The Transmission of (sub)Sovereign Default Risk: Evidence from Puerto Rico*

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Abstract

Puerto Rico's unique characteristics as a U.S. territory allow us to examine the real effects of (sub) sovereign default risk. We conjecture that an increase in the sovereign default risk increases austerity risk, and the real economy contracts. The evidence suggests that in times of increasing default risk, industries with higher exposure to government demand experience significantly sharper declines in employment growth. In addition, fiscal austerity drives reduced output growth via a local fiscal multiplier effect. We also find evidence for a bank-lending channel where increased default risk leads to significant declines in employment in external finance dependent industries, and credit from non-Puerto Rican banks does not substitute for the reduced supply of local credit from Puerto Rican banks.

Keywords: Sovereign debt, default risk, government demand dependence, employment, external finance dependence.

JEL classifications: F3, F4, G15.

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1 Introduction

The global financial crisis and the subsequent debt crises highlight the heightened levels of sovereign default risk across the developed world. A large literature in international finance investigates the costs of sovereign default and default risk.[1] This paper uses Puerto Rico's debt crisis to develop a novel identification strategy to extract the real costs of (sub)sovereign default risk.

For most countries, it is difficult to isolate changes in sovereign default risk from changes in banking and/or currency crises risk or from the impact of government interventions involving private debt contracts. For example, in the most widely studied case of default of Argentina in 2001, the sovereign default crisis was inextricably linked to a concurrent banking and currency crisis (Perez (2015); Hébert and Schreger (2017)). In the case of Greece, the government intervened in the financial system, declaring a bank holiday, limiting deposit withdrawals, and imposing controls on capital outflows (Arellano et al. (2015)). Although Greece remained on the euro, the possibility of exit constituted ex-ante currency crisis risk.

Several factors make the case of Puerto Rico unique. First, as a U.S. territory, Puerto Rico cannot by law abandon the U.S. dollar, effectively eliminating currency crisis risk (U.S. Constitution, Article I, Sections 8 and 10). Second, Puerto Rico's banks are protected by the Federal Deposit Insurance Corporation and comprise a small share of the U.S. banking sector, thereby preventing bank runs and systemic financial risk. Further, according to the Puerto Rico Federal Relations Act of 1950 and the Contracts Clause of the U.S. Constitution, the Puerto Rican government does not have the legal authority to intervene in the banking system to limit deposit withdrawals or impose capital controls. The risk of a banking crisis is therefore de minimis. Third, Puerto Rican data standards conform to the U.S. mainland. An important advantage is that Puerto Rican data on macro-indicators such as employment are available at higher frequencies and disaggregated at the industry level. Puerto Rico's unique characteristics allow us to examine the channels through which (sub)sovereign default

[1] For example, Borensztein and Panizza (2009), Yeyati and Panizza (2011), Cruces and Trebesch (2013), Hébert and Schreger (2017). The related literature provides a more comprehensive list.

can have real effects on the macroeconomy.

We argue that Puerto Rico embodies a set of attributes that make it possible to treat it as an interesting (sub)sovereign. First, it has a constitution, and the ability to tax and create laws on local matters. In almost all of these aspects, Puerto Rico is very much a sovereign akin to U.S. states. However, in some respects it is more sovereign than U.S. states. For example, its subsidiaries, such as municipalities, cannot file for bankruptcy under Chapter 9 of the U.S. Bankruptcy Code.[2] Given its unique status as a U.S. territory, and similar to sovereign nations, the path to restructuring Puerto Rico's debt is therefore particularly unclear.

There are of course some ways in which Puerto Rico is not quite as sovereign as, for example, Greece. While local Puerto Rican laws govern Puerto Rico's bonds, Puerto Rico cannot-in contrast to Greece-quite so easily change its laws to reduce its debt. While it may have some latitude, the Contracts Clause provides U.S. constitutional protection on government interference with private contracts that constrain it more than the European laws perhaps constrained Greece (Commonwealth of Puerto Rico v. Franklin California Tax-Free Trust et al., October 2015).[3] Finally, while there is no possibility of an IMF bailout, there is always the possibility of a federal bailout, which could perhaps be much more significant.[4]

Against this background, this paper provides evidence for a government-demand driven channel for the transmission of sovereign default risk. To fix ideas, we develop a simple theoretical model that illustrates a mechanism connecting sovereign default risk with austerity risk. We do this by introducing sovereign borrowing into a two-period New Keynesian model of a small open economy (à-la Galí and Monacelli, 2005). To highlight the demand-driven transmission mechanism, we introduce multiple sectors with heterogeneous exposures to government demand. By negatively affecting the government's ability to finance spending

[2]Legally, while it is less clear what kind of sovereign immunity Puerto Rico has, it likely has some (Gulati and Weidemaier (2016)).

[3]In addition, enforcement is a real possibility in the case of Puerto Rico, where unpaid creditors can go to court with a real possibility of obtaining recovery, assuming there are some assets.

[4]We are grateful to Mitu Gulati for clarifying many of these details about Puerto Rico's sovereign status.

through borrowing, an increase in sovereign default risk increases the probability of fiscal austerity. In turn, the anticipation of austerity by agents has real effects on the economy. In particular, there is an adverse effect on employment in industries that are relatively more dependent on government demand.

We provide evidence for this mechanism using monthly employment data for Puerto Rican manufacturing industries.[5] We analyze the employment effects of increases in (sub) sovereign default risk by exploiting the cross-sectional variation in ex ante government demand dependence across industries. In other words, the methodology captures the ex ante exposure to default risk across industries based on government demand dependence.[6] The focus on ex ante exposure to default risk allows us to address the endogeneity concern that declines in economic activity may drive up the probability of default and thus confound the identification of employment effects due to rising default probabilities.

The empirical analysis draws on a variety of macro-economic, industry and financial markets databases. For example, GDP data come from both the Federal Reserve Economic Data (FRED) and from Puerto Rico's Government Development Bank (GDB) economic activity index. Annual fiscal balance data are from Puerto Rico's financial statements. default risk of the Puerto Rican government, we use credit default swap spread data from JP Morgan's Markit to calculate the five-year risk neutral cumulative default probability on the debt of the Commonwealth of Puerto Rico.

At the industry level, data on monthly employment by Puerto Rican manufacturers at the three-digit NAICS level come from the BLS Quarterly Census of Employment and Wages. Data to measure the dependence on Puerto Rican government demand and local demand for each three-digit NAICS manufacturing industry comes from the 2012 Economic Census of Island Areas of the U.S. Census Bureau. External finance dependence data are calculated from the COMPUSTAT database. To document the credit crunch in Puerto Rico, we retrieve

[5]We focus on manufacturers because our measure of government demand dependence is available for a relatively large number of industries in the this sector. In contrast, our measure of government demand dependence is only available for three non-manufacturing industries. Note than manufacturing comprises 45.8% of GDP and 68.7% of GNP from 2007-2016.

[6]And similar Rajan and Zingales (1998) for external finance dependence.

data on quarterly call reports from the FDIC.

The main findings are as follows. First, increased default probabilities on Puerto Rican government debt are associated with lower employment growth in industries that are relatively more exposed to Puerto Rican government demand. This finding is consistent with our theory, where default risk impacts austerity risk and agents rationally anticipate future austerity. Moreover, the finding is both statistically and economically significant.

Second, the magnitude of the negative effect of default risk on employment growth in government-demand-dependent industries increases when the government undertakes austerity measures. A potential rationale for this results is that agents learn about future government policy when they observe how austerity measures respond to increased default risk. Although not definitive proof of causality, Granger causality tests reveal that increased default risk drives austerity, indicating the government may undertake austerity in response to borrowing constraints.

Third, fiscal austerity is associated with reduced output growth in Puerto Rico via a local fiscal multiplier effect. This finding further supports the plausibility of our mechanism highlighting the real effects of default risk. Overall, the finding is also consistent with a broader literature that reports a negative relationship between austerity and growth (Auerbach and Gorodnichenko (2012); Jordá and Taylor (2016); Blanchard and Leigh (2014); Chari and Henry (2015); House and Tesar (2015)), in our case considering the interaction between (sub) sovereign default risk and austerity.

Our benchmark regression analysis provides evidence that increased default risk drives a relatively higher decline in government demand-dependent industries. An alternative explanation for our findings could relate to the widely explored transmission channel in the sovereign risk literature that operates through a reduction in bank lending or a credit crunch. That is, if Puerto Rican banks tend to hold Puerto Rican government debt on their balance sheets, then an increase in sovereign default risk could adversely impact the balance sheets of these banks and their ability to provide credit to the local economy. If the bank lending channel operates in Puerto Rico, and if dependence on government demand is correlated

with dependence on external finance, this may suggest that the contraction in employment for firms dependent on government demand could rather result from their dependence on external finance.

Here, we find that increased default probabilities are associated with contractions in employment growth in industries that are relatively more dependent on external finance. Given the degree of Puerto Rico's financial integration with the U.S., the finding that the credit crunch or bank lending channel operates is somewhat surprising. To further verify the plausibility of this mechanism we find that increased default risk Granger causes bank lending declines and that non-Puerto Rican banks do not step in to substitute for the reduced supply of local credit from Puerto Rican banks. We also confirm that a (sub) sovereign ceiling channel operates, further substantiating the existence of a credit crunch. However, it is worth pointing out that although we find evidence for the external finance channel, our benchmark finding that there is a negative relationship between increased default risk and relative declines in employment growth in government-demand dependent industries is quantitatively strengthened by controlling for the bank lending channel.

We conduct several robustness checks to confirm our benchmark results. We find that the results are robust to substituting yield spreads on Puerto Rican debt for the imputed default probabilities and restricting the sample to the post-U.S. financial crisis period. We control for industry-level exposures to recession risk, the population and housing price declines in Puerto Rico, as well as different types of industry-level shocks, and we find that the main results are robust to these alternative specifications.

Related literature: Our paper is closely related to the empirical literature on the costs of sovereign default. To the best of our knowledge, our paper is the first to estimate the economic costs of the risk of default in the case of Puerto Rico. By using high-frequency data, our analysis complements Hébert and Schreger (2017), who exploit a legal ruling to estimate the cost of the risk of default in the case of Argentina. Our case study of Puerto Rico also complements Zettelmeyer et al.'s (2013) case study of the recent Greek default

episode.

Our paper adds to the earlier literature that uses data at lower frequencies. For surveys of this literature, see Borensztein and Panizza (2009), Tomz and Wright (2013), and Reinhart and Trebesch (2016). For instance, Yeyati and Panizza (2011) suggest that output contractions tend to precede defaults and that output starts growing after the quarter in which the default took place, indicating that the costs of default are likely to be driven by anticipation. Arteta and Hale (2008) and Fuentes and Saravia (2011) document that default episodes are associated with declines in foreign credit to the defaulting countries' private sector and declines in foreign direct investment. In contrast, using longer historical data, Tomz and Wright (2010) find that sovereigns rarely defaulted and expropriated foreign investment at the same time. Cruces and Trebesch (2013) document that defaults with larger haircuts are associated with longer periods of exclusion from international financial markets. On the political side, Borensztein and Panizza (2009) and Livshits et al. (2014) find that sovereign defaults are associated with increases in the turnovers of incumbent politicians.

The paper is related to the large theoretical literature on sovereign debt, which can be traced back to Eaton and Gersovitz (1981) and Bulow and Rogoff (1989). More recent quantitative models include Aguiar and Gopinath (2006), Arellano (2008), Mendoza and Yue (2012), and Perez (2015); for a recent survey, see Aguiar et al. (2014).

The paper also contributes to existing studies on the effect of sovereign risk on bank loan supply. Popov and Van Horen (2015) show that banks that were holding risky sovereign debt from Southern European countries, but were incorporated in countries largely unaffected by the sovereign debt crisis suffered value losses on their sovereign debt holdings, leading to a reduction in loan supply. De Marco (2016) also finds evidence that the deterioration in the value of risky sovereign debt led to a reduction in bank loan supply during the European sovereign debt crisis. Becker and Ivashina (2018) document that firms with access to the bond market switch from bank to bond financing if their bank is negatively affected by the sovereign debt crisis. Bofondi et al. (2017) show that Italian banks reduced credit supply due to an increase in their funding cost during the sovereign debt crisis.

Our paper is also closely related to a smaller literature on the transmission of sovereign risk via reduced bank loan supply to the employment of affected firms. Using annual data, Balduzzi et al. (2015) shows that the adverse effect of sovereign risk on the balance sheets of banks is associated with reduced employment by affected firms. Also using annual data, Acharya et al. (2018) document that both the reduction in the value of sovereign debt holdings as well as an active increase in the holdings of risky sovereign debt led to a lending contraction and negative real effects for bank dependent firms during the European sovereign debt crisis. Our paper adds to this literature by using the unique natural experiment of Puerto Rico and higher frequency monthly employment data.

The paper proceeds as follows. Section 2 provides a brief historical background and discusses a time line of the Puerto Rican debt crisis. Section 3 provides a simple theoretical model to motivate the empirical analysis. Section 4 presents the data. Section 5 establishes the relationship between default risk and employment growth in industries relatively more dependent on government demand. Section 6 presents additional tests and robustness checks, and explores alternative explanations. Section 7 concludes.

