries to municipal bonds backed by Treasuries via advanced refunding (so called defeased bonds). Our results are not sensitive to this puzzle and potential bias since our estimate of the risk premium is based on bonds with exact or nearly exact maturities. The effect of the "municipal puzzle" from whatever source cancels due to differencing (cf. $(\mu^m - \mu^n)$ in equation (3)).

Third, the derivation was based on the assumption that the liquidity premia on uninsured and insured bonds was identical, and hence cancelled in step 1. Since insured bonds may appeal to a broader set of investors, it is possible that their liquidity premium is lower than that for uninsured bonds. In this case, an additional term would be subtracted from equation (7), $(l^{uni} - l^{ins}) \geq 0$. Thus, as with the marginal tax rate, the estimates of $\sigma$ reported below would be biased upward in the face of a positive liquidity differential, a bias that would again weigh against the central argument in this paper that the risk premium on Puerto Rican bonds was too low.

Fourth, the results are sensitive to a proper specification of the creditworthiness of bond insurers, as represented by $\phi$. In econometric parlance, $\sigma$ is identified by its exclusion from equation (2), conditional on $\phi$ (as well as the other variables appearing in both equations (1) and (2)). During the financial crisis, several bond insurers experienced severe financial difficulties. If the solvency of companies insuring bonds is seriously questioned, then equation (6) underestimates the true insurer's risk premium and, per equation (7), this underestimate would lead to a downward bias in the estimate of $\sigma$. Such a potential bias would not seem of concern here. The insured bonds in our sample were backed by five insurers (listed in Appendix C, column 6). As of December 2007, all five insurers had been rated by Moody's as Aaa. Some of these insurers had expanded into insuring derivative products, and they faced financial stress during the Global Financial Crisis because of their exposure to mortgage-related assets. However, all but one of the 33 bonds in our sample issued since October 2004 have been insured by only two of those companies, AGC and FSA/AGM. They have maintained their Aaa ratings through October 2008. The next month, their ratings were lowered to Aa2 and Aa3, respectively. One year later, AGC's rating was lowered to that of FSA/AGM. (S&P viewed AGC and FSA/AGM more favorably, lowering their credit rating on October 25, 2010 from AAA to AA+, equivalent to Aaa and Aa1, respectively, on Moody's rating scale.) The Aa3 ratings for AGC and FSA/AGM were lowered to A3 and A2, respectively, in January 2013 (after the last issue date for the bonds in our sample, April 3, 2012). In November 2016, Moody's examined these two insurers and concluded that "[o]ur two pro-forma analyses support our belief that, despite Puerto Rico's financial stress and uncertainty about the ultimate outcome of the negotiation between Puerto Rico and its creditors, the capital positions of our rated guarantors are supportive of their current ratings" (Moody's, 2016, p. 2). The same study reports that total Puerto Rican exposures represent only 41% of total claims paying resources.[15] Investors in Puerto Rican bonds insured by AGC and FSA/AGM "… continue to receive uninterrupted full and timely payment of scheduled principal and interest in accordance with the terms of Assured Guaranty's insurance policies (Assured Guaranty, 2018). The default risk of insurers appears to be

[15] See Moody's (2016, Exhibit 7, p. 6). The 41% figure is a weighted-average of the entries for AGC and FSA/AGM.

adequately captured by equation (6). Nonetheless, the robustness of our computations will be examined in Section 4.1.

Fifth, concern about the financial stability of some insurers of municipal securities can affect the municipal market as a whole. This would be an example of a sector-specific shock. Other shocks that have important impacts on municipal yields are unanticipated changes in regulations (e.g., Dodd-Frank, advanced refunding), legal precedents, and "flights to quality" away from municipals to Treasury securities. These important drivers of municipal yields are accounted for in our estimate of $\sigma$ by the shock variable, s.

### 2.3. Alternative Approaches

Our procedure for identifying and estimating the Treasury Put relies on the unique circumstances surrounding the Puerto Rican debt market. Its simplicity is its strength. In this sub-section, we contrast it to three parametric approaches.[16] One approach forecasts defaults with a procedure similar to the Z-score method (Altman, 2000). The risk premium is measured by the difference between the bond return consistent with this expected default and the actual bond return. While Z-scores are a mainstay for corporate credit analysis, it is quite difficult to implement this approach for municipal bonds because of their very low default rates.

An alternative method to measure the value of government guarantees uses option price data and an explicit pricing model. Kelly, Lustig, and van Nieuwerburgh (KLN, 2016) combine the powerful insights from the Black-Scholes option pricing formula and out-of-the-money options prices for a basket of bank stocks and an index for the financial sector as a whole to estimate changes in risk premia during the financial crisis. The latter index did not rise pari passu with the former. They link this differential to implicit insurance for the financial sector as a whole and conclude that, during the financial crisis, this government guarantee lowered "the

[16] An additional alternative approach exploits unique judicial rulings to estimate the impact of government guarantees. Feld, Kalb, Moessinger, and Osterloh (2017) use an interesting quasi-natural experiment to estimate a government guarantee. When a ruling by a Swiss court removed the explicit liability of cantons for the debt of its municipalities, the risk premium on cantonal debt fell by 26 basis points. This estimate is much smaller than our estimate of the Treasury Put because the fiscal situation of the municipalities was much stronger than that of Puerto Rico and the implicit liability remained. Heppke-Falk and Wolff (2008) document that the relative yields of German *länder* bonds respond positively to debt per capita but, oddly, negatively to interest payments/revenue. The latter paradoxical result is interpreted in terms of a unique ruling by a German court that used this ratio as an indicator of extreme financial distress, hence a predictor of the likelihood of a bailout. This interpretation is reinforced by estimating the same model on only the financially beleaguered Berlin Land. The coefficient on the interest payments/revenue variable is more than twice as large for Berlin compared to the other *länder*.

insurance premium for financial index crash insurance by 73 percent on average" (KLN, p. 1280). This parametric approach relies on the correct specification of a somewhat complicated jump-diffusion pricing model.[17] Bai, Goldstein, and Yang (2019) have argued that a "leverage effect" impacting equity volatility needs to be considered. In this expanded model, the financial crisis has a differential impact on the two options prices considered by KLN, and this differential could explain their results independent of any government guarantee. This concern aside, an options-based approach is not feasible in the current situation because there is no market for out-of-the-money options on Puerto Rican uninsured bonds.

In a recent paper, Atkeson, d'Avernas, Eisfeldt, and Weill (AAEW, 2019) also estimate the value of the government guarantee for banks. They decompose the market/book equity ratio into the fair value and a residual. If book equity and fair value are measured accurately and estimates of the latter captures the value of all future "cash flows associated with bank assets and liabilities not considering the contribution to bank value from government guarantees" (p. 3), then the residual is the value of government guarantees. Based on their forecasting equations, AAEW find that, from 2008 to 2017, approximately one-half the movement in bank valuations (as measured by market to book equity) can be accounted for by variations in the value of government guarantees.

Neither parametric nor non-parametric approaches dominate in estimating the value of government guarantees. Rather, these different approaches illustrate the fundamental tradeoff between simple, non-parametric models (such as the one used in the current study) that are relatively robust but less efficient and more complicated procedures relying on an explicit theory and parameterization that are more efficient but fragile in the face of possible model misspecification or noisy data.[18]

---

[17] Lucas (2012, Section 4) and Lucas and McDonald (2010) discuss some of the critical assumptions underlying the application of derivative pricing techniques – capital structure, its response to income and other shocks, the probability of default, initial conditions, and changes in net worth. Lucas (2012) also surveys the literature on valuing government guarantees.

[18] In the econometrics literature, a similar tradeoff exists between robustness and efficiency. Consider estimating a coefficient of interest in a single equation that is part of a set of simultaneous equations and choosing between 2SLS and 3SLS techniques. The latter is relatively more efficient, but the coefficient of interest may be estimated inconsistently if any of the equations in the system are misspecified. The 2SLS technique trades off these efficiency gains for robustness.

## 3. Data

Our computation of the risk premium on Puerto Rican bonds requires five time series. The primary data source for municipal bond market data is the Electronic Municipal Market Access database (EMMA, http://www.emma.msrb.org) published by the Municipal Securities Rulemaking Body (MSRB).[19] We restrict our search to government general obligation (GO) bonds, those that are backed by the full faith and credit of the Puerto Rican government and do not have any specific revenue streams associated with them. We thus avoid the difficult problem with evaluating the creditworthiness of those revenue streams. The yields on Puerto Rican uninsured and insured GO bonds for different maturities ($r^{P,uni,m}$ and $r^{P,ins,n}$, respectively) are obtained from a careful review of all GO bonds from January 1, 2000 to December 13, 2013.[20] Our initial exploration of the EMMA data identified 279 uninsured and 205 insured GO bonds since January 2000. Entries with maturities less than one year and without sufficient information to compute the yield or determine the issue date or maturity are excluded. A tedious examination of the remaining GO bonds (for each bond offering, reading the Official Statements, cross-checking with online data sources, and resolving discrepancies) identified 45 uninsured bonds that could be matched to 45 insured bonds. Details are provided in Appendix C; specific comments on data collection are in Appendix E.

The quality of the matches is quite good. For each of the 45 matched pairs, the uninsured and insured bonds were issued on the same day (column 5 of Appendix C). Call

[19] While credit default swaps spreads (CDSS) can be useful for several research topics (e.g., when data for demand shocks (Chari, Leary, and Phan, 2020) or the term structure are required), we have chosen to estimate the risk premium with trade data for several reasons. The Puerto Rican CDSS data are only available beginning in January 2008, are based on quotes from a limited number of dealers, and do not trade among end users (i.e., non-dealers) in a secondary market (Van Deventer, 2014). There are several uncertain elements in mapping CDSS to default probabilities: (i) the status of statutory taxation for both dealers and buyers (Sainsbury, 2010) and hence the effective marginal tax rates; (ii) estimates of dealers' markups; (iii) estimates of recovery rates; (iv) dependencies among recovery rates, the risk-free rate, and the default date; (v) limitations on the CDS seller's rights and remedies relative to a traditional insurance guarantee (Assured Guaranty, 2018, p. 8); (vi) negative shocks to the municipal sector arising from a "flight to quality" (such as occurred during the Global Financial Crisis) or an ongoing secular shortage of safe assets, which lower the risk-free return, raise the CDSS, and thus introduce non-random measurement error; and (vii) incentives for CDS buyers to trigger a default event absent compelling financial distress (Bain, Brush, and Natarajan, 2019). Hull, Predescu, and White (2004, pp. 2795-2796) list several other issues.

[20] This sample period is not affected by the large-scale disruptions due to Hurricanes Irma and Maria that struck Puerto Rico in September 2017.

features are very similar among the paired bonds (column 8). Maturities tend to be long: 26 are greater than 20 years; 18 are between 11 and 20 years, and one is less than 10 years (column 9). The maturity matches are exact for 33 pairs (columns 10). For the remaining 12 pairs, the average discrepancy in maturities is two years. The resulting bias on our estimate of $\sigma$ is likely to be modest (column 11; cf. table note 6, for a definition of bias). What bias exists is likely to raise $\sigma$ (an upward bias exists in seven cases, a downward bias in five cases), a result that weighs against the proposition that the risk premium was too low.

The Corporate Aaa yield and Treasury yield curve are obtained from the FRED database. Data for the Treasury yield curve does not always match exactly the maturities of the Puerto Rican bonds. We address this problem with the following two-step procedure. For a Puerto Rican bond of maturity m at time t, we examine the Treasury yield curve at that t (this match on a date can be done exactly) and determine the points on the yield curve immediately below and above maturity m. We then compute a linear approximation based on the location of the Puerto Rican bond maturity relative to the interval defined by the shorter and longer Treasury yields.[21] For example, if the period t Puerto Rican bond has a maturity of 8+ years, we compute the appropriate point on the yield curve as the yield on the 7 year Treasury bond plus the difference in yields on the 10 and 7 year Treasury bonds, divided by the number of days over this 3 year interval, all multiplied by the number of days the Puerto Rican bond with a maturity of 8+ years exceeds the number of days of the 7 year Treasury bond.

The FRED database also provides the yields on Corporate Baa and Non-Investment grade bonds used to compute risk premia for comparative purposes.

The fifth series is the marginal income tax rate for the marginal municipal bond investor ($\tau$). We assume that this investor is a household facing the highest marginal rate on interest income (alternative assumptions are explored in section 4.1). Recall that income from Puerto Rican bonds is triple-tax free. In order to facilitate comparisons between tax-free Puerto Rican and taxable bonds, the former is grossed-up for income taxation. Several steps are involved; see

[21] We believe that his linear approximation between the two points closest to the maturity date on the Puerto Rican bond is likely to be more accurate than using approximations based on the entire yield curve, such as the six-point approximation of Gürkaynak, Sack, and Wright (2007) because of the flatness of the Treasury yield curve at the longer maturities that populate our sample. Note that this adjustment for the maturity premium is not of quantitative importance in this study because of the exact ($m = n$) or near-exact ($m \approx n$) maturity matches for most pairs of uninsured/insured bonds (cf. equation (3)).

Appendix F for details. Most importantly, we must distinguish between regular and alternative minimum tax (AMT) regimes. In either case, we assume that the marginal investor has a high income and is subject to several taxes applicable to high-income investors (generally, adjusted gross income above $200,000).[22] The following discussion is keyed to the entries in Table F1 in Appendix F with row numbers indicted in brackets.

For a taxpayer in the regular tax status, the income from a Treasury bond is subject to taxation at the federal [1] and state levels [2]. The latter is usually deductible against the former, and this deductibility lowers the effective tax rate. Thus, the combined federal and state tax rate is the summation of the two preceding rates less the product of the two rates [3]. We assume that the marginal investor is subject to the highest marginal statutory tax rates at the federal and state levels. Given our assumption that the marginal investor has a high income, Treasury interest income is subject to three additional taxes: the net investment income tax surcharge [4, known as the "Medicare tax"] and phase-outs of the personal exemption [5] and select itemized deductions [6, known as the "Pease Limitation"]. These phase-outs increase the tax on Treasury interest income. The regular marginal tax rate on interest income (item [7]) is the summation of these three effective marginal tax rates and the combined federal and state tax rate.

The AMT regime imposes a different set of marginal income tax rates, as well as two marginal income tax rates from the regular regime. We again assume that the marginal investor faces the highest tax rate [8] and, given this high income, is subject to a phase-out of the AMT exemption [9]. As in the regular tax regime, the AMT investor is also subject to the state income tax [2] and the net investment income tax surcharge [4]. The AMT marginal tax rate on interest income is the summation of these four effective marginal tax rates [10].

To compute a single marginal tax rate, we form a weighted average of the regular and AMT marginal tax rates [14], where the weights are the percentage of select returns filed in the two regimes [11, 12, 13]. Since financial assets are disproportionately held by higher income

[22] Note that we focus on "high," not the "highest" income. In the latter case for very wealthy households, several of the phase-outs discussed below will have been exhausted, and the marginal tax rate for very wealthy households will be lower than that for the merely prosperous. That is, for a potential municipal bond investment, the marginal income tax rate for a household consisting of two full professors (filing jointly) in financial economics will be higher than the marginal income tax rate for Jeff Bezos or Bill Gates.

taxpayers, we count only those returns with AGI exceeding a threshold of $200,000.[23] This marginal tax rate varies from 42.7% in 2000 to a low of 39.0% in 2010 and a high at the end of the sample of 46.3% in 2016.

[23] Ideally, we would have varied the threshold level by year, but such a refined calculation was not feasible given the presentation of the IRS data. The modest rate of inflation during this period and the presence of the bias in both the numerator and denominator of the percent of returns filed under regular tax status suggest that this omission will not result in a large error.

# 4. Results

This section contains our empirical results divided into three sections: before the Detroit bankruptcy of July 2013 when the Treasury Put was live, after the Detroit bankruptcy when the Treasury Put was extinguished, and an estimate of the misallocation costs associated with the Treasury Put and inappropriately low interest rates on Puerto Rican securities.

## 4.1. Before Detroit

The Detroit bankruptcy occurred on July 18, 2013. We examine the 13 bond issue dates comprising 45 sets of matched GO bonds that occurred between January 1, 2000 and the bankruptcy. We study Puerto Rican matched bonds at the initial offering price on or near the issue date. This is the period when bonds are most liquid, institutional interest highest, and prices closest to fundamental value. (The risk premium for all 45 matched Puerto Rican bonds is presented in column 12 of Appendix C, which also contains information about issue (dated) date, bond insurer, amount of the issue, call year, maturity, quality of and, if any, bias from the maturity match.) The risk premium on Puerto Rican bonds is uniformly quite low – relative to Baa bonds -- with two exceptions. The 13$^{th}$ match has a high risk premium of 235 basis points driven by a very low yield on the matched insured bond, which is difficult to understand and out-of-line relative to the other insured bond issued on the same day (match #14) and insured bonds issued five months earlier (match #12). The second occurrence of a high risk premium (relative to Baa bonds) is for bonds issued in May 2008. This month is at the beginning of the financial crisis (the Bear Stearns collapse occurred in March 2008) when markets were severely disrupted.

The results are summarized in Table 2, which aggregates the 45 risk premia into their 13 issue dates and compares them to the risk premia on Corporate Aaa, Corporate Baa, and Non-Investment grade bonds (computed as the difference between the bond yield for a given asset class and the date-comparable yield on a 20-year Treasury bond). As discussed above, the risk premium on Puerto Rican bonds (column 2) generally lies between the risk premia for Corporate Aaa and Baa bonds (columns 1 and 3, respectively). Averaged over all 13 sets of GO bonds issued since 2000, the risk premium on Puerto Rican GO bonds exceeds the comparable risk premium on Corporate Aaa bonds by 68 basis points. Relative to Corporate Baa bonds, the risk premium on Puerto Rican bonds is lower by 30 basis points. That gap widens considerably when computed with respect to Non-Investment grade bonds, and it is a substantial 279 basis points.

These results are robust to variation in the marginal tax rate and insurer creditworthiness. In Panel B, we replace the highest marginal tax rate for the marginal *household* municipal bond investor with the highest marginal tax rate for the marginal *corporate* municipal bond investor, the latter defined as the sum of the federal corporate rate (35.0%) and an average of state corporate rates (6.5%, Chirinko and Wilson, 2017, Figure 2). By happenstance, this figure equals the unweighted average (2000 to 2016) of the household tax rate used in Panel A. This alternative tax rate leads to an inconsequential two basis point increase in the average risk premium. Panel C returns to the baseline tax rate used in Panel A and reduces it by 50%. The average risk premium falls by 17 basis points, amplifying somewhat the puzzle of an excessively low risk premium. As discussed in Section 2.2, the results could be sensitive to the creditworthiness of bond insurers. To assess this sensitivity, we focus on only those bonds insured by the two most creditworthy insurers (AGC and FSA/AGM) and recompute the average risk premium without issues 1 to 5 listed in Table 2. For Puerto Rican bonds insured by these two high quality firms, the average risk premium rises by only two basis points relative to the baseline in Panel A.

Table 2 documents that the compensation for default risk on Puerto Rican bonds was exceptionally low, an outcome that was quite reasonable given the expectation of financial support from the U.S. government.

### 4.2 After Detroit

That expectation was upended by a seismic shock to the municipal bond market. On July 18, 2013, Detroit filed for bankruptcy with liabilities of $18 to $20 billion; this event was widely anticipated.[24] No federal assistance was forthcoming; this event was unexpected. The absence of a bailout is particularly surprising when compared to the New York City bailout of $2.3 billion. A comparable bailout in 2013 would have been between $15.5 to $7.8 billion (using growth in current dollar GDP per capita or the GDP price deflator or as the scaling variable, respectively).

[24] Detroit's woes were well known: a population decline since 1950, deficits in the operating budget since 2008, and increasingly burdensome health care and pension costs, among other problems. In April 2012, the Michigan Governor and the City agreed to a consent decree that involved financial reforms and the creation of an advisory board to oversee most fiscal affairs. On February 19, 2013, the *New York Times* (2013) reported that "[a] review team appointed by the State of Michigan has concluded that Detroit is mired in serious financial problems, a step that draws the city ever closer to emergency oversight by a state-assigned financial manager." Michigan effectively took over Detroit's finances with the appointment of an Emergency Manager on March 14, 2013.

The Detroit bankruptcy was a watershed event. Detroit Mayor Dave Bing, speaking on ABC's *This Week*, seemed to leave the door open for federal assistance, saying that he has engaged in talks with the Obama administration for help (ABC, 2013) and noting the Chrysler and GM had received federal aid when in financial distress. When asked "no federal bailout?," Mayor Bing responded "not yet." *Rollcall* reported that "[s]oon after Detroit filed for protection under Chapter 9 of the bankruptcy code, the Obama Administration made it clear it would not seek a bailout similar to the $2.5 billion [sic] New York City loan package enacted in 1975" (Ota, 2013, p. 2). Eight days after Detroit filed for bankruptcy, Senator Lindsay Graham (2013) introduced an amendment to a bill with the following provisions concerning federal bailouts:

> • No federal funds may be used to purchase or guarantee any asset or obligation of any municipal, local, or county government if that locality has defaulted, is at risk of defaulting, or likely to default absent such federal assistance.
>
> • In addition, the federal government would also be prohibited from issuing lines of credit or providing direct or indirect financial aid to prevent bankruptcy.

The amendment barely failed by a 14 to 16 vote. Other legislation was introduced in July 2013 to specifically exempt the federal government from any liability for state and local pension obligations (Ota, 2013, p. 2). This no-bailout sentiment was echoed by Morningstar (2013, p. 13): "[g]iven the current political climate in Washington, D.C., we also think it is unlikely that the federal government will offer any sort of financial bailout for Puerto Rico." The 2013 Detroit bankruptcy and the federal government's truancy regarding a rescue package for debtors or creditors extinguished the Treasury Put.[25]

The Detroit bankruptcy allows us to identify and quantify the Treasury Put. The effective termination of the Treasury Put will be reflected in a marked increase in the risk premium on Puerto Rican bonds on and shortly after July 18, 2013. No new pairs of uninsured and insured bonds were issued after this date, so we cannot repeat the analysis in Section 4.1 measuring risk

[25] From a political perspective, the non-bailout is also surprising. Detroit is the largest city in the state of Michigan, which is occasionally a critical state in determining the outcome of the Presidential election. For example, in the 2016 election, the two candidates (Trump vs. Clinton) were separated by 0.22% of the total votes cast in Michigan.

premium on the issue date.[26] Instead, we assess the impact of the removal of the Treasury Put by computing risk premia for "double-matched" bonds. They are first matched by issue date and bond characteristics resulting in the same matched pairs used in Table 2 (23,422 trades in 2013). The second match is on the trading day. We identify trades of both bonds in a matched pair that occur on the same day or an adjacent day. (There are 880 double-matched trades in the Before Detroit interval, and 1,016 double-matched trades in the After Detroit interval; the substantial majority of double-matched bonds (84%) were traded on the same day.) For this subset, we compute the yield-to-maturity for uninsured and insured bonds and use equation (7) to compute the risk premium for double-matched bonds (see the notes to Table 3 for details about the computations).

The results are presented in Figure 6 and Tables 3, 4, and 5. Figure 6 plots weekly estimates of $\sigma$ and represents our benchmark result. Before the Detroit bankruptcy of July 18, 2013, the weekly risk premium on Puerto Rican GO bonds is 187 basis points (close to the average risk premium of 167 reported in Table 2 for newly issued bonds). During the week of the Detroit bankruptcy filing (indicated by the box in the middle of Figure 6), $\sigma$ jumps by 98 basis points and continues to rise for the remainder of the year. This pattern of $\sigma$'s is consistent with our view that the absence of a government rescue for Detroit extinguished the Treasury Put.

Table 3 analyzes the means and standard errors of $\sigma$ for the Before and After Detroit intervals. Detroit's bankruptcy filing occurred on July 18, 2013, and we divide risk premia into the Before Detroit (January 1 to July 17, 2013) and an After Detroit (July 18 to December 31, 2013). Row 1 reports our baseline result with daily data. The average risk premia rose from 187 basis points Before Detroit to 556 basis points After Detroit, a differential of 368 basis points. Row 2 repeats the same computation but with the weekly data used in Figure 6; the differential between is 374 basis points. Table 3 documents the substantial rise in the risk premium on Puerto Rican bonds after the Detroit bankruptcy.

As noted above, the comparison of risk premia Before and After Detroit can be understood as a classic difference-in-difference model. Under this interpretation, the data underlying the computation of $\sigma$ are the adjusted returns for uninsured and insured bonds and

[26] The $3.5 billion issuance of uninsured GO bonds on March 11, 2014 is not included in our sample because there were no insured GO bonds issued with which to form matched pairs. Moreover, these bonds were issued with priority and remedy provisions governed by New York law, rather than by Puerto Rican law that governs the other issues in our sample, thus affecting the underlying risk premium.

the Detroit bankruptcy is the treatment. An important condition for the validity of the difference-in-difference interpretation is the existence of common trends for uninsured and insured bonds prior to treatment. In Figure 6, the modest amount of variation in $\sigma$ during the Before interval establishes that this condition is met. Moreover, in a difference-in-difference model, the Treasury Put hypothesis is evaluated formally by a simple difference-in-means test. As shown in column 3, the t-statistics for the differences exceed 10 in both rows 1 and 2.

An alternative explanation of our results is that the purported rise in the risk premium merely reflects a rise in the liquidity premium on uninsured bonds (Friewald, Jankowitsch, and Subrahmanyam, 2012; Passadore and Xu, 2018), as investors might withdraw from the uninsured bond market after the Detroit shock. Consistent with this prediction, trading volume of un-insured bonds fell by 21% between the Before and After intervals. However, the trading volume of insured bonds fell by 22%. Thus, any increases in liquidity premia in the Puerto Rican bond cancel in our calculations (cf. equations (1) to (3)) and cannot be driving the results in Table 3.

The remaining tables report two robustness checks. The response of bond yields to the extinguishing of the Treasury Put may not be immediate because investors in a somewhat illiquid bond market may not react quickly to new information. An additional element tempering the rise of the risk premium is the possibility of a policy reversal regarding Detroit. Recall the policy reversals that occurred with the New York City bankruptcy (after six weeks) and the Northern Rock liquidity squeeze (over several months). Table 4 thus redefines the After interval to begin 14 and 45 days after July 18 (exact dates are provided in the braced items in the table). There is some evidence of a delayed response, as the differentials rise by 22 to 58 basis points relative to the baseline result in row 1 of Table 3.

Table 5 explores the possible role of anticipation effects. Detroit's fiscal woes were well known and the Obama Administration's non-rescue may have been "in the air," so the seismic shock may not have been totally unexpected. Forward-looking investors might have begun trading based on expectations prior to the actual date of the Detroit bankruptcy, raising the estimated $\sigma$ in the Before interval and lowering the differential. We examine this possibility by shifting back the endpoint of the Before interval from July 17 to the last day of the four preceding months ad seriatim, while maintaining a six-month window. Shifting back the end data of the Before interval by 17 or 47 days has virtually no effect on the baseline differential of

368 basis points. For the other shifts in rows 3 to 4, there is a modest increase of 8 and 17 basis points. These results suggest that the non-bailout of Detroit was not anticipated.

Taken together, the evidence in Figure 6 and Tables 3, 4, and 5 suggest that the Treasury Put was at least 350 basis points and perhaps a bit higher.

### 4.3 Misallocation Costs

The Treasury Put misallocates capital. As shown in Figure 7, the Treasury Put lowers finance costs, shifts-out the demand curve for capital, and thus directs capital to inefficient uses. The removal of the Treasury Put is effectively an inward shift of the demand curve. The vertical distance between the two demand curves is our estimate of the Treasury Put. Given this estimate and an estimate of the slope of the supply curve for municipal bonds, the extent of this misallocation can be calculated. The 350 basis point increase in the risk premium leads to approximately a 45% increase in the cost of capital.[27] When multiplied by an estimate of the slope of the supply curve for municipal capital of 0.33, the implied decrease in the stock of capital is 15%, approximately $15 billion.[28]

While sizeable, this misallocation of capital was not responsible for Puerto Rico's financial woes. The Treasury Put induces two opposing effects: a higher level of debt but lower finance costs per unit of debt. The net effect is financially detrimental only if the elasticity of the supply curve for Puerto Rican debt exceeds unity, which is well above the estimate noted above.[29] The ultimate causes of the Puerto Rico's default may be more deeply rooted in internal political failures and external relations with the U.S. mainland.

---

[27] The average yield on uninsured Puerto Rican bonds before Detroit for the period January 2000 to April 2012 (the last issue before the Detroit bankruptcy) is 786 basis points. This yield is the cost of capital influencing the flow of debt to Puerto Rico. The removal of the Treasury Put, estimated here to be 350, would have increased this yield to 1136, a 45% increase.

[28] Published estimates of the municipal supply elasticity are relatively rare. Joulfaian and Matheson (2009) report an elasticity for public-purpose governmental bonds of 0.365 (= 11.50 [T2, C2, L1] * 5.46 [T1, C2, L2] / 172 [T1, C2, L1] where T, C, and L represent table, column, and line, respectively. Metcalf (1993) reports an elasticity for GO bonds of 0.294 (= 39.18 [T4, C2, L1] * 0.63 [T3, C1, L2] / 83.84 [T3, C1, L1]. We average these estimates to obtain an elasticity of 0.33. Metcalf's analysis highlights that the estimate is sensitive to whether the marginal taxpayer is saving (assumed here) or borrowing. If the latter case holds, the Metcalf elasticity would rise to 0.751.

[29] The crucial role of the supply elasticity in determining the potentially deleterious impact of the Treasury Put can be seen in the following inequality for interest payments: $(R+TP)*B[R+TP] > R*B[R]$, where R is the non-distorted market interest rate, $TP = -\Delta R < 0$ the distortion created by the Treasury Put, and B[.] bond supply negatively related to its argument (cf. Figure 7). Manipulating this inequality and

## 5. Summary, Conclusion, And The Policy Dilemma

To answer the questions posed at the beginning of this paper – What went wrong? Why were risk premia so low? Where was market discipline? -- the fundamental cause of these failures was an implicit guarantee of Puerto Rican liabilities, the "Treasury Put." Evaluating the Treasury Put hypothesis is made possible in the case of Puerto Rico given three fortuitous features of the empirical environment – 1) the very weak fiscal and economic conditions of Puerto Rico, 2) pairs of uninsured and insured bonds issued on the same day with the same maturity and other characteristics and 3) the exogenous "seismic shock" of the Detroit bankruptcy and the unexpected absence of federal support. Identification of the Treasury Put is based on five pillars [supporting evidence listed in brackets]:

1. Macroeconomic fundamentals were very weak[Introduction, Figures 1-5, Table 1]
2. The Treasury Put existed [Section 1],
3. Default risk was too low [Section 4.1, Table 2],
4. The Treasury Put was extinguished [Section 4.2],
5. Default risk rose [Section 4.2, Tables 3, 4, and 5].