2 Background: The Puerto Rican Debt Crisis

After ceding to the U.S. in 1898 at the end of the Spanish-American War, Puerto Rico officially became a U.S. Commonwealth in 1952. Since then, the island operates under U.S. judicial, monetary, and tariff systems. About the size of Ireland, Puerto Rico had a dense population of 3.5 million in 2014. If it were a U.S. state, Puerto Rico would be the 29th most populous state. The island's GDP experienced several decades of catch-up growth relative to the mainland after World War II, especially after the passing of several tax reform acts, particularly the passage of Section 936 of the Tax Reform Act of 1976. Section 936 granted federal tax exemptions to U.S. corporations on income originating in U.S. territories.[7] At the same time, the Puerto Rican government granted foreign subsidiaries a tax exemption

[7]See Collins et al. (2007)

on state taxes if the income was repatriated in the form of dividends. Given the attractive tax breaks, a number of U.S. mainland-based corporations established subsidiaries in Puerto Rico. However, in 1996, given concerns about tax avoidance, the Clinton administration signed legislation that phased out Section 936, to be fully repealed by 2006. Meanwhile, the triple tax exempt status of Puerto Rican debt and Puerto Rico's constitutional guarantee that general obligation debt be paid before any other liability fueled an increase in Puerto Rico's debt-to-GNP ratio.

Following the repeal of Section 936, multinational investment in Puerto Rico declined sharply and the economy fell into a recession from which it is yet to recover (see Serrato (2018)). Yields on Puerto Rican debt began rising sharply as Puerto Rico's debt surpassed 100% of GNP in 2012; yields spiked sharply in 2013, with subsequent years marked by continued downgrades of Puerto Rico's credit rating, which reached junk status in 2014. Puerto Rican yields continued to increase in 2014 and 2015, making it more costly for Puerto Rico to roll over its debt and indicating increased risk of default.

Despite the impending default, Puerto Rico is not allowed access to Chapter 9 of the U.S. Bankruptcy Code under which municipalities of U.S. states, like Detroit, can declare bankruptcy and restructure their debt. Nevertheless, the Contracts Clause of the U.S. Constitution prevents states from passing local laws binding creditors to accept losses. However, Puerto Rico passed several local laws aimed at creating a legal framework for agencies of Puerto Rico to restructure their debt, most notably the Puerto Rico Public Corporations Debt Enforcement and Recovery Act of June 28, 2014. The law was modeled after Chapter 9 of the U.S. bankruptcy code. Puerto Rico argued that if its status as a non-state prevented it from accessing Chapter 9, then it should also be exempt from the Contracts Clause that applies to states.

On June 28, 2015, the governor of Puerto Rico announced that the $72 billion stock of debt was not payable,[8] and on June 29, 2015, Standards and Poors (2015) downgraded the general obligation bonds of Puerto Rico to 'CCC-' and wrote, "The downgrades are

[8]http://www.nytimes.com/2015/06/29/business/dealbook/puerto-ricos-governor-says-islands-debts-are-not-payable.html

based on our view that a default, distressed exchange, or redemption of the commonwealth's debt appears to be inevitable within the next six months absent unanticipated significantly favorable changes in the issuers' circumstances." Meanwhile, the U.S. district court in Puerto Rico, the U.S. First Circuit Court of Appeals, and ultimately the Supreme Court on June 13, 2016, struck down the Puerto Rico Public Corporations Debt Enforcement and Recovery Act, determining that Puerto Rico was a state for purposes of the Contracts Clause and not a state for purposes of access to Chapter 9. Following the Supreme Court ruling, the matter of Puerto Rico's inevitable inability to meet its obligations was left to the U.S. Congress.

On June 30, 2016, the U.S. Congress passed PROMESA, establishing a formal legal framework for Puerto Rico to restructure its debt. Puerto Rico formally defaulted the next day, missing $779 million dollars in payments on its general obligation debt. PROMESA placed a stay on any litigation against Puerto Rico relating to default and established a court-supervised restructuring process based on Chapter 9, with the additional stricture that any restructuring plan must be the most favorable legally obtainable by creditors. PROMESA also placed Puerto Rico's budget under the authority of a seven-person oversight board with the goal of balancing Puerto Rico's budget.

The story of the run up to Puerto Rico's default provides unique data and identification and yet is not unfamiliar. Puerto Rico's final default on June 30, 2016, was preceded by several years of economic malaise and legal and political uncertainty relating to the form that Puerto Rico's default would take. Figures 2 and 3 show that Puerto Rico is no exception to the pattern of pre-default declines in activity typically observed in the years leading up to sovereign defaults in emerging markets. Figure 3 also shows that yields on Puerto Rico's debt increased substantially in the years preceding its default, indicating significant anticipation of the default event. The data are consistent with the hypothesis of Yeyati and Panizza (2011) that the typically observed pattern of pre-default declines in output and employment are likely driven by default anticipation "independently of whether or not the country ultimately decides to validate it."

If the hypothesis that anticipation of Puerto Rico's default led to a decline in aggregate

activity holds, we would expect that the timing of the divergence of Puerto Rico's activity from that of the U.S. mainland coincides with an increase in Puerto Rico's default risk. We can test whether the aggregate data are consistent with the hypothesis that default anticipation coincides with a decline in real aggregate activity in Puerto Rico as follows.

We conduct a difference-in-difference analysis of quarterly private employment growth, quarterly economic activity growth, and annual investment spending growth for 2006-2012 versus post-2012.[9] Our control group for the post-2012 period begins in 2006 as we attempt to identify the effect of Puerto Rico's increased default risk on the cointegrating relationship between Puerto Rico's economy and the U.S. economy following the repeal of Section 936. Therefore we limit the pre-2012 period to the years following the full repeal.

The full results and details of our analysis are available in Appendix B. The data suggest that in the post-2012 period, the cointegrating relationship of real activity in Puerto Rico and the U.S. mainland appears to break down. The data appear consistent with the hypothesis that the continued contraction in Puerto Rico's economy post-2012 was due to Puerto Rico specific shocks, rather than shocks originating from the U.S. mainland. Further, recall that the post-2012 period coincides with a significant increase in anticipation of a Puerto Rican default. In what follows, we investigate the potential channels through which increased default anticipation can have real effects on Puerto Rico's economy.

3 A Simple Model

Before embarking on the empirical analysis, it is useful to motivate our main hypothesis through the lens of a simple theoretical model. We introduce sovereign borrowing into a two-period New Keynesian model of a small open economy (à-la Galí and Monacelli, 2005). A key ingredient is the introduction of multiple sectors with heterogeneous exposure to government demand. in The model, which is deliberately simple and abstract, highlights how an increase in the Puerto Rican default risk negatively affects the island government's

[9] As Section 4.1 describes, economic activity growth is quarterly real GDP growth for the U.S. and quarterly growth in the economic activity index from Puerto Rico's GDB for Puerto Rico.

ability to borrow to finance government spending, which then negatively affects industries that are more dependent on government demand.

3.1 Environment

Consider a small open economy with a representative household and a benevolent government. To focus on the link between government borrowing and government spending, we assume for simplicity that only the government has access to an international credit market. This credit market is populated by competitive risk-neutral lenders with deep pockets who discount the future at an exogenous risk-free rate $1 + r^*$.[10] The government uses tax and sovereign borrowing to finance its spending. The household provides up to $\bar{h}$ units of labor inelastically to competitive domestic firms in two sectors that differ in the degree of exposure to the demand that comes from government spending. We denote by m the more exposed sector and by l the less exposed sector.

Following Benigno (2015), we develop the analysis in a two-period setting, which is sufficient to characterize the intertemporal dimension. The first period represents the short run, where there is nominal rigidity. We assume a very simple form of rigidity: the nominal wage in the short run is fixed at an exogenous level $\bar{W}$, and thus there can be involuntary unemployment. The second period represents the long run, where wages can flexibly adjust to clear the labor market.

3.1.1 Households

The representative household derives utility from the consumption C_m and C_l of the domestic goods produced by the two sectors, the consumption an imported foreign good C_f, and from the public good G provided by the government. Their utility is given by:

$$u(C) + v(G) + \beta E[u(C') + v(G')],$$

[10]For the case of Puerto Rico, most of external borrowing comes from the U.S.; as Puerto Rico is a small economy relative to the U.S., it is reasonable to assume that Puerto Rican economic activities do not affect the safe U.S. interest rate, represented by $1 + r^*$.

where the superscript $'$ denotes variables in the long run, $0 < \beta < 1$ denotes the subjective discount factor, u and v are utility functions satisfying the usual conditions ($u', v' > 0, u'', v'' \leq 0$), and the composite consumption is given by a simple Cobb-Douglas aggregation:

$$C = \left[(C_m)^{1-\lambda}(C_l)^{\lambda}\right]^{1-\chi}(C_f)^{\chi},$$

and similarly for C', where λ and χ are consumption share parameters lying in $(0, 1)$.

The household supplies up to $\bar{h}$ units of labor inelastically to the labor market. In the short run, because the nominal wage is fixed at $\bar{W}$, the labor market may not clear and the household will simply supply labor $h \leq \bar{h}$ to match the demand of firms (more on this later). In the long run, the labor market clears and $h' = \bar{h}$. The household owns firms but does not have access to the international financial market. Their budget constraint is

$$P_m C_m + P_l C_l + P_f C_f = \bar{W}h + \Pi - T$$

in the short run, and is

$$P'_m C'_m + P'_l C'_l + P'_f C'_f = W'\bar{h} + \Pi' - T'$$

in the long run, where $P_m, P_l, P_f, P'_m, P'_l, P'_f$ are the prices of the goods, Π and Π' are the profits from firms, and T and T' are lump sum taxes imposed by the government.

3.1.2 Firms

Domestic firms in each sector $j \in \{m, l\}$ are competitive. In each period, taking prices as given, they hire labor from an integrated labor market to maximize profit. The optimization problem in the short run is

$$\Pi_j = \max_{h_j} P_j Y_j - W h_j$$

subject to production function $Y_j = Ah_j^{\alpha}$ where $\alpha \in (0,1)$ is a parameter and $A > 0$ is the common TFP for all firms in the short run. More succinctly, they solve:

$$\Pi_j = \max_{h_j} P_j A h_j^{\alpha} - \bar{W} h_j.$$

The problem in the long run is similar:

$$\Pi'_j = \max_{h'_j} P'_j A' h_j'^{\alpha} - W' h'_j.$$

It is straightforward to derive the labor demand from each sector in the short run as:

$$h_j = \left(\frac{P_j A}{\bar{W}}\right)^{\frac{1}{1-\alpha}}, j \in \{m, l\}$$

and the aggregate labor demand is simply

$$h = h_m + h_l.$$

Remark: For simplicity we have abstracted away from capital in the production function. Introducing capital into the model may enrich the result, as an increase in the default risk may negatively affect the ability of firms to obtain capital and thus further reduce employment.

3.1.3 Nominal Rigidity

As aforementioned, the wage in the short run is fixed at a predetermined level $\bar{W}$ and as a consequence the labor market may not clear. We focus on parameter values such that in equilibrium there is rationing in the labor market in the short run, that is $h < \bar{h}$. By assumption, the representative household supplies labor to meet the demand from firms. Therefore, equilibrium employment in the short run is determined by the aggregate demand for labor.

There is, however, no nominal rigidity in the long run and thus the labor market clears

in that period: $h' = \bar{h}$.

3.1.4 Foreign Good and Foreign Demand

The imports and exports of the economy come from the demand for the foreign good and the foreign demand for the domestically produced goods. Regarding the imported foreign good, we assume for simplicity that the law of one price holds, that is $P_f = eP_f^*$ (and similarly in the long run), where P_f is the price of the foreign good in the local currency, P_f^* is the price in the foreign currency (dollar), and e is the exchange rate. Since the local currency for Puerto Rico is also the dollar, we set $e = 1$. For further simplicity, we normalize $P_f^* = P_f^{*'} = 1$. Thus, the price of the foreign good is always one: $P_f = P_f' = 1$.

Regarding the export of domestic goods, following Galí and Monacelli (2005), we assume that there is an exogenously given foreign demand curve for the goods. The foreign demand for each domestic good $j \in \{m, l\}$ is given by

$$X_j = \zeta P_j^{-\rho},$$

and

$$X_j' = \zeta' P_j^{'-\rho}$$

where ζ and ζ' are positive constants and $\rho > 0$ is an elasticity parameter.

3.1.5 The Government and International Creditors

The government provides the public good using the domestic goods as inputs.[11] An important assumption is some domestic inputs are more necessary for the provision of the public good than others. For simplicity, we assume that *only* inputs from sector m is needed in this process. This is a stark way to model the fact that some sectors in the domestic econ-

[11] We could assume that the provision of the public good requires the foreign good as well, without qualitatively changing the result of the model.

omy, represented here by sector m, are more exposed to government demand than others.[12] Specifically, we assume the following production function for the public good:

$$G = f(G_m), \quad G' = f(G'_m),$$

where G_m is the input of goods from the m sector, and f is a strictly increasing and weakly concave function.

The government can impose lump sum taxes on the representative household and can issue sovereign bonds in the international credit market. To model limited fiscal capacity in a simple way, we assume that the government can raise at most $\bar{T}$ and $\bar{T}'$ in taxation in the short and long run, respectively. In the short run, it chooses the quantity B of one-period non-contingent bonds to issue to international creditors at a price schedule q. The government budget constraint in the short run is:

$$P_m G_m \leq \bar{T} + qB. \tag{1}$$

In the beginning of the long run period, after learning the realization of the TFP A', the government decides to either repay the outstanding amount of debt B or default on it. If it repays, the budget constraint in that period will be:

$$P'_m G'_m \leq \bar{T}' - B.$$

If it defaults, we assume for simplicity that the country will receive an exogenous continuation pay off $\underline{V}$.[13] We focus on parameter values such that the government budget constraints will be binding in equilibrium.

As mentioned before, international creditors are competitive, risk-neutral and have deep

[12] We could more flexibly assume that the provision of the public good requires inputs from both sectors m and l but at different intensity, for example, $G = \left(\gamma_m G_m^{1-\frac{1}{\epsilon}} + \gamma_l G_l^{1-\frac{1}{\epsilon}}\right)^{\frac{\epsilon}{\epsilon-1}}$, where $\gamma_m > \gamma_l > 0$. The result would not change qualitatively.

[13] For concreteness, we could set $\underline{V}$ as the continuation payoff for the representative household if an exogenous fraction of economic output is lost due to default.

pockets, and discount the future at the world risk-free interest rate $1 + r^*$. The bond price is thus simply:

$$q = \frac{1 - \Pr(def)}{1 + r^*}$$

where def is the default dummy, which takes the value of one should there is a default in the long run and zero otherwise, and $\Pr(def)$ is the probability of default on the outstanding debt in the long run that is rationally expected by the creditors. Note that in this setup, the spread between the interest rate that the government faces and the safe interest rate is simply $\Pr(def)$.

3.2 Competitive Equilibrium

Given government policies G, G', B and def, a *competitive equilibrium* consists of prices and quantities that satisfy the optimization of the representative household, of the competitive firms, the labor market clearing in the long run, and the good market clearing conditions. Given the competitive equilibrium quantities and prices that are functions of its policies, the government in the long run chooses def and G' to maximize the representative household's continuation value conditional on the long-run TFP A', and in the short run it chooses G and B to maximize the lifetime expected utility of the representative household.

As the solution to the competitive equilibrium in the long run is straightforward, we focus our analysis on the short run, where there is nominal rigidity and labor market rationing. The short run equilibrium quantities h_m, h_l, C_m, C_l, C_f and prices P_m, P_l solve the following

system of equations:

$$\begin{aligned}
G_m + C_m + \zeta P_m^{-\rho} &= A h_m^{\alpha} \\
C_l + \zeta P_l^{-\rho} &= A h_l^{\alpha} \\
P_m C_m + P_l C_l + C_f &= P_m A h_m^{\alpha} + P_l A h_l^{\alpha} - \bar{T} \\
C_f &= \chi(P_m C_m + P_l C_l + C_f) \\
P_m C_m &= (1-\chi)(1-\lambda)(P_m C_m + P_l C_l + C_f) \\
h_m &= \left(\frac{P_m A}{\bar{W}}\right)^{\frac{1}{1-\alpha}} \\
h_l &= \left(\frac{P_l A}{\bar{W}}\right)^{\frac{1}{1-\alpha}}.
\end{aligned}$$

The first two equations are the market clearing conditions for the two goods. Notice that government spending affects the two sectors asymmetrically. The third equation is the budget constraint of the representative household. The fourth and fifth equations describe the optimal consumption basket for the household. The last two equations are the optimal labor demand for firms in the two sectors.

Combined with the government budget constraint (1), which will hold with equality in equilibrium, the system of equations above can be collapsed into a system of just two equations in two unknowns h_m and h_l:

$$\begin{aligned}
\overbrace{(1-\lambda)\frac{1-\chi}{\chi}\left(qB + \bar{\omega} h_m^{(1-\alpha)(1-\rho)} + \bar{\omega} h_l^{(1-\alpha)(1-\rho)}\right)}^{\text{domestic demand}} + \overbrace{\bar{\omega} h_m^{(1-\alpha)(1-\rho)}}^{\text{foreign demand}} + \overbrace{\left(\bar{T} + qB\right)}^{\text{gov demand}} &= \overbrace{\bar{W} h_m}^{\text{supply}} \quad (2) \\
\lambda\frac{1-\chi}{\chi}\left(qB + \bar{\omega} h_m^{(1-\alpha)(1-\rho)} + \bar{\omega} h_l^{(1-\alpha)(1-\rho)}\right) + \bar{\omega} h_l^{(1-\alpha)(1-\rho)} &= \bar{W} h_l \quad (3)
\end{aligned}$$

where $\bar{\omega} \equiv \left(\frac{\bar{W}}{A}\right)^{1-\rho} \zeta$ is a constant. These are the two good market clearing conditions for the two sectors. The right-hand-side terms $\bar{W} h_m$ and $\bar{W} h_l$ correspond to the nominal value of output (supply) in each sector. The term $qB + \bar{\omega} h_m^{(1-\alpha)(1-\rho)} + \bar{\omega} h_l^{(1-\alpha)(1-\rho)}$ on the left-hand sides corresponds to the total nominal spending $P_m C_m + P_l C_l + C_f$ by the household

(domestic demand). The second terms $\bar{\omega}h_m^{(1-\alpha)(1-\rho)}$ and $\bar{\omega}h_l^{(1-\alpha)(1-\rho)}$ correspond to the values of exports by the two sectors (foreign demand)

In equation (2), the term $\bar{T}+qB$ corresponds to the government demand for the good produced by sector m. The term represents how the government spending asymmetrically affects the demand and thus employment in the two sectors. From (2) and (3), it is straightforward to show that a negative shock to the government demand $\bar{T}+qB$ will reduce short-run employment in the competitive equilibrium, especially in sector m. As shown in Proposition 1 below, an increase in the default risk will reduce the bond revenue qB in equilibrium, hence reduce government spending and equilibrium employment in the short-run.

Figure 1 provides an illustration for the determination of the short-run equilibrium employment. The red and blue solid curves plot equations (2) and (3) respectively in the $h_m \times h_l$ plane. The dashed curves plot what happens to the competitive equilibrium when there is a negative shock to qB. As seen in the figure, due to the shock, employment contracts in both sectors as the competitive equilibrium shifts from point E to $\tilde{E}$. However, the contraction is much more pronounced in sector m, as the reduction in government spending directly hits this sector (as captured by the reduction in the term qB in (2)).

Based on the short-run competitive equilibrium that is characterized by equations (2) and (3), it is straightforward to establish the following comparative statics result:

Proposition 1. *An increase in the default risk reduces the competitive equilibrium employment in the short run, with the effect stronger on sector m that is more exposed to government demand. Specifically, a negative shock to the default value*[14] $\underline{V}$ *raises* $\Pr(def)$ *and reduces* h_l *and especially* h_m*:*

$$\frac{\partial h_m}{\partial \underline{V}} < \frac{\partial h_l}{\partial \underline{V}} < 0.$$

Proposition 1 highlights a direct link between the default risk and austerity risk, and it provides the key testable implication of the model: that an increase in the default risk would disproportionately and negatively affect employment in economic sectors that are

[14] We could also consider a negative shock (in the first-order stochastic dominance sense) to the distribution of the long-run TFP A', which also increases the default risk.

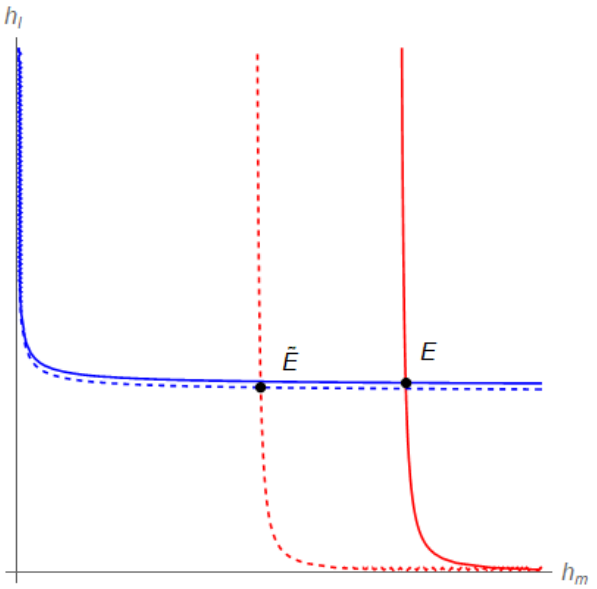


Figure 1: Effect of a negative shock to sovereign borrowing ($qB \downarrow$): short-run equilibrium moves from point E to point $\tilde{E}$.

more dependent or exposed to government demand. We will now test this implication for the case of Puerto Rico.

4 Data

4.1 Macro Data

To assess the effect of Puerto Rico's crisis on the cointegrating relationship of Puerto Rico's economy with the U.S., we collect macroeconomic data for Puerto Rico and the U.S. from 2006 until the most recent available, which varies by series. Data on U.S. quarterly seasonally adjusted real GDP in chained 2009 dollars comes from the Federal Reserve Economic Data (FRED) and runs from 2006:Q1-2016:Q2. As quarterly Puerto Rican GDP data are not available, we measure quarterly Puerto Rican economic activity using the monthly Government Development Bank (GDB) economic activity index, aggregated to the quarterly level using averages, and seasonally adjusting the data with Census X-13.[15] The economic activity index is also available from 2006:Q1 to 2016:Q2 and tracks the behavior of four

[15]Census X-13 fits an ARIMA model to a time series to perform a seasonal adjustment. See https://www.census.gov/srd/www/x13as/

major monthly economic indicators: total nonfarm payroll employment, cement sales, gasoline consumption, and electric power generation. Data on total private employment from the U.S. and Puerto Rico are available from 2006:Q1 to 2016:Q2 and comes from the BLS Employment, Hours, and Earnings section of the Current Employment Statistics Survey. We aggregate the raw monthly data to quarterly values by taking the average and again seasonally adjusting with Census X-13. Data on annual real investment spending for Puerto Rico and the U.S. come from the IMF's World Economic Outlook and are available from 2006 to 2015.

To document the credit crunch in Puerto Rico, we retrieve data on quarterly call reports from the FDIC for the five banks headquartered in Puerto Rico: Banco Santander Puerto Rico, Scotiabank de Puerto Rico, FirstBank Puerto Rico, Oriental Bank, and Banco Popular de Puerto Rico. We collect data on total assets, commercial and industrial loans, and bank exposure to states and political subdivisions in the U.S. via direct loans and ownership of securities, and total capital. We do not have complete data indicating what share of these items are associated with Puerto Rican government entities as opposed to other U.S. issuers. However, as Oriental Bank also files 10-K reports with the SEC, we confirm that all of Oriental's exposure to states and political subdivisions in the U.S. comes from Puerto Rican municipal issuers. We also collect data on annual total loans and leases by Puerto Rican and non-Puerto Rican banks from the Commissioner of Financial Institutions of Puerto Rico.

We extract data about Puerto Rico's annual fiscal balance from the "Statement of Revenue, Expenditures, and Changes in Fund Balances: Governmental Funds" in Puerto Rico's financial statements. Total revenues and expenditures are adjusted to remove intergovernmental transfers, debt service/issuance costs, and interest revenues. We then convert these nominal series to 2016 dollars using U.S. CPI. To investigate the effect of Puerto Rico's discretionary fiscal balance, we calculate the cyclically adjusted primary balance ($CAPB$) detailed in Fedelino et al. (2009). $CAPB$ measures the structural or discretionary component of the government primary balance (revenues minus expenditures) by accounting for the cyclical nature of automatic spending stabilizers and revenues. The cyclical adjustment

is accomplished by measuring the output gap and adjusting the primary balance as follows:

$$\frac{CAPB}{Y_p} = capb = \frac{R}{Y} - \frac{G}{Y_p} \tag{4}$$

where Y is output, Y_p is potential output, R is government revenues, and G is government expenditures.[16] R and G are derived from Puerto Rico's financial statements and adjusted as noted above. To calculate Y and Y_p we rely on an HP filter and Puerto Rico's GNI from the World Bank. We also convert GNI to 2016 dollars using U.S. CPI. As the HP filter's calculation of Y_p is most reliable with a long time series and away from the beginning and end of the time series, we fit the HP filter with the standard annual sensitivity parameter ($\lambda = 100$) to the log of Puerto Rico's real GNI from 1990-2015. We construct Y_p by extracting the trend in log real GNI from the HP filter's output and taking its exponent. With these data, we calculate *capb* described in equation (4).

4.2 Industry-level Data

In order to study the effect of default risk on employment across industries according to exposure to default risk, we collect data on industry-level employment in manufacturing, industry-level dependence on external finance, and industry-level dependence on government demand for all available time periods from 2000-2016. Data on the monthly employment of Puerto Rican manufacturers at the three digit NAICS level comes from the BLS Quarterly Census of Employment and Wages and is available from 2000 to 2016. This provides data on 19 manufacturing industries. More granular levels of the NAICS classification system reduce the coverage of manufacturing employment in Puerto Rico. We seasonally adjust the time series of employment for each three digit industry using the Census X-13 program.

Data to measure the dependence on Puerto Rican government demand (GOV) for each three digit NAICS manufacturing industry comes from the 2012 Economic Census of Island Areas of the U.S. Census Bureau. The Census provides the share of products shipped and

[16] Note this equation requires standard assumptions about the elasticities of revenue and expenditure with respect to the output gap. See Fedelino et al. (2009).

contract receipts within Puerto Rico by class of customer for manufacturing industries and the value of products shipped and contract receipts by product destination for manufacturing industries, including the share shipped within Puerto Rico. To calculate GOV, we multiply each industry's share of Puerto Rican products shipped and contract receipts to the Commonwealth government by the industry's share of products shipped and contract receipts within Puerto Rico to arrive at each industry's share of total sales to the Puerto Rican government. That is, we calculate the ratio:

$$GOV = \frac{\text{Sales to P.R. Government}}{\text{Total Sales}} \tag{5}$$

We focus on manufacturing because our measure of government demand dependence is available for a relatively large number of industries. In contrast, our measure of government demand dependence is only available for three services industries. On average, manufacturing comprises 45.8% of GDP and 68.7% of GNP from 2007-2016. Table A.1 shows GOV, our measure of government demand dependence, for the three-digit NAICS manufacturing industries for which we have data.