Our analysis of this rare situation where the Treasury Put was extinguished documents the existence of a sizeable Treasury Put of at least 350 basis points and a significant misallocation of capital to Puerto Rico of $15 billion.[30]

The conclusion of this study differs from that offered by the GAO (2018). This well-researched document concludes that the misallocation of capital was due largely to information failures. Which view is correct has important implications for the appropriate policy. Under the Information Failure hypothesis, capital flows can be improved by requiring higher quality and more timely information, as recommended by the GAO. However, the radical increase in yields post-Detroit and the recognition that many Puerto Rican bond investors are sophisticated – being either professional money managers or high-income households who hire professional money managers -- militate against the GAO hypothesis.

---

interpreting the TP as the change in the interest rate leads to the following inequality for the price elasticity of the bond supply schedule: $((B[R-\Delta R]-B[R])/B[R-\Delta R]) / (\Delta R/R) > 1.0$.

[30] The existence of a quantitatively important Treasury Put also raises questions about the proper specification of bond pricing formula, which tend to ignore the important role for implicit government guarantees documented in this paper.

By contrast, the Treasury Put hypothesis raises the question how can the implicit guarantee – which effectively is a form of regulatory forbearance -- can be extinguished on a permanent basis? There is a sizeable literature studying the problem of how governments can make binding, credible commitments while providing a safety net.[31] Kareken and Wallace (1978) was one of the earlier contributions in the context of deposit insurance. They conclude that regulation of the assets and liabilities of insured financial intermediaries is essential. More recently, Chari and Kehoe (2016) analyze government bailouts as an inefficient but unavoidable intervention into otherwise efficient markets. They focus on "sustainably efficient" policies and also conclude that regulations – in the form of controlling leverage and taxing size -- are important to achieve a second best outcome. A third approach is "exemplary non-intervention," as has been pursued with the Detroit and Puerto Rican defaults. Doubts exist as to whether the latter policies can be sustained in the face of future crises.

Ending government bailouts has been considered by a working group composed of scholars with diverse backgrounds, and the resulting essays have been published in a 2010 volume edited by Kenneth Scott (law), George Shultz (policymaking), and John Taylor (economics). Shultz (Chapter 1) focuses much of the discussion at the conference on "making failure tolerable," and he concludes the volume by noting "…that we have to *define and measure systemic risk operationally* if we are going to make any progress. Without an operational definition the bailout mentality will continue" (p. 286, italics in original). As demonstrated by the Taylor essay in the same volume (Chapter 4), defining and quantifying an operational measure of systemic risk is a daunting and unresolved task.

Restrictions on borrowings codified in legislation, such as balanced budget amendments, may be another solution that eliminates the need for government guarantees and bailouts. Of course, legislation that is passed can be revoked, but extant legislation creates friction in the system that may temper borrowing and make intervention unnecessary (France and Kahn, 2016).

---

[31] See Inman (2001) for a discussion of the four institutions necessary for enforcing sub-national fiscal discipline in a non-Tiebout environment and Herold (2018) for an extended discussion of insolvency frameworks for sub-national governments. Two recent papers question the wisdom of a commitment strategy. Bornstein and Lorenzoni (2018) argue that a firm commitment to non-intervention can lead to an aggregate demand externality. Discretionary interventions eliminate the latter and may lead to better outcomes, even in the face of moral hazard. Gourinchas, Martin, and Messer (2020) emphasize that a creditor faces a tradeoff between immediate insolvency of the debtor and the possibility of future default, and they show that imperfect commitment to a no-bailout clause may be optimal even though it raises ex-ante borrowings by the debtor due to moral hazard.

State balanced budget amendments arose in the 1840's after several states defaulted on their debts (Heins, 1963, pp. 8-12). In his Nobel Prize lecture and in the popular press, Sargent (2012a, Section VI and 2012b, respectively) and others interpret the adoption by many states of balanced budget restrictions during this period as strengthening fiscal discipline. While the constraints may have been binding in the short-term, such an interpretation underestimates the creativity of accountants, the tenacity of lawyers, and the cunning of politicians and is inconsistent with the huge borrowings that have been undertaken regularly by the 49 "balanced budget" states.[32]

These accumulated state debts are not unexpected. In 1852, the balanced budget restriction in New York's state constitution was challenged in terms of the Special Fund Doctrine, which refers to debt serviced by a specific revenue source. That challenge was rejected, and no further cases were brought for approximately the next 40 years, a period during which there was little borrowing by states save for the exigencies brought about by the Civil War.[33] In 1889, a challenge by Colorado was successful, the Special Fund Doctrine was sustained, and state debt began to grow. The key legal issue is the meaning of "debt." Legal precedents have tended to conclude that debt not explicitly guaranteed by the full faith and credit of a state can be accumulated in states with balanced budget restrictions.[34] "Nonguaranteed borrowing methods can be classified into four broad categories: (1) revenue bonds of state agencies (the special-fund doctrine); (2) public corporations, authorities, and commissions; (3) lease-purchase agreements; and (4) delegation of state functions to political subdivisions" (Heins, 1963, pp. 13-14). Unfunded pension liabilities are another form of debt (qua financial liability) that may be added to this list for some states. Balanced budget restrictions are easy to circumvent. They have not

[32] As of 2018, Vermont is the only state without a statutory balanced budget restriction.

[33] The court's reasoning was prescient and anticipated the unfortunate ramifications of sustaining the Special Fund Doctrine in future cases: "It believed that if a debt could be created 'in regard to one source of revenue, we see no reason why the same thing may not be done in regard to every other source of revenue of the state, including not only all revenue which may arise from property, but also all which may be realized by the exercise of the power of taxation' " (Ratchford, 1941, p. 447).

[34] Ratchford (1941, pp. 464-465) offers a deeply critical view of legal developments: "In the development and application of the special fund doctrine,…[t]he courts have taken a term from the field of finance and around it have developed an attenuated legal doctrine which bears little resemblance to the original meaning of the term."

been successful in constraining deficit financing and hence the possible need for government bailouts.[35]

A second approach to constraining state debt relies on an index of economic growth that lowers interest payments when the state economy weakens. These "growth indexed bonds" (GIB) effectively reduce the upper tail of the debt/GDP ratio, and hence assist states in financial distress. However, as noted by Blanchard, Mauro, and Acalin (2016), this benefit must be balanced against the cost with GIB's from increase in premia due to liquidity, novelty (at least initially), and non-diversifiable cyclical risk (i.e., the GIB is a high beta security). Simulations (Acalin, 2018) suggest that the reduction in the upper tail would be modest for representative parameter values and simple indexing formulas, thus explaining why GBI's have not been introduced widely. Moreover, GIB's would tempt governments to manipulate the indexes to lower debt costs.

A third approach uses ex-post legislative restrictions to preclude bailouts and hopefully constrain borrowing. As noted in Section 4.2, such legislation aimed at states and municipalities was proposed shortly after the Detroit bankruptcy, but it was not adopted.

More recent events offer a similarly bleak prognosis. The Dodd-Frank legislation passed in the United States after the 2007-2008 Global Financial Crisis involved several stringent regulations. However, over time, they have been relaxed by actions of the Executive and Judicial branches. Korea adopted a no-bailout policy after the 1997 financial crisis. This policy was explicitly stated by the Korean government, resonated with the political position of the incoming president, and was confirmed in a Letter of Intent to the IMF (Gormley, Johnson, and Rhee, 2015, pp. 492-493). Despite these favorable conditions, the no-bailout policy was not enforced, as the largest Korean firms received an exceptional amount of aid during the Global Financial crisis. The history of government policy during the Euro Crisis paints an equally uninviting picture. The no-bailout clause in the Maastrict Treaty creating the European Monetary Union, coupled with explicit statements of support of this clause by German Chancellor Kohl, were insufficient to prevent massive bailouts during the Euro crisis by the

[35] A more sanguine view of the efficacy of fiscal rules is supported by the empirical work of Poterba and Rueben (1999) and Fatás and Mihov (2006). The literature is voluminous and results range widely; see Heinemann, Moessinger, and Yeter (2018) for a meta-analysis of 30 studies. Avoiding balanced budget restrictions may nonetheless deter borrowings indirectly because the composition of debt is shifted from low-risk/low-cost debt backed by the full faith and credit of the government and its taxing capacity to higher-risk/higher-cost debt backed by uncertain revenue streams (Heins, 1963, Chapter 4).

European Union and the Eurosystem.[36] In the end, a Gordian Knot may well describe the unresolved tension between restrictive policies that are beneficial and political influences that are pervasive (Rajan and Zingales, 2003; Morck, Wolfenzon, and Yeung, 2005). How to extinguish the Treasury Put on an ongoing basis in a democratic society remains an open question.

[36] In a speech to the German Bundestag introducing the Euro, Chancellor Kohl repeated the following statement twice: "According to the treaty rules, the euro community shall not be liable for the commitments of its member states and there will be no additional financial transfers." (Sinn, 2014, pp. 19-22).

## References


ABC, *This Week With George Stephanopoulos* (July 21, 2013). See https://abcnews.go.com/ThisWeek/video/detroit-mayor-dave-bing-week-interview-citys-bankruptcy-19727824 .

Acalin, Julien, "Growth-indexed Bonds and Debt Distribution: Theoretical Benefits and Practical Limits," Peterson Institute for International Economics Working Paper 18-7 (July 2018)

Altman, Edward I., "Predicting Financial Distress Of Companies: Revisiting The Z-Score And Zeta® Models," http://pages.stern.nyu.edu/~ealtman/Zscores.pdf (July 2000).

Ang, Andrew, Bhansali, Vineer, and Xing, Yuhang, "Decomposing municipal bond yields," Columbia University (n.d.).

Ang, Andrew, and Green, Richard C., "Lowering Borrowing Costs for States and Municipalities Through CommonMuni," *The Hamilton Project* Discussion Paper 2011-01 (February 2011).

Assured Guaranty, *A Stronger Bond: 2018 Annual Report*, (Hamilton, Bermuda: Assured Guaranty Corporation, 2018).

Atkeson, Andrew G., d'Avernas, Adrien, Eisfeldt, Andrea L., and Weill, Pierre-Olivier, "Government Guarantees and the Valuation of American Banks," in Martin Eichenbaum and Jonathan A. Parker (eds.), *NBER Macroeconomics Annual 2018* (Chicago: University of Chicago Press, 2019).

Assured Guaranty, "Assured Guaranty Protects Insured Bondholders from Puerto Rico Defaults: No Action Required of Assured Guaranty Policyholders," (July 5, 2018). See http://assuredguaranty.com/ag-protects-insured-bondholders-from-puerto-rico-defaults-no-action-re.

Bai, Jennie, Goldstein, Robert S., and Yang, Fan, "The Leverage Effect and the Basket-Index Put Spread," *Journal of Financial Economics* 131 (2019), 186-205.

Bain, Benjamin, Brush, Silla, and Natarajan, Sridhar, "Wall Street Titans Cut Deal to Clean Up Shady CDS Trades," *Bloomberg News* (March 5, 2019).

Barron's, "State of the States," *Barron's* (August 27, 2012).

Blanchard, Olivier, Mauro, Paolo, and Acalin, Julien, "The Case for Growth-Indexed Bonds in Advanced Economies Today," Peterson Institute for International Economics Policy Brief Number PB16-2 (February 2016).

Blinder, Alan S., *After The Music Stopped: The Financial Crisis, The Response, And The Work Ahead*, (New York: The Penguin Press, 2013).

Bornstein, Gideon, and Lorenzoni, Guido, "Moral Hazard Misconceptions: The Case of the Greenspan Put," *IMF Economic Review* 66 (2) (June 2018), 251-286.

Brookings Institution, "Appendix One: The D.C. Revitalization Act: History, Provisions and Promises,"(n.d.). See https://www.brookings.edu/wp-content/uploads/2016/07/appendix-1.pdf

Brunnermeier, Markus, Garicano, Luis, Lane, Philip R., Pagano, Marco, Reis, Ricardo, Santos, Tano, Thesmar, David, van Nieuwerburgh, Stijn, and Vayanos, Dimitri, "The Sovereign-Bank Diabolic Loop and ESBies," *American Economic Review* 106(5) (May 2016), 508-512.

Capponi, Agostino, Correll, Felix C., and Stiglitz, Joseph E., "Optimal Bailouts and the Doom Loop with a Financial Network," NBER Working Paper No. 27074 (May 2020).

Chalmers, John M.R., "Default Risk Cannot Explain the Muni Puzzle: Evidence from Municipal Bonds that are Secured by U.S. Treasury Obligations," *The Review of Financial Studies* 11 (1998), 281-308.

Chari, Anusha, Leary, Ryan, and Phan, Toan, "The Transmission of Quasi-Sovereign Default Risk: Evidence from Puerto Rico," University of North Carolina (January 2020).

Chari, V.V., and Kehoe, Patrick, "Bailouts, Time Inconsistency and Optimal Regulation: A Macroeconomic View," *American Economic Review* 106 (9) (September 2016), 2458-2493.

Chirinko, Robert S., and Wilson, Daniel J., "Tax Competition among U.S. States: Racing to the Bottom or Riding on a Seesaw?" *Journal of Public Economics* 155 (November 2017), 147-163.

Collins, Susan M., Bosworth, Barry P., and Soto-Class, Miguel A., *The Economy of Puerto Rico: Restoring Growth* (Washington: Brookings, 2006).

Commonwealth of Puerto Rico, *Financial Information and Operating Data Report* (November 6, 2015).

Curry, Timothy, and Shibut, Lynn, "The Cost of the Savings and Loan Crisis: Truth and Consequences," *FDIC Banking Review* 13, No. 2 (2000), 26-35.

Delatte, Anne-Laure, Fouquau, Julien, and Portes, Richard, "Regime-Dependent Sovereign Risk Pricing During the Euro Crisis," *Review of Finance* 21 (October 2016), 363-385.

Dong, Yi, Hou, Qiannan, Ni, Chenkai, "Implicit government guarantees and credit ratings," *Journal of Corporate Finance* 69 (2021), in press.

Draghi, Mario, Speech at the Global Investment Conference, London (July 26, 2012).

English, William B., "Understanding the Costs of Sovereign Default: American State Debts in the 1840's," *The American Economic Review* 86 (March 1996), 259-275.

Ergungor, O. Emre, "Sovereign Default in the US," Federal Reserve Bank of Cleveland Working Paper No. 16-09 (March 2016).

Esposito, Lucia, "Why Banking and Sovereign Risk Co-move?: The Role of Strategic Complementarities," Bank of Italy (June 2018).

Fatás, Antonio, and Mihov, Ilian, "The Macroeconomic Effects of Fiscal Rules in the US States," *Journal of Public Economics* 90 (2006), 101-117.

Federal Judicial Center, "Jurisdiction: Bankruptcy," https://www.fjc.gov/history/courts/jurisdiction-bankruptcy (n.d.).