Data measuring the dependence on Puerto Rican demand (LD) of each three digit NAICS manufacturing industry comes from the 2012 Economic Census of Island Areas of the U.S. Census Bureau. The Census provides the share of products shipped and contract receipts by product destination. We calculate the ratio:

$$LD = \frac{\text{Sales within P.R.}}{\text{Total Sales}} \tag{6}$$

Data on annual manufacturing output of each three digit NAICS manufacturing industry comes from the Puerto Rico Planning Board. The data is adjusted for inflation to 2016 U.S. dollars using U.S. CPI.

To measure dependence on external finance at the three digit NAICS level, we use the

method described in Rajan and Zingales (1998). That is, we calculate the ratio:

$$EXTFIN = \frac{CAPEX - CFOPER}{CAPEX} \tag{7}$$

where $CAPEX$ is total capital expenditures and $CFOPER$ is total cash flows from operations of a given firm over the period 2000-2015. We calculate the ratio for all U.S. firms in the Compustat database over the period 2000-2015, taking the median for each industry at the three digit NAICS level. See Appendix A.2 for a more detailed description of the construction of $EXTFIN$. Table A.2 shows $EXTFIN$ for the three-digit NAICS manufacturing industries for which we have Puerto Rican employment data. For robustness, we also utilize the pre-crisis estimation period of 1995-2005 and the narrower period of 2005-2015 to calculate $EXTFIN$. The two alternative estimation periods have correlations of over 0.9 with the benchmark period.

4.3 Financial Market Data

To measure the default risk of the Puerto Rican government, we use the credit triangle method of White (2013) and credit default swap spread data from JP Morgan's Markit to calculate the five-year risk neutral cumulative default probability on the debt of the Commonwealth of Puerto Rico.[17] That is, the probability of default within five years. The raw data are daily and run from May 2008 to November 2015. Although the data include spreads on contracts ranging from six months to 30 years, there are substantial gaps for all horizons except five years.[18] Due to these gaps, we use the spreads and recovery rates on five-year credit default swaps to approximate the default probability implied by the five year

[17]The credit triangle method assumes the premium leg of the CDS contract is paid continuously and the hazard rate is constant.

[18]The gaps for contract lengths other than five years results from the fact that the five-year contract is the most popular contract length and the resulting low trading frequency for less popular contract lengths.

contract as follows:

$$\lambda = \frac{S_5}{1 - R} \tag{8}$$

$$P(\text{default within 5 years}) = 1 - \exp(-5\lambda) \tag{9}$$

where λ is the hazard rate, S_5 is the par spread paid for five years of insurance against default, and R is the average recovery rate reported by dealers contributing to Markit. We then generate ΔDEF as the change in the monthly average of the probability of default.

To measure the effect of changes in Puerto Rico's credit risk on private borrowing costs, we collect stock return data for publicly traded companies with primary operations in Puerto Rico. There are four publicly traded companies with primary operations in Puerto Rico and a time series of returns covering the span of the rating and legal events we use to identify changes in Puerto Rico's credit risk. These are: OFG Bancorp (OFG), Banco Popular (BPOP), First Bancorp (FBP), and the health insurer Triple-S Management Corp. (GTS). We collect daily return data on these four firms and the S&P 500 index from 2010-2016. Of course, these four companies are not a representative sample of firms in Puerto Rico. However, this feature is an advantage for our identification strategy. As publicly traded companies with audited financial statements, these companies are large and transparent, thus allowing relatively frictionless access to U.S. capital markets. For such firms, we can reasonably treat the supply of funds as perfectly elastic at the risk-adjusted rate.

To measure the effect of changes in Puerto Rico's credit risk on public borrowing costs, we collect data on the yields of all general obligation debt issued by the Commonwealth of Puerto Rico outstanding during some part of the 2010-2016 period from Bloomberg. We treat stale observations of yield as missing values. That is, if the reported yield of a security does not change on a given day, this is classified as a missing observation.[19] We exclude insured bonds as these embed the credit risk of the insurer. We also exclude bonds that are pre-refunded, as these bonds become risk free when refunded. This results in a sample of

[19]This is standard practice in the finance literature. See for example, Duffee (1998).

471 securities that meet these restrictions and have yield data during at least some of the events we use to identify changes in credit risk. For each security issue, we compute the daily yield spread as the difference between the tax-adjusted yield on the issue and the yield on a Treasury security with the same number of months remaining until maturity, retrieved from FRED.[20]

5 Default Risk, Austerity and Employment

Section 2 provides suggestive evidence that an increase in the risk of default is associated with decline in economic activity, particularly in employment. However, problems of reverse causality plague studies that examine whether finance matters for the real economy or how financial crises affect the real economy (e.g., Levine (2005); Mendoza and Terrones (2008); Laeven and Valencia (2013)). To identify causality, we focus on the differential effect of default risk on sensitive private industries, particularly those more dependent on the government as a client. Ideally, we would use firm-level data on dependence on government demand and employment but these data are only available at the industry-level. We adopt a difference-in-difference approach used by Rajan and Zingales (1998) to study the effects of finance on growth and subsequently by Dell'Ariccia et al. (2008) to study the real effects of banking crises.

We evaluate the hypothesis that an increase in (sub)sovereign default risk disproportionately affects industries that are more dependent on government demand. As industry output is only available at the annual frequency while employment is available at the monthly frequency, we focus on the latter for more powerful tests of the effect of default risk. Our conjecture is that an increase in sovereign default risk would negatively affect the government's borrowing capacity and therefore increase the probability of fiscal austerity. This would imply that industries that are more dependent on government spending would be

[20]The time to maturity is matched using a cubic spline interpolation of the Treasury yield curve. See Appendix A.3 for a description of the process used to adjust the yields of Puerto Rican securities for their tax benefit.

hurt more severely during a period of heightened sovereign default risk.[21] To evaluate the plausibility of this transmission channel, we will also test an additional hypothesis that an increase in (sub)sovereign default risk is associated with an increase in the interest rates of bonds issued by the government of Puerto Rico. We also explore alternative explanations of our findings.

Summary Statistics: Table 1 presents summary statistics for Puerto Rican manufacturing industries, the change in default probabilities, and the change in the cyclically adjusted primary balance. The average industry has 3,931 employees and comprises 5.6% of total manufacturing output. Note that negative average values for this indicator are typical in decades following the original calculations for the 1980s. The average industry depends on local customers for an average of 53.8% of total sales. The average monthly employment growth rate is -0.36% for Puerto Rican manufacturing industries over the sample period. The average change in the cyclically adjusted primary balance is 0.32 percentage points. The data show that default probability increases by 0.92 percentage points in an average month.

Figure 4 presents normalized log employment in manufacturing industries above and below the median of dependence on government demand and default probability. Figure 4 shows that employment in manufacturing industries more dependent on government demand declines relatively more than employment in industries that are less dependent, while there is an overall decline in employment in all manufacturing. Further, the relative decline in employment in sensitive industries appears to follow increased default risk. Figure 5 presents normalized log employment in manufacturing industries above and below the median of dependence on government demand and *capb*. Figure 5 shows that austerity measures by Puerto Rico (increased *capb*) also seem to coincide with decreased employment in more sensitive industries.

Regression analysis: In the benchmark specification we regress employment growth in

[21]Note that we do not claim that default itself is associated with austerity. Rather, our hypothesis hinges on the idea that the increased default *risk* reduces Puerto Rico's ability to borrow to finance government spending, and thus negatively affect the sectors dependent on such spending.

industry i in month t on 12 lags of changes in (sub)sovereign default probabilities and a term that captures the interaction of government demand dependence in an industry i with changes in default probability in month t. We also control for each industry's lagged share of total private employment to allow for convergence in each industry's share of total private employment.[22,23] The specification also includes industry and month fixed effects to capture any time-invariant industry characteristics and any industry-invariant month effects. The standard errors are clustered by industry. We estimate the following benchmark regression:

$$\begin{aligned}\Delta E_{it} = \alpha_i + \mu_t + \nu SH_{it-1} + \sum_{j=1}^{12} \delta_{t-j} * GOV_i * \Delta DEF_{t-j} + \beta * GOV_i \\ * \Delta capb_{prioryear} + \sum_{j=1}^{12} \gamma_{t-j} * GOV_i * \Delta DEF_{t-j} * \Delta capb_{prioryear} + \epsilon_{it}\end{aligned} \tag{10}$$

where α_i and μ_t are fixed effects; ΔDEF_t is the change in the monthly average of default probability in month t; GOV_i is dependence on government demand for industry i; $\Delta capb_{prioryear}$ is the annual first difference in the cyclically adjusted primary balance (expressed as a percentage of potential output) and SH_{it-1} is the share of total private employment of industry i in month $t-1$.

The set of coefficients δ captures the relationship between dependence on government demand and employment given changes in the probability of default. β captures the relationship between dependence on government demand and employment given changes in the cyclically adjusted primary balance. The set of coefficients γ captures the relationship between dependence on government demand and employment given changes in the probability of default and the cyclically adjusted primary balance. That is, heterogeneity in the effect of fiscal policy based on changes in default risk. We exclude contemporaneous values of ΔDEF and $\Delta capb$. We exclude contemporaneous values of ΔDEF to avoid contemporaneous cor-

[22]Note that as the lagged share of total private employment contains a transformed lag of the dependent variable, it may be correlated with industry fixed effects. Nickel (1981) shows that this bias is of order $1/T$. In our estimation, $T = 90$, so this bias is minimal for our case. Judson and Owen (1999) show the bias is about 8% of the true value for the coefficient on the lagged dependent variable for T=30. However, the expected bias on exogenous regressors, our primary interest, is only about 1-3% of the true value for T=30.

[23]This methodology is motivated by Rajan and Zingales (1998), Dell'Ariccia et al. (2008), Borensztein and Panizza (2009), and Borensztein and Panizza (2010).

relation. Following Borensztein and Panizza (2010) and given the relatively high frequency of our data, we use several lags of the interaction terms to allow some time for changes in default risk to affect employment. The coefficient on SH_{it-1} indicates whether industries comprising a larger share of total private employment tend to have lower growth rates.

We include 12 lags of the interaction terms as the effects are insignificant beyond the 12^{th} lag. For robustness, we include three lags of the industry-level employment growth rate (ΔE_{it}).[24] This approach controls for autocorrelation in employment growth rates and potential serial autocorrelation in the errors of the benchmark specification. As an additional robustness check, we use the change in the monthly average yield spread of Puerto Rican five-year bonds in place of the change in default probability. The results remain robust to these tests.

Of course, the primary challenge to any attempt to identify the causal effect of increased default risk on employment is reverse causality. That is, increases in the risk of default may be a consequence of declining economic growth. However, in our benchmark specification, the identification strategy relies on differences in employment growth rates across manufacturing industries in a given month.[25] Therefore, reverse causality is a concern only if the relative growth of any given manufacturing industry in a given month affects the probability of default. In our view, this is far less plausible than reverse causality in the aggregate.

After estimating (10), we conduct Granger causality tests on $\Delta capb$ and ΔDEF to capture the lead lag relationship between default risk and fiscal policy as follows:

$$\Delta capb_{annual} = \alpha_i + \beta \Delta capb_{prioryear} + \sum_{j=1}^{12} \delta_{t-j} \Delta DEF_{t-j} + \epsilon_{it} \tag{11}$$

$$\Delta DEF_t = \alpha_i + \beta \Delta capb_{prioryear} + \sum_{j=1}^{12} \delta_{t-j} \Delta DEF_{t-j} + \epsilon_{it} \tag{12}$$

The Granger causality tests reported in Table 2 reveal that default risk Granger causes Puerto Rico's cyclically adjusted primary balance and indicate that increased default risk

[24] We use three lags of E_{it} because optimal lag selection information criteria selected three lags as optimal.
[25] Note than manufacturing comprises 45.8% of GDP and 68.7% of GNP from 2007-2016.

drives austerity. The data suggest that Puerto Rico's cyclically adjusted primary balance does not Granger cause default risk. Puerto Rico's pre-default austerity measures may therefore form a real effect of default anticipation. That is, the results are consistent with the hypothesis that the government responds to increased default risk with austerity, either to reassure markets or due to the increased financing constraints associated with default risk.

Table 3 presents the estimates from the benchmark specification of equation (10). In Column 1, we regress employment growth on a constant, SH_{it-1}, and a series of 12 lags of the interaction of dependence on government demand and the change in monthly default probability. For brevity, we show only the sum of the interaction terms and a test for joint significance of the interaction terms.[26] The sum of the coefficients on the interaction terms is negative, and the interaction terms are jointly significant at the 1% level. The results are consistent with the hypothesis that increased default risk is associated with relatively lower employment growth in industries more dependent on government demand. In column 2, we control for an interaction of the prior year first difference in *capb* and GOV. The coefficient is statistically significant at the 5% level and indicates that increased *capb* (austerity) is associated with relatively lower employment growth in government demand dependent industries. In column 3, we combine the independent variables of columns 1 and 2 with a triple interaction of ΔDEF, GOV, and $\Delta capb_{prioryear}$. The coefficient on the triple interaction is jointly significant at the 1% level and indicates that the negative effect of default risk on employment growth in industries relatively more dependent on government demand increases when the government undertakes austerity measures. Similarly, the negative effect of austerity on employment growth in industries relatively more dependent on government demand increases when default risk increases.