Federal Reserve Bank of New York, "Report On The Competitiveness of Puerto Rico's Economy," (June 29, 2012).

Feenberg, Daniel, and Poterba, James M., "Which Households Own Municipal Bonds? Evidence from Tax Returns," *National Tax Journal* 44 (December 1991, Part 1), 93-103.

Feld, Lars P., Kalb, Alexander, Moessinger, Marc-Daniel, and Osterloh, Steffen, "Sovereign bond market reactions to no-bailout clauses and fiscal rules – The Swiss experience," *Journal of International Money and Finance* 70 (2017), 319-343.

France, Virginia G., and Kahn, Charles M., "Law As A Constraint on Bailouts: Emergency Support for Central Counterparties," *Journal of Financial Intermediation* 28 (2016), 22-31.

FRED, Federal Reserve Economic Data. See https://fred.stlouisfed.org.

Friewald, Nils, Jankowitsch, Rainer, Subrahmanyam, Marti G., "Illiquidity or credit deterioration: A study of liquidity in the US corporate bond market during financial crises," *Journal of Financial Economics* 105 (2012), 18-36.

GAO (U. S. General Accounting Office), "PUERTO RICO: Factors Contributing to the Debt Crisis and Potential Federal Actions to Address Them," GAO Report to Congressional Committees, GAO-18-387 (May 2018).

Gordon, Tracy, "Predicting Municipal Fiscal Distress: Aspiration or Reality?," Urban-Brookings Tax Policy Center Working Paper WP18TG1 (September 2018).

Gormley, Todd A., Johnson, Simon, and Rhee, Changyong, "Ending 'Too Big To Fail': Government Promises Versus Investor Perceptions," *Review of Finance* 19 (2015), 491-518.

Gourinchas, Pierre-Olivier, Martin, Philippe, and Messer, Todd E., "The Economics of Sovereign Debt, Bailouts, and the Eurozone Crisis," NBER Working Paper No. 27403 (June 2020).

Graham, Lindsey, "Lindsey Graham: A Conservative Leader Who Gets Things Done." Press Release (July 26, 2013).

Gürkaynak, Refet S., Sack, Brian, and Wright , Jonathan H., "The U.S. Treasury yield curve: 1961 to the present," *Journal of Monetary Economics* 54 (2007), 2291-2304.

Hamilton, James D., "Historical Causes of Postwar Oil Shocks and Recessions," *The Energy Journal* 6 (1985), 97-116.

He, Zhiguo, and Milbradt, Konstantin, "Endogenous Liquidity and Defaultable Bonds," *Econometrica* 82 (July 2014), 1443-1508.

Heinemann, Friedrich, Moessinger, Marc-Daniel, and Yeter, Mustafa, "Do Fiscal Rules Constrain Fiscal Policy? A Meta-Regression-Analysis," *European Journal of Political Economy* 51 (2018), 69-92.

Heppke-Falk, Kirsten H. and Wolff, Guntram B., "Moral Hazard and Bail-Out in Fiscal Federations: Evidence for the German Länder," *Kyklos* 61 (2008), 425-446.

Heins, A. James, *Constitutional Restrictions Against State Debt* (Madison: University of Wisconsin Press, 1963).

Herold, Katharina, "Insolvency Frameworks for Sub-national Governments," *OECD Working Papers on Fiscal Federalism*, No. 23 (2018).

Hobson, J.A., *Imperialism* (Ann Arbor: University of Michigan Press, 1938 (second printing 1967)).

Hull, John, Predescu, Mirela, and White, Alan, "The Relationship Between Credit Default Swap Spreads, Bond Yields, and Credit Rating Announcements," *Journal of Banking and Finance* 28 (2004), 2789-2811.

Inman, Robert P., "Transfers and Bailouts: Institutions for Enforcing Local Fiscal Discipline," *Constitutional Political Economy* 12/2 (June 2001), 141-160.

Jenks, Leland Hamilton, *The Migration of British Capital To 1875* (New York and London: Alfred A. Knopf, 1938).

Jensen, Michael C., Fama, Eugene F., Long, John B. Jr., Ruback, Richard S., Schwert, G. William, Smith, Clifford W. Jr., and Warner, Jerold, "Clinical Papers and Their Role in the Development of Financial Economics," *Journal of Financial Economics* 24 (1989), 3-6.

Jin, Shuang, Wang, Wei, and Zhang, Zilong, "The Real Effects of Implicit Government Guarantees: Evidence from Chinese SOE Defaults," HKUST (2020).

Joulfaian, David, and Matheson, Thornton, "The Supply Elasticity of Tax-Exempt Bonds," *National Tax Association Proceedings* (2009), 136-142.

Kalotay, Andrew J., and Dorigan, Michael P., "What Makes the Municipal Yield Curve Rise?," *The Journal of Fixed Income* (Winter 2008), 1-7.

Kareken, John, and Wallace, Neil, "Deposit Insurance and Bank Regulation: A Partial Equilibrium Exposition," *Journal of Business* 51/3 (July 1978), 413-438.

Kay, John, *Other People's Money* (New York: Public Affairs, 2015).

Kelly, Bryan, Lustig, Hanno, and van Nieuwerburgh, Stijn, "Too-Systematic-to-Fail: What Option Markets Imply about Sector-Wide Government Guarantees," *American Economic Review* 106 (2016), 1278-1319.

King, Mervyn, *The End of Alchemy: Money, Banking, and the Future of the Global Economy* (New York: W.W. Norton & Company, 2016).

Körner, Tobias, and Schnabel, Isabel, "Abolishing Public Guarantees in the Absence of Market Discipline," Ruhr Economic Papers #437 (August 2013).

Krishnamurthy, Arvind, Nagel, Stefan, and Vissing-Jorgensen, Annette, "ECB Policies Involving Government Bond Purchases: Impact and Channels," *Review of Finance* 22/1 (2018), 1-44.

Krueger, Anne O., Teja, Ranjit, and Wolfe, Andrew, "Puerto Rico – A Way Forward," Report (June 29, 2015).

Longstaff, Francis A., "Municipal Debt and Marginal Tax Rates: Is There a Tax Premium in Asset Prices?" *The Journal of Finance* 66, No. 3 (June 2011), 721-751.

Lucas, Deborah, "Valuation of Government Policies and Projects," *Annual Review of Financial Economics* 4 (2012), 39-58.

Lucas, Deborah, and McDonald, Robert, "Valuing Government Guarantees: Fannie and Freddie Revisited," in Deborah Lucas (ed.), *Measuring and Managing Federal Financial Risk* (Chicago: University of Chicago Press, 2010), 131-154.

Lustig, Nora, "The Mexican Peso Crisis: The Foreseeable and the Surprise," Brookings Institution (June 1995).

Metcalf, Gilbert E., "Federal taxation and the supply of state debt," *Journal of Public Economics* 51 (1993), 269-285.

Miller, Marcus, Weller, Paul, and Zhang, Lei, "Moral Hazard and the US Stock Market: Analyzing the 'Greenspan Put'," *The Economic Journal* 112 (March 2002), C171-C186.

Moody's, "Assured Guaranty, Ltd. and National Public Finance Guarantee Corp: Scenario Analysis Highlights Assured Guaranty's Greater Resilience to Puerto Rico Losses," *ISSUER IN-DEPTH* (November 2, 2016).

Moody's. "Rating Scale and Definitions," (no date; n.d.). See https://www.moodys.com/sites/products/ProductAttachments/AP075378_1_1408_KI.pdf

Morck, Randall, Wolfenzon, Daniel, and Yeung, Bernard, "Corporate Governance, Economic Entrenchment, and Growth," *Journal of Economic Literature* 43 (2005), 655-720.

Moretti, Enrico, and Wilson, Daniel J., "The Effect of State Taxes on the Geographical Location of Top Earners: Evidence from Star Scientists," *American Economic Review* 107(7) (July 2017), 1858-1903.

Morningstar, "Morningstar Special Report: Puerto Rico Fiscal Strain: Implications for Investors." (October 16, 2013).

*New York Times*, "Lockheed Bailout Largest by U.S.," (August 2, 1979).

*New York Times*, "Infamous 'Drop Dead' Was Never Said By Ford," (12.28.06).

*New York Times*, "State Control Draws Closer for Detroit After Fiscal Review," (February 19, 2013).

*New York Times*, "Hurricane-Torn Puerto Rico Says It Can't Pay Any of Its Debts for 5 Years," (January 24, 2018).

*Pensions & Investments,* "Puerto Rico Bankruptcy Pits Investors Against Pensioners," (May 15, 2017).

Ota, Alan K., "Detroit's Woes Put New Spotlight on Pension Overhaul Proposals," *Rollcall* (July 24, 2013).

Passadore, Juan, and Xu, Yu, "Illiquidity in Sovereign Debt Markets," Einaudi Institute of Economics and Finance (June 2018).

Poterba, James M., and Rueben, Kim, "State Fiscal Institutions and the U.S. Municipal Bond Market," in James M. Poterba and Jurgen von Hagen (eds.), *Fiscal Institutions and Fiscal Performance* (Chicago: University of Chicago Press, 1999), 181-208.

Rajan, Raghuram G., and Zingales, Luigi, *Saving Capitalism from the Capitalists: Unleashing the Power of Financial Markets to Create Wealth and Spread Opportunity* (New York: Crown Business/Random House, 2003).

Ramey, Valerie A., and Shapiro, Matthew D., "Costly Capital Reallocation and the Effects of Government Spending," *Carnegie-Rochester Conference Series on Public Policy* 48(1) (1998), 145-194.

Ratchford, B.U., *American State Debts* (Durham: Duke University Press, 1941). Reprinted (New York: AMS Press, 1966).

Romer, Christina D., and Romer, David H., "Does Monetary Policy Matter? A New Test in the Spirit of Friedman and Schwartz" in Olivier J. Blanchard and Stanley Fischer (eds.), *NBER Macroeconomics Annual* 4 (1989), 121-170.

Romer, Christina D., and Romer, David H., "New Evidence on the Impact of Financial Crises in Advanced Countries," *American Economic Review* 107 (October 2017), 3072-3118.

Sainsbury, Caleb, "Taxation of Credit Default Swaps: A Guaranteed Solution?," *Review of Banking & Financial Law* 30 (2010), 443-472.

Sargent, Thomas J., "Nobel Lecture: United States Then, Europe Now," *Journal of Political Economy* 120, No. 1 (February 2012a), 1-40.

Sargent, Thomas J., "An American History Lesson for Europe," *Wall Street* Journal (February 3, 2012b).

Schankel, Alan, "Puerto Rico's Debt Overload," *Janney Fixed Income Strategy* (July 27, 2012).

Scott, Kenneth E., Shultz, George P., and Taylor, John B., *Ending Government Bailouts As We Know Them* (Stanford: Hoover Institution Press, 2010).

Sinn, Hans-Werner, *The Euro Trap: On Bursting Bubbles, Budgets, and Beliefs* (Oxford: Oxford University Press, 2014).

Sinn, Gerlinde, and Sinn, Hans-Werner, *Jumpstart: The Economic Unification of Germany* (translated by Juli Irving-Lessmann) (Cambridge, Massachusetts: MIT Press, 1994).

Skeel, David A., Jr., *Debt's Dominion: A History Of Bankruptcy Law In America* (Princeton and Oxford: Princeton University Press, 2001).

United Nations, Population Division, Department of Economic and Social Affairs, *World Population Prospects: The 2017 Revision, Medium fertility variant, 2015 – 2100*. DVD Edition. See https://www.un.org/development/desa/publications/world-population-prospects-the-2017-revision.html.

U.S. Congress, "Puerto Rico Oversight, Management, and Economic Stability Act" or "PROMESA," Public Law 114-187 (June 30, 2016).

U.S. Treasury, *Citizens' Report: Office of Financial Stability – Troubled Asset Relief Program*," (Fiscal Year 2017).

Van Deventer, Donald, "Puerto Rico And Municipal Credit Default Swap Trading Volume 2010-2013," *Seeking Alpha* (February 10, 2014).

Warren, Charles, *Bankruptcy in United States History* (Cambridge: Harvard University Press, 1935). Reprinted (New York: Da Capo Press, 1972).

*Washington Post*, "When the Taxpayers Saved Lee Iacocca's Bacon, What Did They Get Out of It?," (May 13, 1984).

**Table 1**
Median Age Of the Population. Source: United Nations (2017).

| **Country** | **2015** | **2040** | **Annualized Growth Rate (%)** |
|---|---|---|---|
| | (1) | (2) | (3) |
| **Puerto Rico** | **36.4** | **45.8** | **0.923** |
| Caribbean Region | 30.3 | 37.7 | 0.878 |
| United States | 37.6 | 41.2 | 0.366 |
| More Developed Countries | 41.1 | 45.5 | 0.408 |
| Less Developed Countries | 27.8 | 33.1 | 0.700 |

**Table 2**
Risk Premia Across Issue Dates Matched Pairs (Basis Points). Details concerning data sources and the estimation of the risk premia are discussed in Sections 2 and 3. For Corporate Aaa, Corporate Baa, and Non-Investment grade bonds (ICE BofAML U.S. High Yield Master II Index tracking below investment grade corporate debt) the risk premia are the yield on this asset class less the 20-year Treasury yield; these data were retrieved from FRED, Federal Reserve Bank of St. Louis, https://fred.stlouisfed.org/series/DAAA, https://fred.stlouisfed.org/series/DBAA, https://fred.stlouisfed.org/series/BAMLH0A0HYM2EY, and https://fred.stlouisfed.org/series/DGS20, respectively. The results presented in Panel A to C are based on different tax rates: in Panel A, the highest marginal tax rate for the marginal municipal bond household investor, as discussed in Section 3 and Appendix F; in Panel B, the corporate marginal income tax rate defined as the sum of the federal corporate rate (35.0%) and an average of state corporate rates (6.5%, Chirinko and Wilson, 2017, Figure 2, which happens to equal the unweighted average (2000 to 2016) of the tax rate used in Panel A; in Panel C, the baseline tax rate used in Panel A halved. The results in panel D exclude bond issues numbers 1 to 5 as listed in Table 2 (or, equivalently, bonds 1 to 12 listed in Appendix C); the insurers for these bonds had lower credit quality than the insurers for bond issues numbers 6 to 13. Averages are computed as the average of the 13 issues. For the Puerto Rican risk premia, there may be a difference between this figure and the average of all risk premia (since the number of bonds per issue differs). The difference is small; the latter average equals 175 in Panel A.

| **Issue Date** | **Corporate Aaa** | **Puerto Rican** | **Corporate Baa** | **Non-Investment Grade ("Junk")** |
|---|---|---|---|---|
| **A. Baseline: Highest $\tau$** | (1) | (2) | (3) | (4) |
| 1. March 15, 2000 | 135 | 169 | 205 | 547 |
| 2. October 25, 2001 | 168 | 217 | 256 | 827 |
| 3. April 4, 2002 | 90 | 125 | 221 | 604 |
| 4. August 8, 2002 | 115 | 166 | 239 | 816 |
| 5. May 18, 2004 | 59 | 120 | 130 | 302 |
| 6. October 7, 2004 | 59 | 176 | 135 | 248 |
| 7. October 16, 2007 | 86 | 140 | 169 | 351 |
| 8. May 7, 2008 | 99 | 276 | 231 | 543 |
| 9. September 17, 2009 | 96 | 193 | 217 | 622 |
| 10. February 17, 2011 | 81 | 125 | 170 | 253 |
| 11. March 17, 2011 | 89 | 131 | 180 | 303 |
| 12. July 12, 2011 | 100 | 180 | 182 | 348 |
| 13. April 3, 2012 | 105 | 150 | 231 | 428 |
| **Average** | **99** | **167** | **197** | **476** |
| | | | | |
| **B. Corporate $\tau$ = MEAN[$\tau$]** | | | | |
| **Average** | **99** | **169** | **197** | **476** |
| **C. $\tau$ / 2** | | | | |
| **Average** | **99** | **150** | **197** | **476** |
| **D. High-Quality Insurers Highest $\tau$** | | | | |
| **Average** | **89** | **171** | **189** | **387** |