The top panel of Table 4 summarizes the economic significance of the interaction terms using specification 1 of Table 3. The economic magnitude of the effect is significant. Table 4 shows that if ΔDEF is at the 25th percentile (-1.9 pp) for the prior 12 months and SH_{t-1} is at its sample average, monthly employment growth for industries at the 25th percentile of

[26] Table A.4 of appendix A.5 shows the full specification.

dependence on government demand is predicted to be -0.12%. Similarly, monthly employment growth at the 75th percentile of government demand is predicted to be 0.02% if ΔDEF is at the 25th percentile for the prior 12 months. Thus, if ΔDEF is at the 25th percentile for the prior 12 months, employment growth is predicted to be 0.15 percentage points higher for the industry at the 75th percentile of dependence on government demand than in the industry at the 25th percentile of dependence on government demand. The magnitude of this effect amounts to 40.3% of the monthly average employment growth rate of -0.36%.

Next, we conduct the same sensitivity analysis for high values of default risk when ΔDEF is at the 75th and 90th percentiles over the prior 12 months. If ΔDEF is at the 75th percentile, employment growth is predicted to be 0.3 percentage points lower for an industry at the 75th percentile of government demand dependence than in an industry at the 25th percentile. The magnitude of this effect amounts to approximately three-quarters of the average monthly employment growth rate of -0.36%. Finally, if ΔDEF is at the 90th percentile (9.0 pp), the employment growth difference between industries at the 75th percentile and industries at the 25th percentile is predicted to be 0.68 percentage points. The magnitude of this fall is nearly double the average monthly employment growth rate. Our estimates also predict that employment growth differential between industries at the 75th and 25th percentiles of government demand dependence will be 0.4 percentage points lower when the default probability is at the 75th percentile rather than the 25th percentile-the magnitude is comparable to the average monthly employment growth rate.

The bottom panel of Table 4 conducts the same exercise for the marginal effect of the cyclically adjusted primary balance, $\Delta capb$, as the top panel of Table 4 does for ΔDEF, using specification 2. The results show that higher values of $\Delta capb$ (austerity) are associated with relatively lower employment growth in more government demand dependent industries. We observe this pattern for the 75th and 90th percentiles of $\Delta capb$, which are high levels of austerity. The findings indicate that austerity leads to contractionary effects on employment in government demand dependent industries. The estimates predict that when $\Delta capb$ is at the 75th percentile, employment growth is expected to be .13% lower in the industry at

the 75th percentile of dependence on government demand versus the industry at the 25th percentile.

To get a better understanding of the relative marginal effects of default risk and fiscal policy, we use specification 3 of Table 3 to calculate the impact of a one standard deviation increase in $\Delta capb$ when the value of ΔDEF is at the sample average and of a one standard deviation increase in ΔDEF when $\Delta capb$ is at its sample average. The results are in Figure 6. Figure 6 shows that a one standard deviation in $\Delta capb$ does not have a significant effect on employment growth when ΔDEF is at its mean. In contrast, a one standard deviation increase in ΔDEF is associated with a significantly reduced employment growth rate when $\Delta capb$ is at its sample mean. The magnitude of this effect increases for more government demand dependent industries. Similar to Table 4, Figure 6 shows that a one standard deviation increase in ΔDEF is associated with -2.5% employment growth at the 90th percentile of dependence on government demand. The results suggest that default risk has a significant effects on employment growth when fiscal policy is at its sample average.

To further investigate the interaction of default risk and fiscal policy, we use specification 3 of Table 3 to calculate the marginal effects of a one standard deviation increase in $\Delta capb$ for different values of ΔDEF and of a one standard deviation increase in ΔDEF for changes in $\Delta capb$. The results are in Figures 7 and 8. Figure 7 shows that the marginal effect of ΔDEF is always negative and higher in magnitude for industries at the 75th percentile of GOV versus the industries at the 25th percentile. The magnitude of the difference between the 75th and 25th percentile of GOV increases when $\Delta capb$ increases. That is, we observe a stronger contractionary effect of default risk on employment growth in more sensitive industries when the government implements austerity measures. Figure 7 shows that a one standard deviation increase in ΔDEF is associated with -3.1% employment growth at the 90th percentile of $\Delta capb$ and the 75th percentile of GOV versus -0.6% employment growth at the 90th percentile of $\Delta capb$ and the 25th percentile of GOV. This difference is six times the average monthly employment growth.

So far, the results support the hypothesis that austerity measures are significant when

combined with increased default risk. One potential rationale for these results is that agents learn about future government policy when they observe austerity measures in response to increased default risk. To investigate whether the data further support this hypothesis, we estimate (11) and (12) to determine if the data show that changes in default risk Granger cause fiscal policy measures or vice versa. First, we estimate (11) and find that the set of coefficients δ have a positive sum and are jointly significant at the 5% level. Thus, we find that changes in default risk appear to Granger cause changes in fiscal policy. Further, the positive sum of the coefficients indicates that increased default risk is associated with austerity measures. Second, we estimate (12) and find that β is not statistically significant. The finding suggests that changes in fiscal policy do not Granger cause changes in default risk. The results support the hypothesis that governments may enact austerity measures when default risk rises to either stave off default or because borrowing constraints become binding when default risk rises.

Overall, the results suggest that employment growth falls in industries that are more exposed to default risk via the government demand channel *relative* to those less exposed. Recall that average monthly employment growth for manufacturing industries above the median dependence on government demand is -0.58% while employment growth is -0.30% on average for industries below the median of dependence on government demand during the sample period. The estimates in this section suggest that increased default risk drives austerity and explains the relative decline in employment growth in more government demand dependent industries. The evidence is consistent with the hypothesis that default risk is an important driver of the decline in Puerto Rican employment over the sample period.

A potential concern about our results is that the final repeal of Section 936 tax benefits for companies operating in Puerto Rico in 2006 may affect employment and bias our results. However, given that our benchmark sample begins in mid-2008; the final repeal of Section 936 in 2006 would need to have a differential impact on employment growth in sensitive industries over two years after the event to cause identification issues. Therefore, we view this as an unlikely source of bias in our results.

5.1 The Local Fiscal Multiplier

Our investigation of the impact of changes in default risk on employment growth in government demand dependent manufacturing industries confirms the link between default risk and austerity risk and shows that austerity is Granger-caused by default risk. We also find that austerity has a contractionary effect on the relative employment growth in government demand-dependent manufacturing industries. In this section, we examine the impact of austerity via a local fiscal multiplier effect for Puerto Rican manufacturers.

Regression Analysis: Table 1 presents annual summary statistics for Puerto Rican manufacturing industries, the change in default probabilities, and the change in the cyclically adjusted primary balance. The CAPB is widely used as a measure of the government's fiscal stance because it filters out changes in the fiscal deficit caused by fluctuations in the business cycle, thereby isolating the impact of discretionary changes in policy (Guajardo et al. (2011); Jordá and Taylor (2016)). We regress output growth in industry i in year t on a lag of industry-level output growth and the annual first difference in the cyclically adjusted primary balance. The standard errors are clustered by industry. We estimate the following specification:

$$\Delta Y_{it} = \alpha + \beta \Delta Y_{it-1} + \gamma \Delta capb_t + \epsilon_{it} \tag{13}$$

where ΔY_{it} is the annual output growth rate for industry i in year t and $\Delta capb_t$ is the annual first difference in the cyclically adjusted primary balance (expressed as a percentage of potential output). The coefficient γ is our estimate of the fiscal multiplier. We rely on the cyclical adjustment of the primary balance and the control for the lag of the dependent variable to satisfy the assumption that $\Delta capb$ is exogenous.

Table 5 presents the results from our estimation of equation (13). In Column 1, we regress output growth on a constant, and the change in the cyclically adjusted primary balance. The coefficient on $\Delta capb$ is negative and significant at the 1% level, consistent with the hypothesis that austerity and reduced output growth for Puerto Rican manufacturers are correlated. Specifically, a fiscal contraction of 1% of potential output on average, correlates with a 0.95% decrease in the output growth rate of Puerto Rican manufacturers.

In column 2, we include industry-level fixed effects to control for industry-level unobserved heterogeneity. The coefficient on $\Delta capb$ remains statistically significant at the 1% level and is economically similar to the initial estimate. In column 3, we include the interaction of $GOV * \Delta DEF$ to investigate whether an increase in default risk correlates with a differential effect on output growth for government demand-dependent industries. The coefficient on $GOV * \Delta DEF$ is negative and significant at the 10% level. The finding confirms that, in addition to employment growth declines, default risk is correlated with a contractionary effect on the output growth in government demand-dependent industries.

6 Robustness Checks and Alternative Explanations

This section conducts a series of tests to examine the robustness of our main findings. We also explore alternative explanations for our findings. We begin with a series of robustness exercises.

6.1 Robustness Checks

An alternative measure of default probability: To ensure our results are robust to alternative measures of financial distress for the Puerto Rican government, we substitute the change in the monthly average yield spread of Puerto Rican five-year securities for the change in default probability in our benchmark models. The benchmark results remain qualitatively the same.[27]

Restricting the sample to the period after the global financial crisis: One concern about our benchmark results is that spreads on Puerto Rican CDS spreads may have increased and employment may have declined relatively more in external finance and/or government spending dependent industries during the global financial crisis. Indeed, evidence suggests that banking crises have a more adverse impact on the value added of external finance dependent industries (see Dell'Ariccia et al. (2008)). For this reason, we repeat our benchmark

[27]The sample of yield spreads for our results begins in 2001. However, the results are robust to restricting the sample to the period used in the benchmark results.

specifications and restrict the sample to the year 2010 and thereafter. The benchmark results are qualitatively unaffected. Also, note that including the crisis period in our estimations attenuates the magnitudes of our coefficient estimates.

Alternative calculation periods for $EXTFIN^{US}$ and GOV: To ensure our results are not sensitive to the estimation period used to calculate dependence on external finance, we also repeat our benchmark specifications using the pre-crisis estimation period of 1995-2005 and the narrower period of 2005-2015 to calculate $EXTFIN^{US}$. Similarly, we estimate our benchmark specifications using the average of the GOV measure from the 2012 Economic census and the 2007 Economic Census. Our results remain robust.

Recession risk: Another potential concern about our benchmark estimates is that increased risk of recession may be the cause of increased default probabilities. If true, this could explain relatively lower employment growth in external finance-dependent industries. This follows because lenders may know that recessions have a relatively larger negative impact on the activity of external finance-dependent industries and restrict quantities or increase prices of loans to more exposed industries. Similarly, recession risk could also explain relatively lower employment growth in industries more dependent on government spending as agents may expect that recessions have a differential impact on the employment in these industries.

To allow for these possibilities, we control for each industry's sensitivity to the wider economy. We compute $\Delta DEF_t * CYC_i$ where CYC_i is the sensitivity of employment growth in industry i to economic growth in Puerto Rico. To estimate CYC_i, we perform simple regressions of employment growth on growth in the Puerto Rican Economic Activity Index from January 1990 through December 2007.[28] We use the coefficients from these regressions as a measure of CYC_i and include 12 lags of $DEF_t * CYC_i$ in our benchmark models. The benchmark results remain robust.

Industry-specific shocks: We also address the potential endogeneity of industry-specific shocks. It is conceivable that there is a correlation between increases in Puerto Rican default

[28] We use the period beginning with the first available employment data and ending just before the sample for our benchmark regression to prevent endogeniety of the CYC_i measure to employment growth.

probabilities and negative U.S. mainland-wide shocks to certain manufacturing industries, especially if such industries represent an outsized portion of Puerto Rico's tax base. If such industries also tend to be more dependent on external finance or government demand, this would bias our benchmark results. To control for this possibility, we include 12 lags of U.S. growth of industrial production and employment in each industry in our benchmark models.[29] The results indicate that our benchmark results are robust.

Puerto Rican industry-specific shocks: Industry-specific shocks unique to Puerto Rico are another potential endogeniety concern if they occur in industries that represent a relatively large share of Puerto Rico's tax revenues, affect default risk, and occur in industries more reliant on external finance or government spending. We do not have data on industry-specific shares of Puerto Rican tax revenues. However, we posit that industries that comprise a larger share of Puerto Rico's private employment would also tend to make up a relatively larger share of Puerto Rico's tax revenues. If this endogeneity problem exists, we would expect that industries that are more dependent on external finance or government demand and make up a relatively larger share of Puerto Rico's private employment may drive our benchmark findings.

To test this hypothesis, we generate an indicator H_{EXTFIN}, which takes the value of one when an industry has both above the median dependence on external finance and above the median share of total private employment. We also we generate an indicator H_{GOV} which takes the value one when an industry has both above the median dependence on external government spending and above the median share of total private employment. We include 12 lags of the interaction $H_{EXTFIN} * EXTFIN_i^{US} * \Delta DEF_t$ and of the interaction $H_{GOV} * GOV_i * \Delta DEF_t$ in our benchmark models. The results are consistent with the hypothesis that industry-specific shocks unique to Puerto Rico do not appear to drive our benchmark results.

[29] U.S. industrial production is only available for 16 of the 19 manufacturing industries in our benchmark sample. In addition, production in six of these industries is aggregated with another industry, providing only 13 unique monthly series. For example, industrial production for the industries 311 and 312 are reported as the sum of the two. We seasonally adjust growth in industrial production and U.S. employment using Census X-13.

Population shocks: We also consider the possibility that Puerto Rico's population decline drove default risk and employment declines in industries more dependent on external finance or government spending. To control for this possibility, we include the interactions $\Delta POP_{prioryear} * EXTFIN^{US}$ and $\Delta POP_{prioryear} * GOV$ in our benchmark models, where $\Delta POP_{prioryear}$ is the growth rate of Puerto Rico's population in the prior year.[30] Our benchmark results are robust.

Housing price shocks: The housing price decline in Puerto Rico is another major characteristic of the crisis that could drive default risk and employment declines in industries more dependent on external finance or government spending. To control for this possibility, we include four lags of the interactions $\Delta HP * EXTFIN^{US}$ and $\Delta HP * GOV$ in our benchmark models, where ΔHP is the quarterly growth rate of Puerto Rico's housing price index.[31] Our benchmark results are robust.

Alternative lags of the dependent variable: We include three lags of the dependent variable in the benchmark specifications.[32] This approach controls for autocorrelation in employment growth rates and serial correlation in the benchmark errors. The benchmark results are qualitatively the same.

6.2 An Alternative Explanation: External Finance and Bank Lending

Our empirical analysis provides evidence that increased default risk drives a relatively higher decline in government demand-dependent industries. An alternative explanation for our findings could relate to the widely explored transmission channel in the sovereign risk literature which operates through a reduction in bank lending or a credit crunch. That is, if Puerto Rican banks tend to hold Puerto Rican government debt on their balance sheets, then an increase in sovereign default risk could adversely impact the balance sheets of these banks

[30] We retrieve annual population in Puerto Rico from WDI.

[31] We retrieve the purchase-only quarterly, seasonally adjusted housing price index for Puerto Rico from the FHFA.

[32] We chose three lags because optimal lag selection information criteria select three lags as optimal and because the standard errors of the regressors stabilize at the third lag.

and their ability to provide credit to the local economy. The contraction in the supply of credit could negatively affect firms in industries that are typically more dependent on bank loans for their financing. Several theoretical papers in the recent literature suggest that this mechanism is prominent behind the "deadly embrace" between the balance sheets of the governments and the financial sector in European economies during recent financial crises (see, inter alia, Farhi and Tirole (2017)).

If the bank lending channel operates in Puerto Rico, and if dependence on government demand is correlated with dependence on external finance, this may suggest that the contraction in employment for firms dependent on government demand could result from their dependence on external finance.[33] However, we hypothesize that an increase in sovereign default risk ought to have little effect on external finance dependent industries given that Puerto Rico is an open economy that is financially integrated with the U.S. mainland. In theory, firms located in Puerto Rico can continue to seek external finance in the form of loans or equity/debt issuance from non-Puerto Rican banks. Thus, the effect on the local supply of credit may have a limited effect on these firms.

To test this hypothesis, we examine whether default risk has a differential effect on employment in external finance dependent industries. To further evaluate the plausibility of this mechanism, we investigate the relationship between default risk and lending by Puerto Rican banks: we examine (i) the role of non-Puerto Rican banks operating in Puerto Rico; and (ii) the (sub) sovereign ceiling effect.

6.2.1 The External Finance Channel

First, we evaluate the hypothesis that an increase in (sub)sovereign default risk disproportionately affects industries that are more dependent on external finance. As a first step, we investigate the behavior of employment in industries according to dependence on external finance. The relative ranking of $EXTFIN$ by industry is the relevant measure and is

[33]Notably, industries with above the median dependence on government demand and industries with below the median dependence on government demand show no statistical difference in their dependence on external finance. Nevertheless, we explore the role of external finance dependence here.

relatively stable over time.[34] Figure 9 presents normalized log employment in manufacturing industries above and below the median of dependence on external finance and default probability. Figure 9 shows that employment in manufacturing industries more dependent on external finance declines relatively more than employment in industries less dependent on external finance and that employment in all manufacturing industries decline overall. Further, the relative decline in employment in sensitive industries appears to lag default risk.

Regression analysis: We regress employment growth in industry i in month t on 12 lags of changes in (sub)sovereign default probabilities and a term that captures the interaction of government demand dependence in an industry i with changes in default probability in month t. We also include 12 lags of changes in (sub)sovereign default probabilities and terms that capture the interaction of external finance dependence in industry i and local demand dependence in industry i with changes in default probability in month t. We control for each industry's lagged share of total private employment to allow for convergence in each industry's share of total private employment.[35] The specification also includes industry and month fixed effects to capture any time-invariant industry characteristics and any industry-invariant month effects.[36] The standard errors are clustered by industry. We estimate the following regression:

$$\begin{aligned}\Delta E_{it} = \alpha_i + \mu_t + \nu SH_{it-1} + \sum_{j=1}^{12} \delta_{t-j} * GOV_i * \Delta DEF_{t-j} + \sum_{j=1}^{12} \gamma_{t-j} \\ * EXTFIN_i^{US} * \Delta DEF_{t-j} + \sum_{j=1}^{12} \beta_{t-j} * LD_i * \Delta DEF_{t-j} + \epsilon_{it}\end{aligned} \tag{14}$$

where α_i and μ_t are fixed effects; ΔDEF_t is the change in the monthly average of default probability in month t; GOV_i is dependence on government demand for industry i;

[34] See Appendix A.2.See Klingebiel et al. (2006).

[35] Note that as the lagged share of total private employment contains a transformed lag of the dependent variable, it may be correlated with industry fixed effects. Nickel (1981) shows that this bias is of order $1/T$. In our estimation, $T = 90$, so this bias is minimal for our case. Judson and Owen (1999) show the bias is about 8% of the true value for the coefficient on the lagged dependent variable for T=30. However, the expected bias on exogenous regressors, our primary interest, is only about 1-3% of the true value for T=30.

[36] This methodology is motivated by Rajan and Zingales (1998), Dell'Ariccia et al. (2008), Borensztein and Panizza (2009), and Borensztein and Panizza (2010).

$EXTFIN_i^{US}$ is the Rajan and Zingales (1998) measure of dependence on external finance for industry i; LD_i is dependence on Puerto Rican demand for industry i; and SH_{it-1} is the share of total private employment of industry i in month $t-1$.

The set of coefficients δ determine whether controlling for the role of external finance dependence affects our prior results regarding the effect of changes in default probability on industries more exposed to government demand. The set of coefficients γ captures the relationship between dependence on external finance and employment given changes in the probability of default. The set of coefficients β determine whether industries relatively more exposed to Puerto Rican demand are disproportionately affected by changes in default probability. The coefficient on SH_{it-1} indicates whether industries comprising a larger share of total private employment tend to have lower growth rates.

In addition to the reverse causality problem discussed in the context of the government demand channel, a further challenge to identifying the bank lending channel is that if industries more dependent on external finance are relatively more affected by declines in aggregate demand; in addition to the supply of loans to these industries through the bank lending channel, loan demand in these industries may be disproportionately affected. For this reason, we control for exposure to Puerto Rican demand with LD and allow changes in default risk to disproportionately affect industries according to local demand dependence.

Figure 9 shows the path of DEF over the period of data availability. The results are in Table 6. In column 1, we regress employment growth on a constant, SH_{it-1}, 12 lags of the interaction of dependence on external finance and the change in monthly default probability, and fixed effects. SH_{it-1} is negative and significant at the 1% level. The negative coefficient on SH_{it-1} indicates that employment in industries that comprise a larger share of total employment tends to grow at slower rates, controlling for industry fixed effects. The finding is consistent with the hypothesis that industry-level shares of total employment tend to converge over time. Specifically, the coefficient of -2.8 indicates that a one standard deviation increase in share of total private employment is associated with a reduction in monthly employment growth of 1.4%. This is a substantial effect, given the average monthly

employment growth rate of -0.36%.[37] For brevity, we show only the sum of the interaction terms and a test for joint significance of the interaction terms.[38] The sum of the coefficients on the interaction terms is negative and the interaction terms are jointly significant at the 1% level. The results are consistent with the hypothesis that increased default risk is associated with relatively lower employment growth in industries more dependent on external finance. This result is counter-intuitive for Puerto Rico, given its access to U.S. lending.

In column 2, we control for 12 lags of the interaction of dependence on local demand and the change in monthly default probability. The sum of the coefficients on the interaction terms is negative and the interaction terms are jointly significant at the 1% level. The results are consistent with the hypothesis that increased default risk is associated with relatively lower employment growth in industries more dependent on local demand. Importantly, the coefficients on the interactions of dependence on external finance and the change in monthly default probabilities remain jointly significant at the 1% level with a negative sum. Given that we control for the potential effect of default risk on loan demand with the interactions between the change in default risk and dependence on local demand, the results are consistent with the hypothesis that increased default probability disproportionately affects employment in industries more dependent on external finance via a reduced *supply* of credit through the bank lending channel.

In column 3, we control for 12 lags of the interaction of dependence on government demand and the change in monthly default probability. The sum of the coefficients on the interaction terms is negative and the interaction terms are jointly significant at the 1% level. The results are consistent with the hypothesis that increased default risk is associated with relatively lower employment growth in industries more dependent on government demand. Indeed, the sum of the coefficients is substantially increased in magnitude relative to our initial investigation in Table 3. Therefore, although the bank lending channel

[37]Note that the median within-industry standard deviation in the share of total private employment is 5% of the figure for the full sample.

[38]Table A.3 of appendix A.4 shows the full specification. The results show that all of the individually significant coefficients are negative, with the largest and most statistically significant coefficient occurring on the third lag of the interaction term.

appears to explain a relative decline in employment in sensitive industries, our benchmark finding that increased default risk is associated with a relative decline in employment growth in government-dependent industries is qualitatively unaffected by controlling for the bank lending channel.

Table 7 summarizes the economic significance of the $EXTFIN$ interaction terms using specification 3 of Table 6. Table 7 shows that if ΔDEF is at the 25th percentile (-1.9 pp) for the prior 12 months and SH_{t-1}, LD, and GOV are at their sample average, monthly employment growth for industries at the 25th and 75th percentiles of external finance dependence is predicted to be -0.09% and -0.02%, respectively. Thus, for low values of default risk in the prior year, employment growth is predicted to be 0.07 percentage points higher for industries at higher values of external finance dependence than for industries at lower percentiles-the difference amounts to 18.4% of the monthly average employment growth rate of -0.36%.

Next, we conduct the same sensitivity analysis for high values of ΔDEF at the 75th and 90th percentiles for the prior 12 months. If ΔDEF is at the 75th percentile (3.4 pp) for the prior 12 months, employment growth is predicted to be 0.12 percentage points lower for an industry at the 75th percentile than for an industry at the 25th percentile of dependence on external finance. The magnitude of this difference is 32.7% of the monthly average employment growth rate. Finally, if ΔDEF is at the 90th percentile (9.0 pp) for the prior 12 months, employment growth is predicted to be 0.31 percentage points lower for an industry at the 75th percentile than for an industry at the 25th percentile of external finance dependence which is 86.1% of the monthly average employment growth rate. The coefficients also allow us to predict that monthly employment growth in an industry at the 75th percentile of external finance dependence is 0.19 percentage points lower than in an industry at the 25th percentile when the default probability is at the 75th rather than the 25th percentile. The magnitude of this effect amounts to 52.8% of the monthly average employment growth rate of -0.36%.

For comparison to our earlier results in Table 4, Table 7 also summarizes the economic

significance of the GOV interaction terms using specification 3 of Table 6. Table 7 shows that if ΔDEF is at the 25th percentile (-1.9 pp) for the prior 12 months, employment growth is predicted to be 0.28 percentage points higher for an industry at the 75th percentile than for an industry at the 25th percentile of government demand dependence which is 77.5% of the monthly average employment growth rate. This is an approximate doubling of the effect observed in Table 4 of 40.3%. If ΔDEF is at the 75th percentile (3.4 pp) for the prior 12 months, employment growth is predicted to be 0.50 percentage points lower for an industry at the 75th percentile than for an industry at the 25th percentile of government demand dependence which is 137.6% of the monthly average employment growth rate. This is an approximate doubling of the effect observed in Table 4 of 71.6%. Finally, if ΔDEF is at the 90th percentile (9.0 pp) for the prior 12 months, employment growth is predicted to be 1.3 percentage points lower for an industry at the 75th percentile than for an industry at the 25th percentile of government demand dependence which is 362.0% of the monthly average employment growth rate. This is an approximate doubling of the effect observed in Table 4 of 188.2%. The results show that both the bank lending channel and the government demand channel are economically important predictors of relative employment growth. Further, the government demand channel approximately doubles in economic importance when we control for the bank lending channel compared to our initial investigation in Table 4.

6.2.2 The Role of Non-Puerto Rican Banks and the (sub) Sovereign Ceiling

The previous subsection provides evidence in support of the hypothesis that heightened sovereign risk leads banks to reduce lending and results in a disproportionately detrimental employment effect on external finance dependent industries. The external financial constraints/credit crunch hypothesis also rests on the premise that non-Puerto Rican banks, which are presumably far less exposed to Puerto Rican debt do not act as substitutes for the reduced supply of credit from Puerto Rican banks. We must also explore whether increased sovereign risk affects the cost of capital for Puerto Rican manufacturers via a (sub) sovereign ceiling channel.

To confirm the data are consistent with the hypothesis that Puerto Rico's crisis and increased default risk are associated with a contraction in credit, we first investigate the relationship between default risk and banking in Puerto Rico using balance sheet data for Puerto Rican banks from the FDIC. Figure 10 shows that commercial and industrial loans as a percentage of GNP declined by 35.9% from 2008 through 2015. This is notable as these loans are directly relevant for our investigation of the effect of the credit channel on employment in manufacturing. Further, loans to Puerto Rican municipal entities total about 40% of capital in Puerto Rico's banks, indicating that Puerto Rican banks are highly exposed to the Puerto Rican government.[39] The data suggest that losses on holding Puerto Rican government debt would create substantial constraints on bank lending in Puerto Rico.