**Table 3**
Risk Premia Before And After The Detroit Bankruptcy Double-Matched Pairs, Benchmark Results (Basis Points), January 2013 to December 2013. The first figure in a cell is the risk premium estimated Before Detroit, After Detroit, and the Differential between these two risk premia in columns 1, 2, and 3, respectively. The risk premia are stated in basis points. Column 3 is the Difference-in-Difference estimate of the Treasury Put. Standard errors are in parentheses. The dates defining the intervals are given in braces. Entries in the first and second rows are for all $\sigma$'s in the sample computed on a daily or weekly basis, respectively. (The means of these two series differ because of holidays, which drive a small wedge between the average of a series and the average of weekly averages.) The date of the Detroit bankruptcy falls on a Thursday, and these two days are added to the subsequent week in computing a weekly average. The data used to compute risk premia are "double-matched." They are first matched by issue date and bond characteristics resulting in the same matched pairs used in Table 2 (23,422 trades in 2013). (The one exception is matched pair #15, which was removed because of erratic behavior in the After Detroit interval for the insured bond. The insurer of this bond was AGC, one of the two most creditworthy insurers of Puerto Rican bonds (cf. the discussion in Section 2.2 about the creditworthiness of AGC).) The second match is on the trading day. We identify trades of both bonds in a matched pair that occur on the same day or an adjacent day. There are 880 double-matched trades in the Before Detroit interval and 1,016 double-matched trades in the After Detroit interval. When the bonds in a matched pair are traded on an adjacent day, the date for the insured bond was changed to the date for the uninsured bond. The risk premia are computed according to equation (7). An entry for a given day is the average of risk premia that are associated with double-matched bonds traded on that day. (For programming reasons, we do not include the adjustment for maturities with Treasury data; this omission is of no quantitative importance since the maturity differences are non-existent or small.)

| | **Before Detroit** | **After Detroit** | **Differential** |
|---|---|---|---|
| | (1) | (2) | (3) |
| **Daily** | 187<br>(5)<br>{1.1.13 to 7.17.13} | 556<br>(22)<br>{7.18.13 to 12.31.13} | 368<br>(21) |
| **Weekly** | 187<br>(5)<br>{1.1.13 to 7.17.13} | 561<br>(40)<br>{7.18.13 to 12.31.13} | 374<br>(37) |

**Table 4**
Risk Premia Before And After The Detroit Bankruptcy Double-Matched Pairs, Robustness Results (Basis Points), January 2013 to December 2013. The first figure in a cell is the risk premium estimated Before Detroit, After Detroit, and the Differential between these two risk premia in columns 1, 2, and 3, respectively. The risk premia are stated in basis points. Column 3 is the Difference-in-Difference estimate of the Treasury Put. Standard errors are in parentheses. Dates defining the intervals are in braces. Entries are for all $\sigma$'s in the sample computed on a daily basis. Entries in rows 1 and 2 allow for a delayed response to the extinguishing of the Treasury Put by defining the beginning of the After Detroit interval 14 and 30 days after July 17, 2013. See the notes to Table 3 for further details.

| | **Before Detroit** | **After Detroit** | **Differential** |
|---|---|---|---|
| | (1) | (2) | (3) |
| **Delayed Response** | | | |
| **14 Days** | 187<br>(5)<br>{1.1.13 to 7.17.13} | 577<br>(23)<br>{8.1.13 to 12.31.13} | 390<br>(21) |
| **30 Days** | 187<br>(5)<br>{1.1.13 to 7.17.13} | 613<br>(23)<br>{8.16.13 to 12.31.13} | 426<br>(20) |

**Table 5**
Risk Premia Before And After The Detroit Bankruptcy Double-Matched Pairs, Robustness Results (Basis Points), October 2012 to December 2013. The first figure in a cell represent the risk premium estimated Before Detroit, After Detroit, and the Differential between these two risk premia in columns 1, 2, and 3, respectively. The risk premia are stated in basis points. Column 3 is the Difference-in-Difference estimate of the Treasury Put. Standard errors are in parentheses. Dates defining the intervals are in braces. Entries are for all $\sigma$'s in the sample computed on a daily basis. Entries allow for anticipation effects for the extinguishing of the Treasury Put by defining the end of the Before Detroit interval 17, 47, 78, and 108 days before July 18, 2013 and maintaining a six month window. See the notes to Table 3 for further details.

| | **Before Detroit** | **After Detroit** | **Differential** |
|---|---|---|---|
| | (1) | (2) | (3) |
| **Anticipation Effects** | | | |
| **17 Days** | | | |
| | 189 | 556 | 366 |
| | (6) | (22) | (22) |
| | {1.1.13 to 6.30.13} | {7.18.13 to 12.31.13} | |
| **47 Days** | | | |
| | 186 | 556 | 369 |
| | (6) | (22) | (24) |
| | {12.1.12 to 5.31.13} | {7.18.13 to 12.31.13} | |
| **78 Days** | | | |
| | 180 | 556 | 376 |
| | (5) | (22) | (27) |
| | {11.1.12 to 4.30.13} | {7.18.13 to 12.31.13} | |
| **108 Days** | | | |
| | 170 | 556 | 385 |
| | (5) | (22) | (31) |
| | {10.1.12 to 3.31.13} | {7.18.13 to 12.31.13} | |

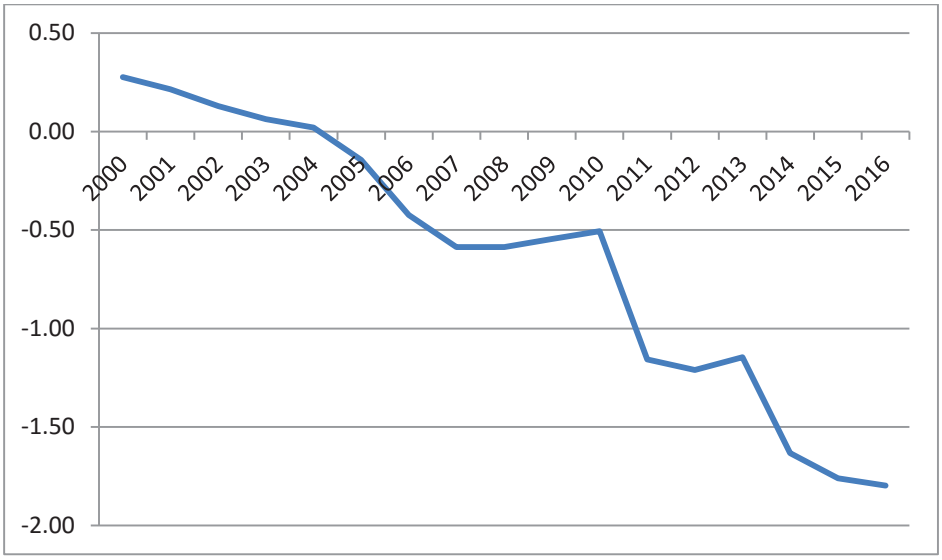


**Figure 1.** Population Growth, 2000-2016. Annual population growth rate for year t is the exponential rate of growth of midyear population from year t-1 to t, expressed as a percentage. Population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship--except for refugees not permanently settled in the country of asylum, who are generally considered part of the population of the country of origin. Source: World Bank, Population Growth for Puerto Rico [SPPOPGROWPRI]; retrieved from FRED, Federal Reserve Bank of St. Louis, https://fred.stlouisfed.org/series/SPPOPGROWPRI.

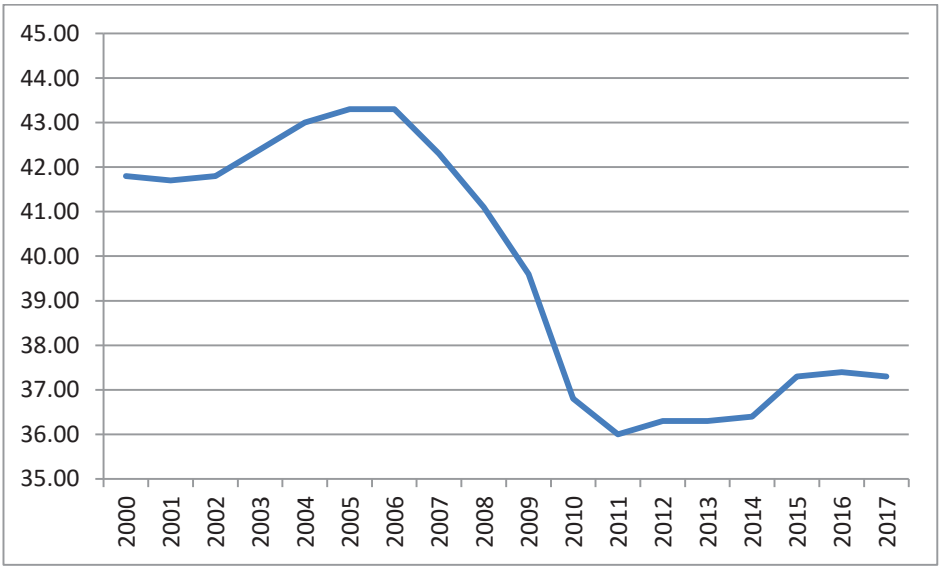


**Figure 2.** Employment To Population Ratio, 2000-2017. Employment to population ratio is the proportion of a country's working-age population that is employed. Ages 15 and older are generally considered the working-age population (modeled ILO estimate). Source: World Bank, Employment to Population Ratio for Puerto Rico [SLEMPTOTLSPZSPRI]; retrieved from FRED, Federal Reserve Bank of St. Louis, https://fred.stlouisfed.org/series/SLEMPTOTLSPZSPRI.

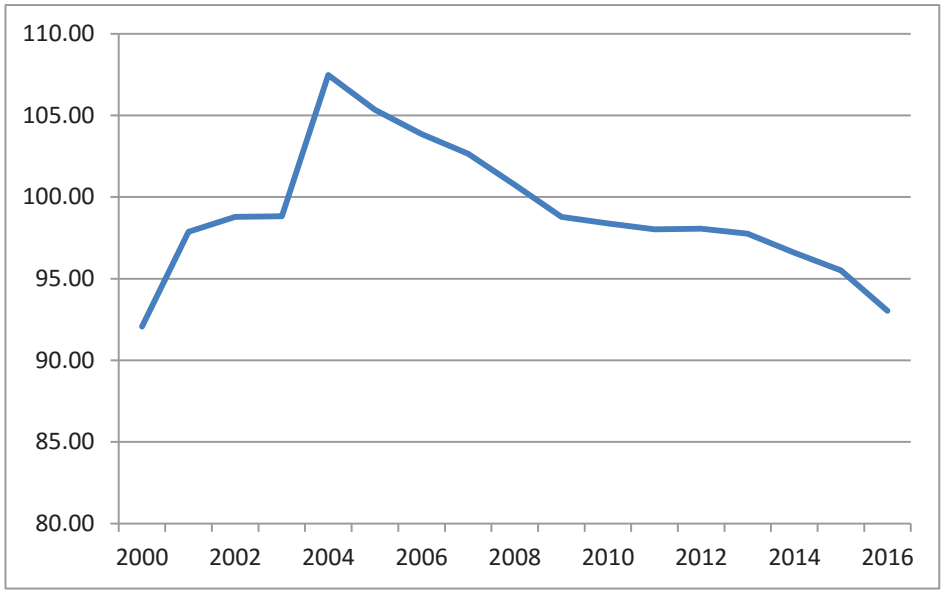


**Figure 3.** Gross Domestic Product (constant 2010 US$), 2000-2016. Source: World Bank, World Development Indicators; retrieved from https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.

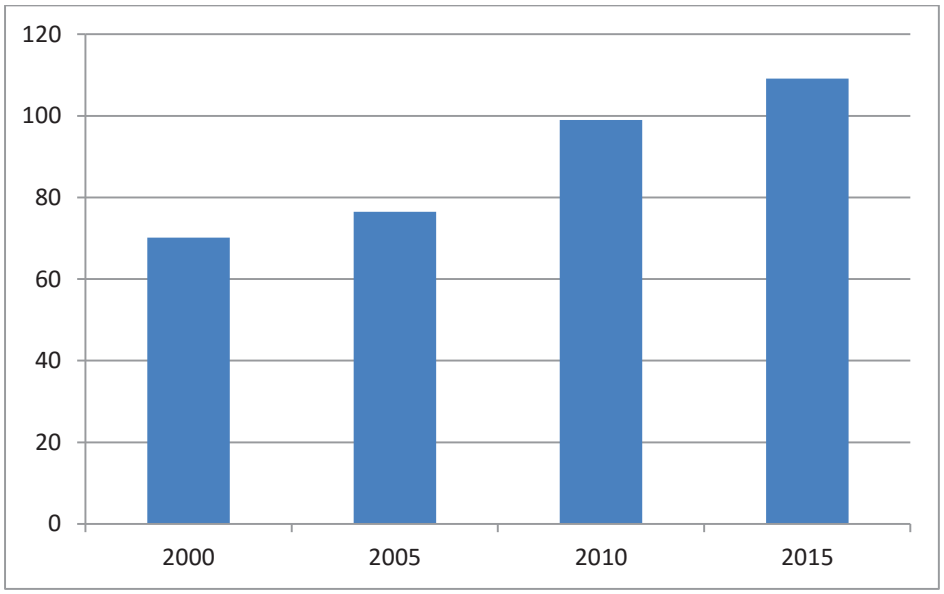


**Figure 4.** Public Liabilities, As A Ratio To Nominal GDP, Various Years. The numerator is the sum of debt and unfunded pension liabilities for the public sector; the denominator is nominal GDP. See Appendix A for details about the construction of the numbers in this Figure: 70.2, 76.5, 99.0, and 109.1 for 2000 to 2015, respectively. Some studies scale by GNP, which substantially increases the ratio. See Appendix A for a discussion of differences between using GDP and GNP as the scaling variable.