To formally test the relationship between default risk and lending, we conduct Granger causality tests on the monthly first difference in default probability (ΔDEF) and the quarterly first difference in commercial and industrial loans as a percentage of GNP (ΔCIL) as follows:

$$\Delta CIL_t = \alpha_i + \sum_{k=1}^{4} \beta \Delta CIL_{t-k} + \sum_{j=1}^{12} \delta_{t-j} \Delta DEF_{t-j} + \epsilon_{it} \tag{15}$$

$$\Delta DEF_t = \alpha_i + \sum_{k=1}^{4} \gamma \Delta CIL_{t-k} + \sum_{j=1}^{12} \eta_{t-j} \Delta DEF_{t-j} + \epsilon_{it} \tag{16}$$

where we include the prior four quarters of changes in commercial and industrial lending and the prior four quarters of changes in default probability in both tests (note that k indexes quarters not months). We conduct Wald tests of the hypotheses $H_0 : \delta_1 = ... = \delta_{12} = 0$ and $H_0 : \gamma_1 = ... = \gamma_4 = 0$. The F statistic of 4.71 reported in Table 8 shows that the set of coefficients δ are jointly significant at the 1% level. That is, that default risk Granger causes commercial and industrial lending. The sum of the coefficients of -0.017 indicates that the data are consistent with the hypothesis that increased default risk for Puerto Rico reduces commercial and industrial lending by Puerto Rican banks. The F statistic of 0.24 indicates

[39] As noted in Section 4.1, we can only confirm these figures on loans to U.S. political subdivisions are loans to Puerto Rican municipal entities for Oriental Bank.

that the set of coefficients γ are not jointly significant and suggests that commercial and industrial lending do not Granger cause default risk.

Having confirmed the data support our hypothesis that increased sovereign default risk has an adverse impact on the lending of Puerto Rican banks that hold Puerto Rican government debt, we turn to the second premise underlying our results. That is, that non-Puerto Rican banks do not substitute for the reduced supply of credit from Puerto Rican banks. Figure 11 shows that normalized log total loans and leases from banks operating in Puerto Rico declined monotonically over the 2008-2016 period by about 73%. The share of loans and leases from non-Puerto Rican banks also declined over this period from 19% in 2008 to 4% in 2016. It is clear that rather than substituting for the credit crunch we document for Puerto Rican banks, non-Puerto Rican banks reduced their share in Puerto Rican lending during the crisis.

Finally, we investigate the possibility that borrowing by Puerto Rican manufacturers is adversely affected by a (sub) sovereign ceiling channel. That is, downgrades of Puerto Rico's credit rating may result in mechanical downgrades of the credit ratings of manufacturers at or above Puerto Rico's credit rating and thus increase their borrowing costs.[40] If true, this channel could partially explain the finding that increased sovereign risk results in disproportionate effects for external finance dependent manufacturing industries. To investigate this possibility, we use Bloomberg to search for debt issued by non-government and non-financial firms domiciled in Puerto Rico. We find only one Puerto Rican manufacturer issued bonds during our period of interest; Warner Chilcott, a pharmaceutical manufacturer. During our sample period, the firm's credit was downgraded by Moody's once, in October, 2009. During this period, the firm was rated below Puerto Rico's credit rating. From the data it appears that bond financing does not substitute for the bank credit crunch we document. We conduct several tests to ensure the robustness of our results. These results are omitted from the main paper for brevity and are available in the online appendix.[41]

[40] See Almeida et al. (2017).

[41] For the online appendix, please visit This has to be updated. https://www.dropbox.com/s/zg9eo3uzqkn6omq/The%20Costs%20of%20%28sub%29Sovereign%20Default%20Risk_Evidence%20from%20Puerto%20Rico_Online%20Appendix.pdf?dl=0.

In summary, the results thus far provide evidence in support of the hypotheses that an increase in the risk of sovereign default disproportionately affects industries that are more dependent on government demand or external finance. Appendix C provides additional supporting evidence that changes in sovereign default risk are transmitted to changes in the borrowing costs of banks and the public sector.

7 Conclusion

This paper uses Puerto Rico's debt crisis to develop a novel identification strategy to extract the real costs of (sub)sovereign default risk. We use Puerto Rico as a case study because Puerto Rico's unique characteristics as a U.S. territory allow us to examine a novel channel through which (sub)sovereign default risk can have real effects on the macroeconomy.

Puerto Rico's (sub)sovereign default crisis differs from existing cases of sovereign default. Specifically, Puerto Rico's unique legal relationship with the United States effectively eliminates the risks of currency and banking crises, or government interference in private contracts, which make it difficult to isolate default risk in other instances of sovereign default. An important advantage is the availability of Puerto Rican data on macro-indicators such as employment at higher frequencies and disaggregated at the industry level.

We propose a novel mechanism using a New Keynesian model of Puerto Rico as a small open economy wherein an increase in sovereign default risk negatively affects the government's borrowing capacity. The effect on the government's borrowing capacity increases the probability of fiscal austerity which is rationally anticipated by agents; this anticipation then has real effects. We establish empirically that increased default risk reduces employment in manufacturing industries that are ex ante more exposed or sensitive to default risk due to greater dependence on government demand.

Specifically, increased default probabilities drive lower employment growth in industries that are relatively more exposed to Puerto Rican government demand. This finding is consistent with our novel mechanism whereby default risk impacts austerity risk and agents

rationally anticipate future austerity. Further, the magnitude of the negative effect of default risk on employment growth in government-demand-dependent industries increases when the government undertakes austerity measures. A potential rationale for these results is that agents learn about future government policy when they observe how austerity measures are implemented in response to increased default risk.

To confirm the plausibility of our proposed mechanism, we also show that austerity has a contractionary effect on output and verify that controlling for the widely explored bank lending channel does not qualitatively affect our results. We also find that increased default probabilities drives lower employment growth in external finance dependent industries. Given the degree of Puerto Rico's financial integration with the U.S., the finding is surprising. Our results also suggest that increased credit risk significantly increased the cost of capital for the Puerto Rican government and Puerto Rican banks.

The lessons learned from Puerto Rico's crisis apply to state and municipal governments throughout the United States. Tax preferences can create large-scale economic bubbles, tax-exempt bonds can inflate debt levels, and delaying comprehensive tax reform can cause substantial fiscal problems in the face of adverse shocks that increase government default risk. Increased default risk following such shocks can also drive the government to cut spending, which can further reduce output and employment, especially in industries directly reliant on government demand. Importantly, our results suggest that firms can anticipate government spending cuts and reduce hiring when default risk increases.

While the literature explores the effects of default risk on financial intermediation, existing models that embed sovereign default risk have paid less attention to demand-driven transmission mechanisms. We propose a mechanism whereby sovereign default risk can create demand-driven recessions and confirm that the channel operates for the case of Puerto Rico.

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Table 1: Summary Statistics

	Obs	Mean	Std. Dev.	Median	P25	P75	Min	Max
Industry-Level Statistics								
$Employees$	1,343	3,930.8	4,690.1	2,006.9	1196.8	4993.8	271.3	23,901.4
$OutputShare$	102	0.0563	0.1611	0.0035	0.0019	0.0164	0.0003	0.6955
$EXTFIN^{US}$	17	-0.3709	0.6080	-0.4496	-0.6572	-0.2329	-1.1710	1.5617
GOV	17	0.0191	0.0187	0.0139	0.0058	0.0281	0.0027	0.0692
LD	17	0.5384	0.2792	0.5694	0.2860	0.8008	0.0467	0.9777
ΔE	1,343	-0.0036	0.0292	-0.0031	-0.0123	0.0048	-0.2948	0.2670
SH	1,343	0.0059	0.0070	0.0030	0.0018	0.0074	0.0004	0.0358
Macroeconomic Statistics								
$\Delta capb$	7	0.0032	0.0130	-0.0012	-0.0046	0.0170	-0.0117	0.0255
ΔDEF	90	0.0092	0.0833	0.0026	-0.0192	0.0341	-0.2982	0.2814
Local Fiscal Multiplier Statistics								
ΔDEF	136	0.0684	0.1662	0.0707	-0.0353	0.1649	-0.2235	0.3698
$\Delta capb$	266	-0.0021	0.0154	-0.0034	-0.0075	0.0128	-0.0327	0.0227
GOV	136	0.0191	0.0187	0.0139	0.0058	0.0281	0.0027	0.0692
ΔY	266	-0.0079	0.1108	0.0098	-0.0337	0.0281	-0.6846	0.5110

Notes: *Employees* measures the industry-level monthly number of employees. *OutputShare* is the annual average share of total manufacturing income. ΔDEF is the change in the monthly average of the five-year cumulative default probability for the Commonwealth of Puerto Rico. $EXTFIN^{US}$ is the Rajan and Zingales (1998) measure of industry-level dependence on external finance, calculated for the 2000-2015 period. GOV measures industry-level dependence on government demand. LD proxies local demand by measuring the share of sales to Puerto Rican customers. ΔE is the industry-level monthly employment growth rate. SH is the industry-level share of total private employment. $\Delta capb$ is the first difference in the cyclically adjusted primary balance (expressed as a percentage of potential output). ΔY is the industry-level annual output growth rate.

Table 2: Default Risk Granger Causes Discretionary Fiscal Policy

	$\Delta capb_{annual}$	ΔDEF_t
Constant	0.0039***	0.0030
	(0.0014)	(0.0120)
$\sum_{j=1}^{12} \Delta DEF_{t-j}$	0.2406	-0.8980
$\Delta capb_{prioryear}$	0.0853	0.5656
	(0.1093)	(0.8880)
Observations	79	79
F test ΔDEF jointly significant	2.20**	1.17
Prob>F	0.0219	0.3235

Notes: ΔDEF is the change in the monthly average of the five-year cumulative default probability for the Commonwealth of Puerto Rico. $\Delta capb$ is the annual first difference in the cyclically adjusted primary balance. The model is estimated using OLS. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Standard errors are in parentheses.

Table 3: Increased Default Probability & Austerity Associated with Significantly Lower Employment Growth in Government Demand Dependent Industries

	(1)	(2)	(3)
Constant	0.0116	0.0025	0.0154*
	(0.0076)	(0.0035)	(0.0086)
SH_{t-1}	-2.2381***	-0.3827	-2.2426***
	(0.6420)	(0.4113)	(0.6215)
$GOV * \Delta capb_{prioryear}$		-3.6859**	2.2507
		(1.3132)	(1.9278)
$\sum_{j=1}^{12} GOV * \Delta DEF_{t-j}$	-3.3875		-5.9455
$\sum_{j=1}^{12} GOV * \Delta DEF_{t-j} * \Delta capb_{prioryear}$			-271.5450
Observations	1,343	2,907	1,343
Industry Fixed Effects	Y	Y	Y
Time Fixed Effects	Y	Y	Y
F test $GOV * \Delta DEF$ jointly significant	5.67***		6.66***
Prob> F	0.0009		0.0003
F test $GOV * \Delta DEF * \Delta capb_{prioryear}$ jointly significant			151.55***
Prob> F			0.0000

Notes: ΔDEF is the change in the monthly average of the five-year cumulative default probability for the Commonwealth of Puerto Rico and runs from June 2008 to November 2015. GOV measures industry-level dependence on government sales from the 2012 Economic Census. $\Delta capb_{prioryear}$ is the prior year first difference in the cyclically adjusted primary balance, expressed as a percentage of potential output. SH_{t-1} is the lagged industry-level share of total private employment. This table presents the aggregated coefficient on 12 lags of the $EXTFIN^{US} * \Delta DEF$ variable and $\Delta capb_{prioryear} * \Delta DEF$. Appendix Table A4 presents the dis-aggregated coefficients on the 12 lags of the interaction terms between GOV and $\Delta capb_{prioryear}$ with ΔDEF. The model is estimated using OLS. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Standard errors are in parentheses and are clustered by industry.

Table 4: Increased Default Probability & Austerity Associated with Economically Significantly Lower Employment Growth in Industries More Dependent on Government Demand

	ΔDEF	ΔDEF	ΔDEF
	25th pctile	75th pctile	90th pctile
GOV 25th pctile	-0.0012	-0.0023	-0.0034
GOV 75th pctile	0.0002	-0.0049	-0.0101
Difference	0.0015	-0.0026	-0.0068
Percent of average monthly employment growth	40.3%	71.6%	188.2%
	$\Delta capb$	$\Delta capb$	$\Delta capb$
	25th pctile	75th pctile	90th pctile
GOV 25th pctile	0.0003	-0.0001	-0.0003
GOV 75th pctile	0.0007	-0.0014	-0.0022
Difference	0.0003	-0.0013	-0.0019
Percent of average monthly employment growth	9.7%	35.7%	53.4%

Notes: Each figure in the top panel of the table comes from this formula: $\hat{\alpha} + \hat{\nu} * \bar{SH} + \sum_{j=1}^{12} \hat{\delta_{t-j}} * GOV * \Delta DEF$. The cells vary according to values of GOV and ΔDEF. The coefficients used are from the benchmark regression in Table 3 Column 1. Each figure in the bottom panel of the table comes from this formula: $\hat{\alpha} + \hat{\nu} * \bar{SH} + \sum_{j=1}^{12} \hat{\delta_{t-j}} * GOV * \Delta DEF + \hat{\beta} * GOV * \Delta capb_{prioryear} + \sum_{j=1}^{12} \hat{\gamma_{t-j}} * GOV * \Delta DEF * \Delta capb_{prioryear}$. The cells vary according to values of GOV and $\Delta capb$. The coefficients used are from the benchmark regression in Table 3 Column 2.