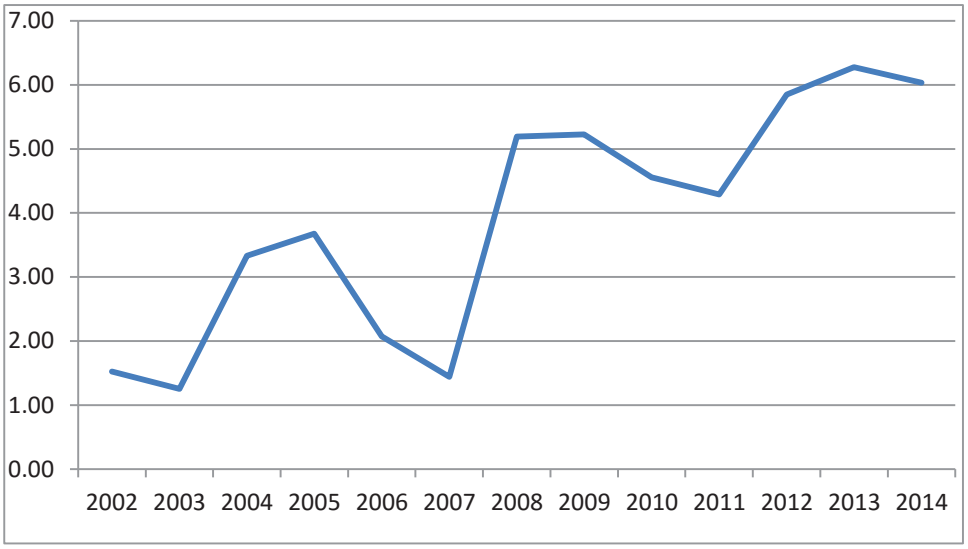


**Figure 5.** Government Deficits, As A Percentage Of GDP, 2002-2014. Sources: Deficit data (GAO, 2018, Figure 2, p. 9; data provided via a FOIA request to the GAO; these data are compiled from Puerto Rico's publicly available, audited financial statements. GDP data, World Bank [NYGDPMKTPCDPRI]; retrieved from FRED, Federal Reserve Bank of St. Louis, https://fred.stlouisfed.org/series/NYGDPMKTPCDPRI.

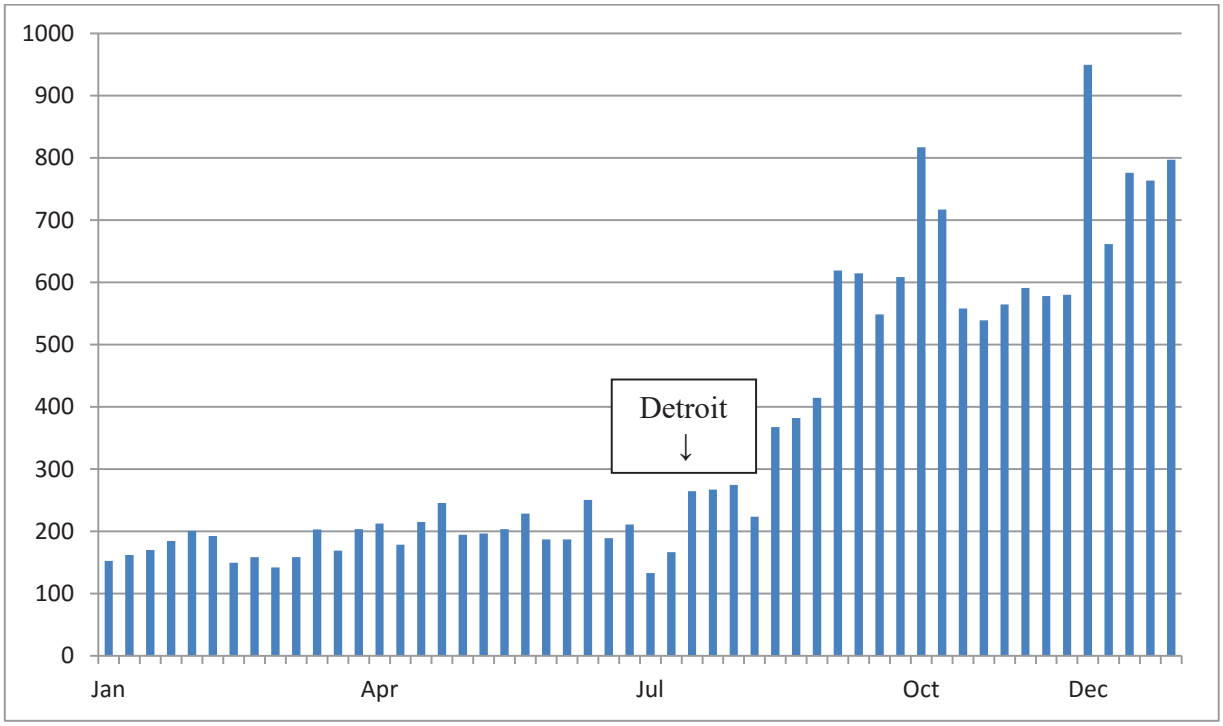


**Figure 6.** Risk Premia Before And After The Detroit Bankruptcy, Double-Matched Pairs, Benchmark Results (Basis Points), Weekly Data, January 2013 to December 2013. See the notes to Table 3 for details.

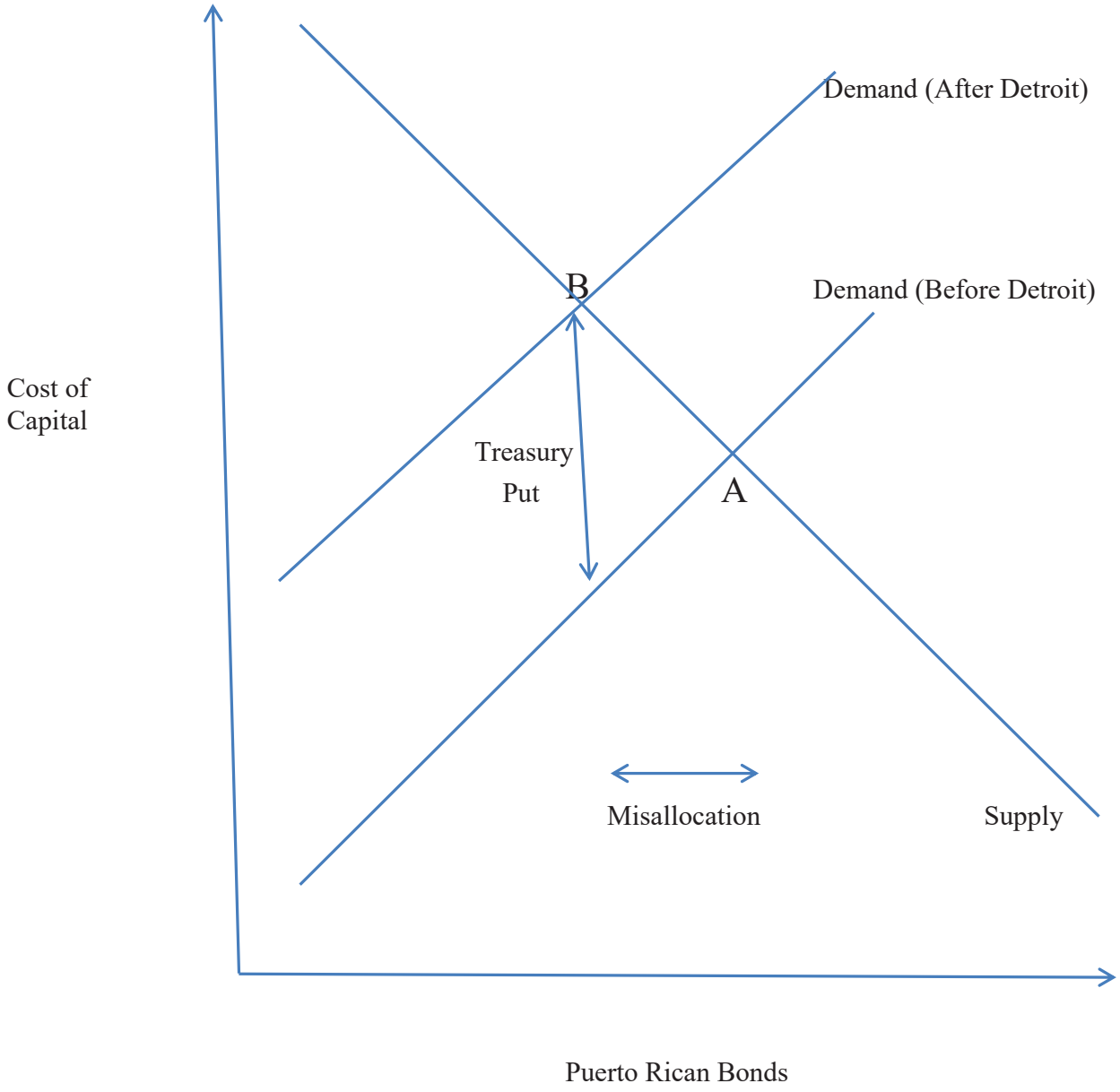


**Figure 7.** The Market For Puerto Rican Bonds And The Treasury Put

## Appendix A. Computing The Debt/GDP And Unfunded Pension Liabilities/GDP Ratios

This appendix provides details for the date presented in Figure 4.

The fiscal situation of a sovereign state –a nation, a sub-national unit (e.g., a U.S. state or city), or a territory (e.g., the Commonwealth of Puerto Rico) -- is often evaluated by the ratio of outstanding liabilities to some measure of economic activity. The two most frequently used measures of economic activity are gross domestic product (GDP) and gross national product (GNP). (Unless otherwise stated, GDP and GNP are in nominal terms.) GDP measures the value of economic activity within the borders of a sovereign state regardless if it is undertaken by citizens (both persons and businesses) or foreigners. GNP equals GDP plus the economic activity of its citizens working abroad less the economic activity of foreigners working within its borders. (GNP is sometimes labeled gross national income.) For most countries, the two measures are quite close. But when there is a large foreign presence, GDP will exceed GNP. Such a situation holds, for example for Ireland, Luxembourg, and Puerto Rico. Since the measure of economic activity is meant to capture the ability of a sovereign state to repay its debts, GDP is the more appropriate concept because the activities it measures can be taxed.

A sovereign state's liabilities are the sum of outstanding debt plus unfunded pension liabilities. Data on the outstanding debt of Puerto Rico has been collected by Krueger, Teja, and Wolfe (2015) but it was stated relative to GNP. In Table A1, the debt/GDP data (column 3) are computed as the product of debt/GNP (column 1) multiplied by the GNP/GDP ratio (column 2) in Table A1,

## Table A1 -- Computing The Debt/GDP And Total Liabilities/GDP Ratios

| Year | Debt/GNP (%) | GNP/GDP | Debt/GDP (%) | Total Liabilities/GDP (%) | GDP (Nominal, billions $) |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| 2000 | 63.2 | 0.671 | 42.4 | 70.2 | 61.7 |
| 2005 | 71.2 | 0.649 | 46.2 | 76.5 | 83.9 |
| 2010 | 90.9 | 0.658 | 59.8 | 99.0 | 98.4 |
| 2015 | 100.2 | 0.658 | 65.9 | 109.1 | 103.1 |

**Notes And Sources**:
Column 1: Krueger, Teja, and Wolfe (2015, p. 9); unfunded pension obligations are excluded.

Column 2: University of Pennsylvania, Ratio of GNP to GDP for Puerto Rico [GNPGDPPRA156NUPN]; retrieved from FRED, Federal Reserve Bank of St. Louis, https://fred.stlouisfed.org/series/GNPGDPPRA156NUPN. No data are available for 2015; the 2015 value equals the 2010 value.

Column 3: Transformation: the product of columns 1 and 2.

Column 4: Transformation: column 3 multiplied by 1.654, per the discussion below in this appendix.

Column 5: GDP data, World Bank [NYGDPMKTPCDPRI]; retrieved from FRED, Federal Reserve Bank of St. Louis, https://fred.stlouisfed.org/series/NYGDPMKTPCDPRI.

The debt figures in columns 1, 2, and 3 of Table B1 exclude unfunded pension liabilities. We use two different data sources to estimate unfunded pension liabilities. *Barron's* (2012) contains data for 2012 on unfunded pension liabilities, as well as outstanding debt. However, their debt figure of $51.9 is approximately 17% lower than the implied debt figure in column 3, the latter interpolated linearly between the 2010 and 2015 data (62.3%). We believe that the Krueger, Teja, and Wolfe data are more accurate. To attenuate measurement error, we thus use the ratio of unfunded pension liabilities to debt in the Barron's data, 0.638 (= 33.1 / 51.9). The second data source is from *Pensions & Investments* (2017), which reports a ratio of unfunded pension liabilities to debt of 0.670 (= 50.0 / 74.0); we round down slightly since the article mentions that the estimate of unfunded pension liabilities is slightly below 50. We average these

two ratios (0.654) and assume that this estimate can be used to adjust the debt figures in the above appendix table. The results of these computations are presented in column 4.

These figures may represent a lower bound. Morningstar (2013) reports that debt and unfunded liabilities are $88.6 (p. 5) and $37.0 (p. 4), respectively, in 2013, resulting in a Total Liabilities / GDP ratio of 1.23. This ratio is 17% higher than the comparable ratio in Table A1 (based on a linear interpolation between 2010 and 2015.

## Appendix B. Puerto Rican Government Deficits

This appendix provides details for the date presented in Figure 5. The figures in columns 1 to 5 are in billions of U.S. dollars. The figures in columns 6 to 9 are stated as percentages.

| Year | Deficit | | | | | Deficit As A Percentage Of GDP | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Budgetary (Cash) Basis | Budgetary (Cash) Basis | Accrual Basis | Operating Basis | GDP | Budgetary (Cash) Basis | Budgetary (Cash) Basis | Accrual Basis | Operating Basis |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| 2002 | 1.09 | | | | 71.62 | 1.52 | | | |
| 2003 | 0.94 | | | | 74.83 | 1.25 | | | |
| 2004 | 2.68 | | | | 80.32 | 3.33 | | | |
| 2005 | 3.09 | | | | 83.91 | 3.68 | | | |
| 2006 | 1.81 | | | | 87.28 | 2.07 | | | |
| 2007 | 1.29 | | | | 89.52 | 1.44 | | | |
| 2008 | 4.86 | | | | 93.64 | 5.19 | | | |
| 2009 | 5.04 | 2.86 | 3.52 | 2.68 | 96.39 | 5.23 | 2.97 | 3.65 | 2.78 |
| 2010 | 4.48 | 2.72 | 4.35 | 1.81 | 98.38 | 4.56 | 2.77 | 4.42 | 1.84 |
| 2011 | 4.30 | 1.80 | 3.79 | 1.09 | 100.35 | 4.29 | 1.79 | 3.77 | 1.09 |
| 2012 | 5.94 | 2.38 | 5.22 | 2.75 | 101.56 | 5.85 | 2.34 | 5.14 | 2.71 |
| 2013 | 6.43 | 1.31 | 3.61 | 2.55 | 102.45 | 6.28 | 1.28 | 3.52 | 2.49 |
| 2014 | 6.18 | | | | 102.45 | 6.03 | | | |
| | | . | | | | | | | |
| Average, 2009 to 2013 | | | | | | 5.24 | 2.23 | 4.10 | 2.18 |
| | | | | | | | | | |
| Ratio To The Average in Column 7 | | | | | | | 1.00 | 1.84 | 0.98 |

**Notes And Sources:**
Column 1: GAO (2018, Figure 2, p. 9. Data provided via a FOIA request to the GAO. These data are based on a careful analysis of government financial statements by the GAO, and they are compiled from Puerto Rico's publicly available, audited financial statements.

Column 2: Commonwealth of Puerto Rico (2015, p. 64).

Column 3: Commonwealth of Puerto Rico (2015, p. 66, Total Government).

Column 4: Commonwealth of Puerto Rico (2015, p. 66, Total Government less Debt Service less COFINA Debt Service less principal payments (per fn. (1)).

Column 5: World Bank [NYGDPMKTPCDPRI]; retrieved from FRED, Federal Reserve Bank of St. Louis, https://fred.stlouisfed.org/series/NYGDPMKTPCDPRI.

Column 6: Transformation, column 1 divided by column 5, times 100.

Column 7: Transformation, column 2 divided by column 5, times 100.

Column 8: Transformation, column 3 divided by column 5, times 100.

Column 9: Transformation, column 4 divided by column 5, times 100.

## Appendix C. Summary Information For 45 Matched Uninsured/Insured Bonds

| Match # | Spread-sheet Line Number Also Search for "##" | CUSIP Uninsured Bond (Red)[1] | CUSIP Insured Bond (Blue)[1] | Calendar Date Of Uninsured and Insured Matched Bonds | Company Backing The Insured Bond[2] | Amount Of Issue Of Insured Bond (millions $, Blue)[1] | Call Year (R/B)[1] | MATURITY DATE (Red/Blue)[1] | Quality Of The Matu-rity Match | Bias For σ From Matu-rity Match[5] | σ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| 1 | 74 | 745145QC9 | 745145QB1 | 3-15-2000 | MBIA | 110.935 | 05/10 | 29/26 | Not Exact | Up-ward | 1.690 |
| 2 | 539 | 745145YN6 | 745145YR7 | 10-25-2001 | MBIA | 1.000 | N[3]/N | 16/16 | Exact | | 2.131 |
| 3 | 540 | 745145YP1 | 745145YR7 | 10-25-2001 | MBIA | 1.000 | N/N | 16/16 | Exact | | 2.131 |
| 4 | 546 | 745145YX4 | 745145YY2 | 10-25-2001 | Ambac | 6.770 | N/N | 19/19 | Exact | | 2.182 |
| 5 | 546 | 745145YX4 | 745145ZA3 | 10-25-2001 | Ambac | 18.190 | N/N | 19/19 | Exact | | 2.182 |
| 6 | 548 | 745145YZ9 | 745145YY2 | 10-25-2001 | Ambac | 6.770 | N/N | 19/19 | Exact | | 2.183 |
| 7 | 548 | 745145YZ9 | 745145ZA3 | 10-25-2001 | Ambac | 18.190 | N/N | 19/19 | Exact | | 2.183 |
| 8 | 665 | 745145VT6 | 745145VU3 | 4-4-2002 | FGIC | 21.190 | N/N | 05/05 | Exact | | 1.245 |
| 9 | 784 | 745145R61 | 745145R53 745145R79 | 8-8-2002 | FGIC | 130.290/19.260 | 12/12 | 27/32&22 | Not Exact | Up-ward | 1.662 |
| 10 | 1305 | 7451458M7 | 7451458N5 | 5-18-2004 | FSA | 29.165 | [4] | 30/31 | Not Exact | Down-ward | 1.205 |

| Match # | Spread-sheet Line Number Also Search for "##" | CUSIP Uninsured Bond (Red)[1] | CUSIP Insured Bond (Blue)[1] | Calendar Date Of Uninsured and Insured Matched Bonds | Company Backing The Insured Bond[2] | Amount Of Issue Of Insured Bond (millions $, Blue)[1] | Call Year (R/B)[1] | MATURITY DATE (Red/Blue)[1] | Quality Of The Matu-rity Match | Bias For σ From Matu-rity Match[6] | σ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 11 | 1305 | 7451458M7 | 7451458P0 | 5-18-2004 | MBIA | 40.000 | [4/] | 30/31 | Not Exact | Down-ward | 1.205 |
| 12 | 1305 | 7451458M7 | 7451458Q8 | 5-18-2004 | FGIC | 22.315 | [4/] | 30/31 | Not Exact | Down-ward | 1.202 |
| 13 | 1414 | 74514LCR6 | 74514LCS4 | 10-7-2004 | FSA | 8.560 | 12/N | 14/14 | Exact | | 2.345 |
| 14 | 1420 | 74514LCX3 | 74514LCW5 | 10-7-2004 | FSA | 14.985 | 14/14 | 19/18 | Not Exact | Up-ward | 1.170 |
| 15 | 2261 | 74514LNB9 | 74514LNA1 | 10-16-2007 | AGC | 24.940 | N/N | 17/17 | Exact | | 1.388 |
| 16 | 2262 | 74514LNC7 | 74514LNA1 | 10-16-2007 | AGC & MBIA | 53.215& 24.940 | N/N | 18/ 17&19 | Not Exact | Up-ward | 1.416 |
| 17 | 2416 | 74514LSN8 | 74514LTE7 | 5-7-2008 | AGC | 36.110 | N/N | 14/14 | Exact | | 2.615 |
| 18 | 2416 | 74514LSN8 | 74514LTF4 | 5-7-2008 | AGC | 27.360 | N/N | 14/14 | Exact | | 2.615 |
| 19 | 2417 | 74514LSP3 | 74514LTG2 | 5-7-2008 | AGC | 50.220 | N/N | 15/15 | Exact | | 2.779 |
| 20 | 2417 | 74514LSP3 | 74514LTH0 | 5-7-2008 | AGC | 15.995 | N/N | 15/15 | Exact | | 2.779 |
| 21 | 2426 | 74514LSQ1 | 74514LTJ6 | 5-7-2008 | AGC | 53.955 | N/N | 16/16 | Exact | | 2.878 |
| 22 | 2426 | 74514LSQ1 | 74514LTL1 | 5-7-2008 | AGC | 16.605 | N/N | 16/16 | Exact | | 2.878 |

| Match # | Spread-sheet Line Number Also Search for "##" | CUSIP Uninsured Bond (Red)[1] | CUSIP Insured Bond (Blue)[1] | Calendar Date Of Uninsured and Insured Matched Bonds | Company Backing The Insured Bond[2] | Amount Of Issue Of Insured Bond (millions $, Blue)[1] | Call Year (R/B)[1] | MATURITY DATE (Red/Blue)[1] | Quality Of The Matu-rity Match | Bias For σ From Matu-rity Match[6] | σ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 23 | 2793 | 74514LVV6 | 74514LVT1 | 9-17-2009 | FSA | 42.790 | 14/20 | 31/30 | Not Exact | Up-ward | 1.960 |
| 24 | 2793 | 74514LVV6 | 74514LVU8 | 9-17-2009 | FSA | 51.045 | 14/20 | 31/31 | Exact | | 1.896 |
| 25 | 3154 | 74514LWK9 | 74514LWP8 | 2-17-2011 | FSA/AGM | 35.420 | 21/21 | 28/27 | Not Exact | Up-ward | 1.297 |
| 26 | 3156 | 74514LWM5 | 74514LWL7 | 2-17-2011 | FSA/AGM | 42.025 | 16/16 | 33/33 | Exact | | 1.229 |
| 27 | 3157 | 74514LWQ6 | 74514LWT0 | 2-17-2011 | FSA/AGM | 15.000 | 21/21 | 34/34 | Exact | | 1.220 |
| 28 | 3183 | 74514LXA0 | 74514LXF9 | 3-17-2011 | FSA/AGM | 20.000 | 16/16 | 32/32 | Exact | | 1.300 |
| 29 | 3184 | 74514LXB8 | 74514LXF9 | 3-17-2011 | FSA/AGM | 20.000 | 16/16 | 32/32 | Exact | | 1.298 |
| 30 | 3185 | 74514LWZ6 | 74514LXC6 | 3-17-2011 | FSA/AGM | 40.000 | 16/16 | 35/36 | Not Exact | Down-ward | 1.246 |
| 31 | 3187 | 74514LXH5 | 74514LXC6 | 3-17-2011 | FSA/AGM | 40.000 | 35/16 | 36/36 | Exact | | 1.301 |
| 32 | 3189 | 74514LWX1 | 74514LXG7 | 3-17-2011 | FSA/AGM | 105.000 | N/16 | 40/37 | Not Exact | Up-ward | 1.396 |
| 33 | 3276 | 74514LZF7 | 74514LZD2 | 7-12-2011 | FSA/AGM | 5.900 | 16/16 | 19/19 | Exact | | 1.631 |
| 34 | 3277 | 74514LZH3 | 74514LZD2 | 7-12-2011 | FSA/AGM | 5.900 | 16/16 | 19/19 | Exact | | 2.033 |

| Match # | Spread-sheet Line Number Also Search for "##" | CUSIP Uninsured Bond (Red)[1] | CUSIP Insured Bond (Blue)[1] | Calendar Date Of Uninsured and Insured Matched Bonds | Company Backing The Insured Bond[2] | Amount Of Issue Of Insured Bond (millions $, Blue)[1] | Call Year (R/B)[1] | MATURITY DATE (Red/Blue)[1] | Quality Of The Matu-rity Match | Bias For σ From Matu-rity Match[6] | σ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | 3279 | 74514LZG5 | 74514LZE0 | 7-12-2011 | FSA/AGM | 4.500 | 16/16 | 20/20 | Exact | | 1.615 |
| 36 | 3280 | 74514LZJ9 | 74514LZE0 | 7-12-2011 | FSA/AGM | 4.500 | 16/16 | 20/20 | Exact | | 1.936 |
| 37 | 3482 | 74514LA56 | 74514LD46 | 4-3-2012 | FSA/AGM | 20.000 | N/N | 22/22 | Exact | | 1.460 |
| 38 | 3484 | 74514LC70 | 74514LD53 | 4-3-2012 | FSA/AGM | 5.000 | 22/22 | 23/23 | Exact | | 1.541 |
| 39 | 3486 | 74514LC88 | 74514LD61 | 4-3-2012 | FSA/AGM | 5.000 | 22/22 | 24/24 | Exact | | 1.460 |
| 40 | 3487 | 74514LA72 | 74514LD61 | 4-3-2012 | FSA/AGM | 5.000 | 22/22 | 24/24 | Exact | | 1.591 |
| 41 | 3489 | 74514LA80 | 74514LD79 | 4-3-2012 | FSA/AGM | 5.000 | 22/22 | 25/25 | Exact | | 1.427 |
| 42 | 3493 | 74514LB22 | 74514LD87 | 4-3-2012 | FSA/AGM | 11.520 | 22/22 | 27/27 | Exact | | 1.771 |
| 43 | 3499 & 3500 | 74514LC39 74514LB63 | 74514LD20 | 4-3-2012 | FSA/AGM | 322.925 | 22/22 | 33&37/35 | Not Exact | Down-ward | 1.305 |
| 44 | 3503 | 74514LC62 | 74514LD46 | 4-3-2012 | FSA/AGM | 20.000 | 22/22 | 22/22 | Exact | | 1.460 |
| 45 | 3504 | 74514LC70 | 74514LD53 | 4-3-2012 | FSA/AGM | 5.000 | 22/22 | 23/23 | Exact | | 1.460 |

Notes:

The Official Statements (OS) are available from the first author upon request.

[1] "Red" and "Blue" identify uninsured and insured bonds, respectively.

[2] Insurance companies: Ambac, AGC, FGIC, FSA, MBIA. FSA was acquired by AGC in July 2009 and renamed Assured Guaranty Municipal Corporation (AGM). AGC and FSA/AGM were rated Aaa during most of the sample period and no lower than A3 (as of January 2013); see Section 2.2 for further discussion of their credit ratings.

[3] "N" indicates not callable.

[4] Both the uninsured and insured bonds are callable at the discretion of and on any Mandatory Tender Date set by the Secretary of the Treasury of the Commonwealth of Puerto Rico.

[5] Bias is based on the assumption that the term structure is upward sloping. Thus, a longer maturity bond, ceteris paribus, will have a higher yield. For example, in row 1, the slightly greater maturity for the uninsured bond results in a higher yield than would have occurred if the uninsured bond had the exact same maturity as its matched insured bond. This positive differential leads to an upward bias in our estimate of the risk premium, $\sigma$.

## Appendix D. Moody's Rating Scale – Long-Term Debt

| Rating | Description |
|---|---|
| **Investment Grade** | |
| Aaa | Obligations rated Aaa are judged to be of the highest quality, with minimal risk. |
| Aa1 | Obligations rated Aa are judged to be of high quality and are subject to very low credit risk. |
| Aa2 | |
| Aa3 | |
| A1 | Obligations rated A are considered upper-medium-grade and are subject to low credit risk. |
| A2 | |
| A3 | |
| Baa1 | Obligations rated Baa are subject to moderate credit risk. They are considered medium-grade and as such may possess speculative characteristics. |
| Baa2 | |
| Baa3 | |
| | |
| **Non-Investment Grade** | |
| Ba1 | Obligations rated Ba are judged to have speculative elements and are subject to substantial credit risk. |
| Ba2 | |
| Ba3 | |
| B1 | Obligations rated B are considered speculative and are subject to high credit risk. |
| B2 | |
| B3 | |
| Caa1 | Obligations rated Caa are judged to be of poor standing and are subject to very high credit risk. |
| Caa2 | |
| Caa3 | |
| Ca | Obligations rated Ca are highly speculative and are likely in, or very near, default, with some prospect of recovery in principal and interest. |
| C | Obligations rated C are the lowest-rated class of bonds and are typically in default, with little prospect for recovery of principal and interest. |

Notes: Long-term debt has an original maturity of one year or greater. Source: Moody's (n.d.) Rating Scale and Definitions; https://www.moodys.com/sites/products/ProductAttachments/AP075378_1_1408_KI.pdf

## Appendix E. Comments On Data Collection For Puerto Rican Bonds And Interest Rates

**Puerto Rican Bonds**

The following detailed comments concern various assumptions and procedures used in collecting the Puerto Rican bond data.

1. The Official Statements (OS) are available from the author upon request.

2. If a bond has a very short maturity (usually less than one year) and is not insured, it is not included in our list of uninsured bonds for subsequent analysis.

3. Absence of an OS for a particular issue is important. We look for some documentation in an OS about that particular bond. If no information is found, even if data are available on EMMA, this bond in not included in our list (e.g. CUSIP 745145Y55).

4. However, if two or more bonds without an OS are the sum of a bond with an OS, we include these bonds. In some cases, the same bond has two or more CUSIP's. For example,

   - 74514LPY7 and 74514LQA8 refer to the same bond, which is also listed as 74514LKB2;

   - 74514LPZ4 and 74514LQB6 refer to the same bond, which is also listed as 74514LKC0.

   We include all bonds because the two or more CUSIP's refer to non-overlapping trading patterns. By including both bonds, we capture all trading activity.

5. For the five items below denoted by Pqr in the penultimate column, we include the issue amount for the comparable security listed above that entry. It appears that the Pqr bond and its preceding information refer to the same security with disjoint trading histories.

| | | | | | |
|---|---|---|---|---|---|
| 2007-10-04 | 74514LLX3 | 7/1/2020 | 5.00 | 13.700 | 105 |
| 2007-10-04 | 74514LMP9 | 7/1/2020 | 5.00 | Pqr | 105 |
| 2007-10-04 | 74514LLY1 | 7/1/2021 | 5.00 | 14.400 | 104.762 |
| 2007-10-04 | 74514LMQ7 | 7/1/2021 | 5.00 | Pqr | 104.762 |
| 2007-10-04 | 74514LLZ8 | 7/1/2022 | 5.00 | 15.100 | 104.459 |
| 2007-10-04 | 74514LMR5 | 7/1/2022 | 5.00 | Pqr | 104.459 |
| 2007-10-04 | 74514LMA2 | 7/1/2023 | 5.00 | 15.850 | 104.21 |
| 2007-10-04 | 74514LNH6 | 7/1/2023 | 5.00 | Pqr | 104.21 |
| 2007-10-04 | 74514LMB0 | 7/1/2024 | 5.00 | 16.650 | 103.561 |
| 2007-10-04 | 74514LMG9 | 7/1/2025 | 5.00 | 17.500 | 103.21 |
| 2007-10-04 | 74514LMD6 | 7/1/2026 | 5.00 | 18.350 | 103.324 |
| 2007-10-04 | 74514LNJ2 | 7/1/2026 | 5.00 | Pqr | 103.324 |

6. For 10.16.07, the data for 74514LNA1 and74514LNB9 are not consistent in EMMA when compared to the OS. We assume the data in the OS is the correct data. In effect, the data for 74514LNA1 and74514LNB9 need to be swapped with each other to be consistent with the information in the OS.

7. If EMMA indicates a lower amount at issuance relative to the OS, we use the data for EMMA.

8. If a bond is listed in the OS but does not appear in EMMA, then
   a) if we have a CUSIP from the OS, we include the bond or
   b) if we do not have a CUSIP from the OS, we exclude the bond.

9. For the bonds placed on May 18, 2004, the yield figures (0.0383 for all three bonds) reported in the OS have been converted to the equivalent bond prices to ensure reporting uniformity with respect to the other bonds in the table. The bond prices have been computed with a precision of two.

**Interest Rates**

10. Trades in uninsured and insured bonds comprising double-matched bonds #30 and #31 occurred on July 17, 2013 and July 18, 2013, thus straddling this important day. These two datapoints have been deleted from the sample.

11. Three Aaa and Baa datapoints were interpolated: 12.31.65, 12.31.71, 11.11.16.

12. Two Municipal 20 datapoints were interpolated: 1.1.71, 9.14.01.

13. Three Treasury datapoints were estimated. Yields for 30-year Treasuries are missing from 2.19.02 to 2.8.06. However, yields for 20-year Treasuries are available for this period. We compute the difference between the 30-year and 20-year Treasuries for the two years before and after this interval; the average difference is -0.1517. This figure is added to the 20-year Treasury yield for three dated dates falling in the interval: 10.16.03, 11.25.03, 10.07.04. Only the latter dated date has a matched bond that enters the analysis in Tables 2 and 3.

14. A fourth Treasury datapoint, 11.11.10, was linearly interpolated.

## Appendix F. Computing The Marginal Income Tax Rate For The Marginal Municipal Bond Household Investor

Table F1 lists the tax rates and other variables needed to compute the marginal income tax rate for the marginal municipal bond investor assumed to be a household. Investors in Puerto Rican bonds are not assessed these taxes. The data are provided in Table F2.

### Table F1 -- Taxation Of Income From Treasury And Puerto Rican Bonds Regular And Alternative Minimum Tax (AMT) Regimes Data Sources

| | **Tax Regime:** | **Regular** | | | **AMT** | |
|---|---|---|---|---|---|---|
| | **Issuer:** | **U.S. Treasury** | **Puerto Rico** | | **U.S. Treasury** | **Puerto Rico** |
| | **Tax Rates** | (1) | (2) | | (3) | (4) |
| 1 | Federal tax rate $[\tau^{F}]$ | Yes | No | | No | No |
| 2 | State tax rate $[\tau^{S}]$ | Yes | No | | Yes | No |
| 3 | Net federal and state tax rate $[\tau^{FS} \equiv \tau^{F} + \tau^{S} - \tau^{F} * \tau^{S}]$ | Yes | No | | No | No |
| 4 | 3.8% (net investment income tax (NII, "Medicare Tax")) $[\tau^{NII} \equiv 0.038]$ | Yes | No | | Yes | No |
| 5 | 2.0% (phase-out of personal exemptions (PPE)) $[\tau^{PPE} \equiv (0.02/2,500) * \tau^{FS}]$ | Yes | No | | No | No |
| 6 | 3.0% (phase-out of itemized deductions (PID, Pease Limitation)) $[\tau^{PID} \equiv 0.03 * \tau^{FS}]$ | Yes | No | | No | No |
| 7 | Regular marginal tax rate on interest income | Yes | No | | No | No |

| | | | | | | |
|---|---|---|---|---|---|---|
| | $[\tau^{REG} \equiv \tau^{FS} + \tau^{NII} + \tau^{PPE} + \tau^{PID}]$ | | | | | |
| 8 | AMT federal tax rate<br>$[\tau^{A}]$ | No | No | | Yes | No |
| 9 | 25.0%*AMT tax rate (phase-out of AMT exemption)<br>$[0.25*\tau^{A}]$ | No | No | | Yes | No |
| 10 | AMT marginal tax rate on interest income<br>$[\tau^{AMT} \equiv \tau^{A} *1.25 + \tau^{S} + \tau^{NII}]$ | No | No | | Yes | No |
| 11 | Number of total returns filed with AGI $\geq$ \$200,000<br>$[N^{TOTAL}]$ | ------- | ------- | | ------- | ------- |
| 12 | Number of AMT returns filed with AGI $\geq$ \$200,000<br>$[N^{AMT}]$ | ------- | ------- | | ------- | ------- |
| 13 | Percent of returns filed under regular tax status<br>$[\omega^{REG} = (N^{TOTAL} - N^{AMT}) / N^{TOTAL}]$ | ------- | ------- | | ------- | ------- |
| 14 | Marginal tax rate on interest income<br>$[\tau \equiv \omega^{REG} * \tau^{REG} + (1 - \omega^{REG}) * \tau^{AMT}]$ | ------- | ------- | | ------- | ------- |

**Notes And Sources (presented by row number)**
Several of the sources below are to the website of the Internal Revenue Service (IRS, https://www.irs.gov ).

1. Source: IRS (*Statistics of Income* (SOI), Table 23).

2. Source: Daniel Wilson (Federal Reserve Bank of San Francisco). Weighted-average of the individual state tax rates, where the individual state data are from the NBER TAXSIM model for the period 1999 to 2011 and the weights are state personal income. For the period 2012 to 2016, values for the weighted-average are assumed equal to the 2011 value. State tax data from the SOI Public Use Files suggests that there is little variation in the average state tax rates for the period 2011 to 2016 (http://users.nber.org/~taxsim/marginal-tax-rates/as.html). See Moretti and Wilson (2017) for more details about the source data.

3. Transformation: State taxes are assumed deductible against federal taxes.

4. Source: IRS. This tax began in 2013.

5. Source: IRS. Phase-outs are in effect from 1999 to 2000, eliminated from 2001 to 2012 under the 2001 Bush tax cuts (the *Economic Growth and Tax Relief Reconciliation Act of 2001*), and reinstated from 2013 to the present. In 2015, phase-out increments are determined discretely in terms of $2,500 "steps." The computation linearizes the step function. The same pattern is assumed for all years in which phase-outs were in effect.

6. Source: IRS. Phase-outs are in effect as follows: 1999-2005, 3%; 2006-2007, 2%, 2008-2009, 1%; 2010-2012, 0%; 2013-present, 3% (*American Taxpayer Relief Act*, 2012). For 2015, the computation is based on the assumption that adjusted gross income (AGI) is too high to permit the deduction of medical/dental and casualty/theft expenses, that there are no gambling losses, and that investment funds are not borrowed.

7. Transformation.

8. Source: IRS. This figure is for the highest marginal income tax rate under AMT.

9. Source: IRS.

10. Transformation.

11. Source: IRS. For 2004 to 2014, data obtained from *SOI Tax Stats – Historic Table 2* (https://www.irs.gov/uac/soi-tax-stats-historic-table-2). For 1999 to 2003, only data for total returns are available from *SOI Tax Stats – Individual Income Tax Returns Publication 1304 (Complete Report)* (https://www.irs.gov/uac/soi-tax-stats-individual-income-tax-returns-publication-1304-complete-report#_tbla). For the 1999 to 2003 period, the ratio $\omega^{REG}$ in row 13 is estimated directly as the total returns ratio (REG / (REG + AMT) in year t divided by the total returns ratio in 2004, all multiplied by the high income ratio (REG / (REG + AMT) for AGI $\geq$ $200,000) for 2004. A comparison of the total returns data from the two different data sources for 2004 and 2005 indicates a very close match. The data for these computations are contained in the EXCEL file "Computing the REG Weight."

12. Same as 11.

13. Transformation.

14. Transformation.

## Table F2 -- Taxation Of Income From Treasury And Puerto Rican Bonds
## Regular And Alternative Minimum Tax (AMT) Regimes
## Data Series

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1999 | 0.3960 | 0.0519 | 0.4274 | 0.0000 | 0.0000 | 0.0128 | 0.4402 | 0.2800 | 0.0700 | 0.4019 | ------- | ------- | 0.6481 | **0.4267** |
| 2000 | 0.3960 | 0.0519 | 0.4274 | 0.0000 | 0.0000 | 0.0128 | 0.4402 | 0.2800 | 0.0700 | 0.4019 | ------- | ------- | 0.6468 | **0.4267** |
| 2001 | 0.3910 | 0.0519 | 0.4226 | 0.0000 | 0.0000 | 0.0127 | 0.4353 | 0.2800 | 0.0700 | 0.4019 | ------- | ------- | 0.6477 | **0.4235** |
| 2002 | 0.3860 | 0.0518 | 0.4178 | 0.0000 | 0.0000 | 0.0125 | 0.4303 | 0.2800 | 0.0700 | 0.4018 | ------- | ------- | 0.6439 | **0.4201** |
| 2003 | 0.3500 | 0.0518 | 0.3836 | 0.0000 | 0.0000 | 0.0115 | 0.3952 | 0.2800 | 0.0700 | 0.4018 | ------- | ------- | 0.6417 | **0.3975** |
| 2004 | 0.3500 | 0.0517 | 0.3836 | 0.0000 | 0.0000 | 0.0115 | 0.3951 | 0.2800 | 0.0700 | 0.4017 | 3.062 | 1.735 | 0.6382 | **0.3975** |
| 2005 | 0.3500 | 0.0514 | 0.3834 | 0.0000 | 0.0000 | 0.0115 | 0.3949 | 0.2800 | 0.0700 | 0.4014 | 3.589 | 2.202 | 0.6198 | **0.3973** |
| 2006 | 0.3500 | 0.0502 | 0.3826 | 0.0000 | 0.0000 | 0.0077 | 0.3903 | 0.2800 | 0.0700 | 0.4002 | 4.076 | 2.632 | 0.6076 | **0.3942** |
| 2007 | 0.3500 | 0.0499 | 0.3825 | 0.0000 | 0.0000 | 0.0076 | 0.3901 | 0.2800 | 0.0700 | 0.3999 | 4.572 | 2.923 | 0.6101 | **0.3939** |
| 2008 | 0.3500 | 0.0496 | 0.3823 | 0.0000 | 0.0000 | 0.0038 | 0.3861 | 0.2800 | 0.0700 | 0.3996 | 4.371 | 2.847 | 0.6056 | **0.3914** |
| 2009 | 0.3500 | 0.0500 | 0.3825 | 0.0000 | 0.0000 | 0.0038 | 0.3863 | 0.2800 | 0.0700 | 0.4000 | 3.930 | 2.725 | 0.5905 | **0.3919** |
| 2010 | 0.3500 | 0.0499 | 0.3824 | 0.0000 | 0.0000 | 0.0000 | 0.3824 | 0.2800 | 0.0700 | 0.3999 | 4.299 | 3.031 | 0.5865 | **0.3896** |
| 2011 | 0.3500 | 0.0502 | 0.3827 | 0.0000 | 0.0000 | 0.0000 | 0.3827 | 0.2800 | 0.0700 | 0.4002 | 4.710 | 3.285 | 0.5891 | **0.3899** |
| 2012 | 0.3500 | 0.0502 | 0.3827 | 0.0000 | 0.0000 | 0.0000 | 0.3827 | 0.2800 | 0.0700 | 0.4002 | 5.274 | 3.454 | 0.6043 | **0.3896** |
| 2013 | 0.3960 | 0.0502 | 0.4263 | 0.0380 | 0.0000 | 0.0128 | 0.4771 | 0.2800 | 0.0700 | 0.4382 | 5.597 | 3.214 | 0.6352 | **0.4629** |
| 2014 | 0.3960 | 0.0502 | 0.4263 | 0.0380 | 0.0000 | 0.0128 | 0.4771 | 0.2800 | 0.0700 | 0.4382 | 6.235 | 3.487 | 0.6413 | **0.4632** |
| 2015 | 0.3960 | 0.0502 | 0.4263 | 0.0380 | 0.0000 | 0.0128 | 0.4771 | 0.2800 | 0.0700 | 0.4382 | ------- | ------- | 0.6413 | **0.4632** |
| 2016 | 0.3960 | 0.0502 | 0.4263 | 0.0380 | 0.0000 | 0.0128 | 0.4771 | 0.2800 | 0.0700 | 0.4382 | ------- | ------- | 0.6413 | **0.4632** |
| Avg. 2000 2016 | 0.3681 | 0.0507 | 0.4001 | 0.0089 | 0.0000 | 0.0086 | 0.4177 | 0.2800 | 0.0700 | 0.4096 | ------- | ------- | 0.6230 | 0.4150 |

**Notes and Sources:**
See Notes and Sources to Table F1.

## Acknowledgement

Very useful comments and suggestions have been received from participants at the Annual Municipal Finance Conference (especially Tracy Gordon and Brad Setser), the International Symposium on Money, Banking and Finance (especially Clément Mathonnat), the American Economic Association Meetings (especially Ryan Leary and Jim Poterba), the Einaudi Institute of Economics and Finance (especially Francesco Lippi), the German Ministry of Finance's *Inaugural Fiscal Policy Seminar: Rethinking Market Discipline*, Goethe University (especially Alfons Weichenrieder), the Institute for Monetary and Economic Studies/Bank of Japan (especially Shouta Miki), the University of Chicago (especially Luigi Zingales), the University of Illinois at Chicago (especially Dominique Badoer and Andrew Hanson), and the University of Melbourne and from John Chalmers, Joan Farre-Mensa, David Hanson, Charles Kahn, Itay Goldstein, Rick Holzinger, John Hund, Helen Ladd, David Merriman, John Miller, Peter Orr, Andrey Pakhomov, Michael Pagano, Andrea Riquier, Alan Schankel, Barnet Sherman, David Sjoquist, Chris Sims, David Skeel, Mike Stanton, Stijn Van Nieuwerburgh, Sally Wallace, and Pierre Yared. Particular thanks is owed to Daisuke Ikeda for his careful reading of the entire manuscript. The author thanks the Booth School/University of Chicago, the Einaudi Institute of Economics and Finance, and the Institute for Monetary and Economic Studies for most hospitable environments in which to complete most of this research. Financial support from both organizations is gratefully acknowledged. All errors and omissions remain the sole responsibility of the author, and the conclusions do not necessarily reflect the views of organizations with which he is associated or who have supported this research.

## Declaration of Interests

This work has received financial support from the Booth School/University of Chicago and the Einaudi Institute of Economics and Finance. These funding sources had no role in study design, in the collection, analysis, and/or interpretation of the data, in the writing of the report, or in the decision to submit the article for publication. Researchers at both institutions have offered comments on preliminary drafts.