Table 5: Austerity and Default Risk Have Real Effects on the Output Growth of Puerto Rican Manufacturers

	(1)	(2)	(3)
Constant	-0.0088	-0.0095***	-0.0053
	(0.0066)	(0.0010)	(0.0274)
ΔY_{it-1}	0.2349**	0.1464	0.1750*
	(0.1113)	(0.1118)	(0.0972)
$\Delta capb_t$	-0.9470***	-1.0703***	
	(0.2890)	(0.3101)	
$GOV * \Delta DEF_t$			-6.2783*
			(3.0879)
Observations	266	266	136
Sector Fixed Effects	N	Y	Y
Time Fixed Effects	N	N	Y

Notes: ΔDEF is the change in the annual average of the five-year cumulative default probability for the Commonwealth of Puerto Rico. $\Delta capb$ is the annual first difference in the cyclically adjusted primary balance (expressed as a percentage of potential output). GOV measures industry-level dependence on government demand. ΔY is the industry-level annual output growth rate.

Table 6: Increased Default Probability is Associated with Statistically Significant Lower Employment Growth in Industries More Dependent on External Finance

	(1)	(2)	(3)
Constant	0.0189**	0.0170**	0.0155*
	(0.0078)	(0.0072)	(0.0077)
SH_{t-1}	-2.7585***	-2.6101***	-2.5770***
	(0.7085)	(0.5855)	(0.5877)
$\sum_{j=1}^{12} EXTFIN^{US} * \Delta DEF_{t-j}$	-0.0313	-0.0931	-0.0814
$\sum_{j=1}^{12} LD * \Delta DEF_{t-j}$		-0.0628	0.2438
$\sum_{j=1}^{12} GOV * \Delta DEF_{t-j}$			-6.5147
Observations	1,501	1,422	1,343
Industry Fixed Effects	Y	Y	Y
Time Fixed Effects	Y	Y	Y
F test $EXTFIN^{US} * \Delta DEF$ jointly significant	25.90***	36.35***	31.41***
Prob>F	0.0000	0.0000	0.0000
F test $LD * \Delta DEF$ jointly significant		12.33***	108.13***
Prob> F		0.0000	0.0000
F test $GOV * \Delta DEF$ jointly significant			171.63***
Prob> F			0.0000

Notes: ΔDEF is the change in the monthly average of the five-year cumulative default probability for the Commonwealth of Puerto Rico. SH_{t-1} is the lagged industry-level share of total private employment. GOV measures industry-level dependence on government sales from the 2012 Economic Census. $EXTFIN^{US}$ is the Rajan and Zingales (1998) measure of industry-level dependence on external finance, calculated for the 2000-2015 period. LD proxies local demand by measuring the share of sales to Puerto Rican customers. This table presents the aggregated coefficient on 12 lags of the $EXTFIN^{US} * \Delta DEF$, the $LD * \Delta DEF$, and the $GOV * \Delta DEF$ variables. Appendix Table A3 presents the dis-aggregated coefficients on the 12 lags. The model is estimated using OLS. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Standard errors are in parentheses and are clustered by industry.

Table 7: Increased Default Probability is Associated with Economically Significant Lower Employment Growth in Industries More Dependent on External Finance and Government Demand

	ΔDEF 25th pctile	ΔDEF 75th pctile	ΔDEF 90th pctile
$EXTFIN^{US}$ 25th pctile	-0.0009	0.0024	0.0057
$EXTFIN^{US}$ 75th pctile	-0.0002	0.0012	0.0026
Difference	0.0007	-0.0012	-0.0031
Percent of average monthly employment growth	18.4%	32.7%	86.1%
GOV 25th pctile	-0.0021	0.0045	0.0114
GOV 75th pctile	0.0007	-0.0004	-0.0016
Difference	0.0028	-0.0050	-0.0130
Percent of average monthly employment growth	77.5%	137.6%	362.0%

Notes: Each figure in the body of the table comes from this formula: $\hat{\alpha} + \hat{\nu} * \bar{SH} + \sum_{j=1}^{12} \hat{\delta_{t-j}} * GOV_i * \Delta DEF_{t-j} + \sum_{j=1}^{12} \hat{\gamma_{t-j}} * EXTFIN_i^{US} * \Delta DEF_{t-j} + \sum_{j=1}^{12} \hat{\beta_{t-j}} * LD_i * \Delta DEF_{t-j}$. The cells vary according to values of $EXTFIN^{US}$, ΔDEF, and GOV. The coefficients used are from the benchmark regression in Table 6 Column 3.

Table 8: Default Risk Granger Causes Commercial and Industrial Lending

	ΔCIL_t	ΔDEF_t
Constant	-0.0014***	0.0062
	(0.0005)	(0.0108)
$\sum_{j=1}^{12} \Delta DEF_{t-j}$	-0.017	-0.8538
$\sum_{k=1}^{4} \Delta CIL_{t-k}$	-0.1541	1.6753
Observations	79	79
F test ΔDEF jointly significant	4.71***	1.01
Prob>F	0.0000	0.4548
F test ΔCIL jointly significant	2.14*	0.24
Prob>F	0.0858	0.9156

Notes: ΔDEF is the change in the monthly average of the five-year cumulative default probability for the Commonwealth of Puerto Rico. ΔCIL is the quarterly first difference in commercial and industrial loans as a percentage of GNP. The model is estimated using OLS. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Standard errors are in parentheses.

Figure 2: Puerto Rico GNP vs. U.S. GNP

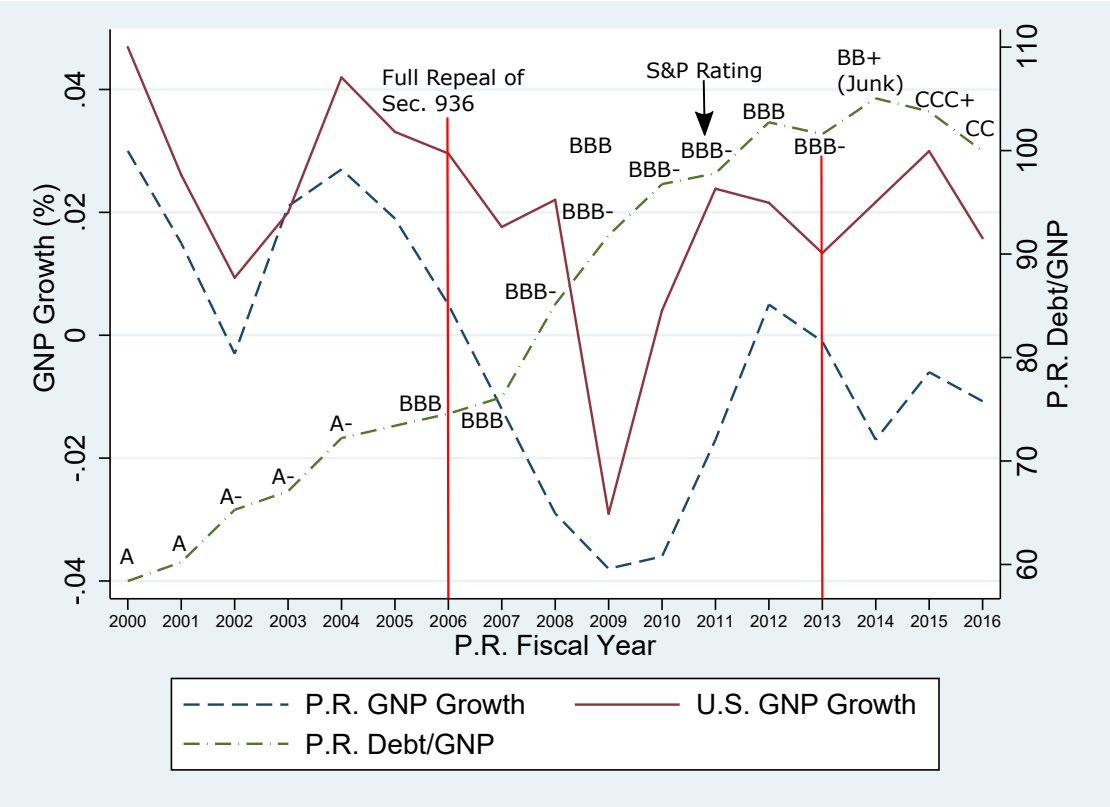


Figure 3: Employment and Yields

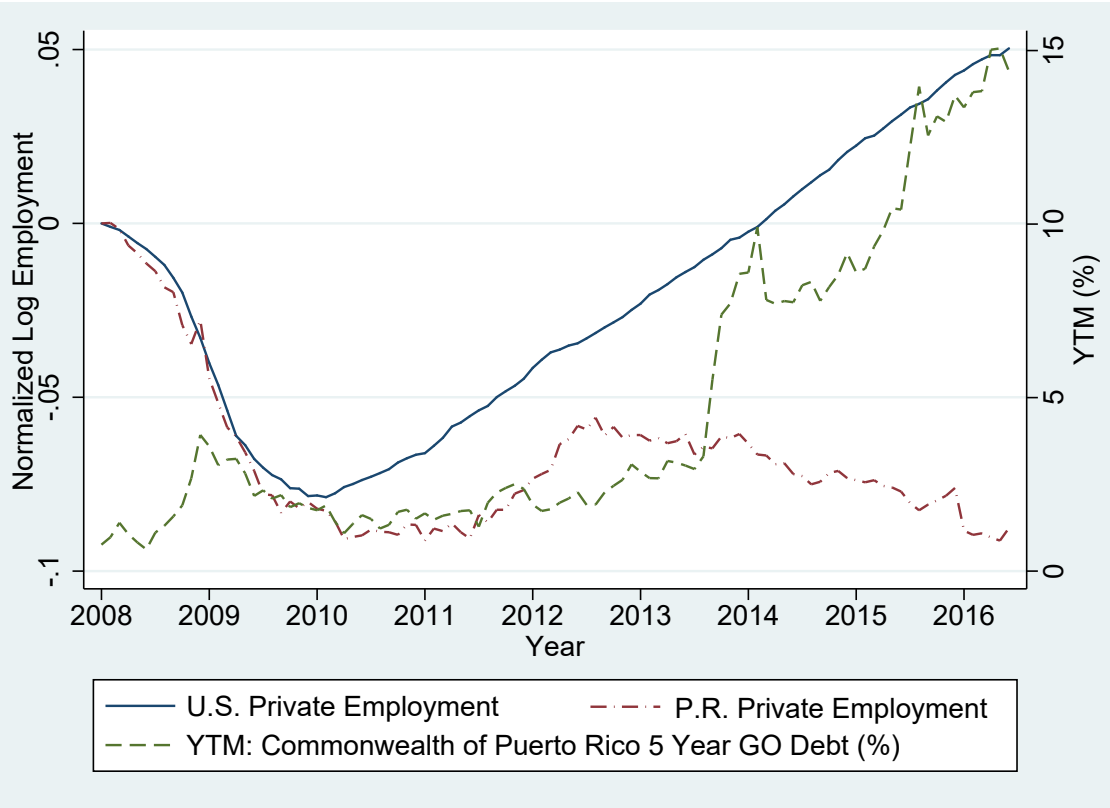


Figure 4: Employment by Dependence on Government Demand and Default Probability

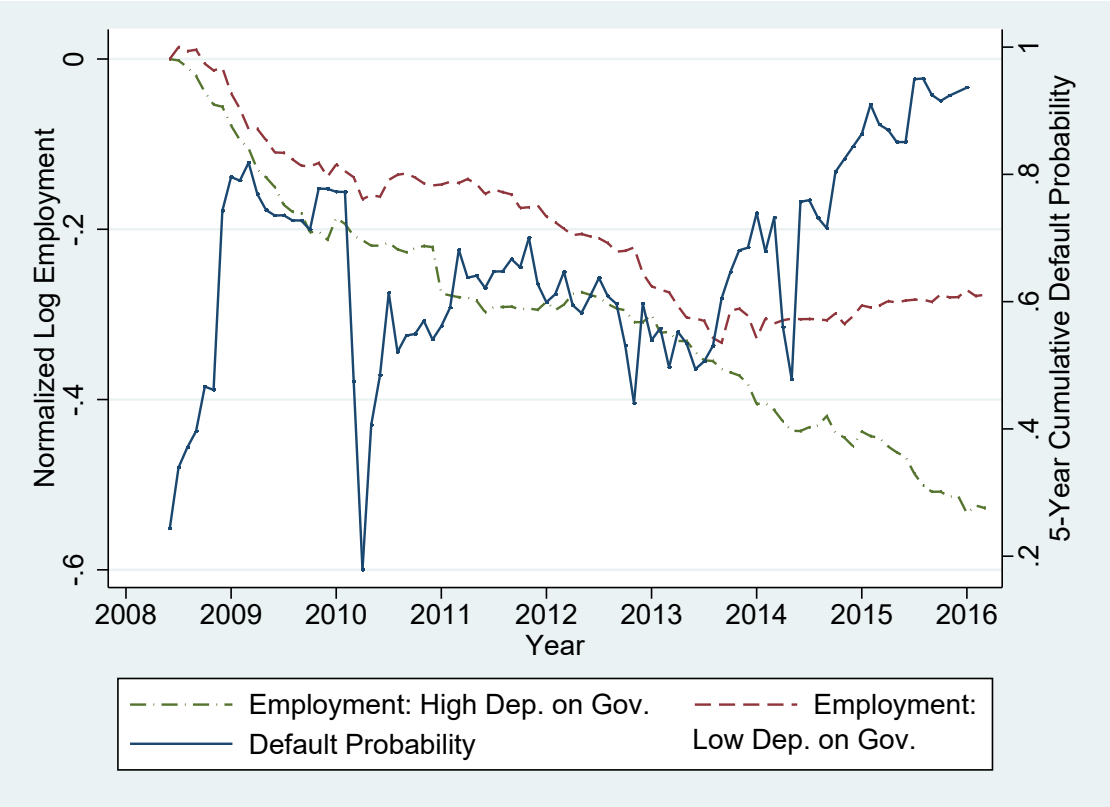


Figure 5: Employment by Dependence on Government Demand and Austerity

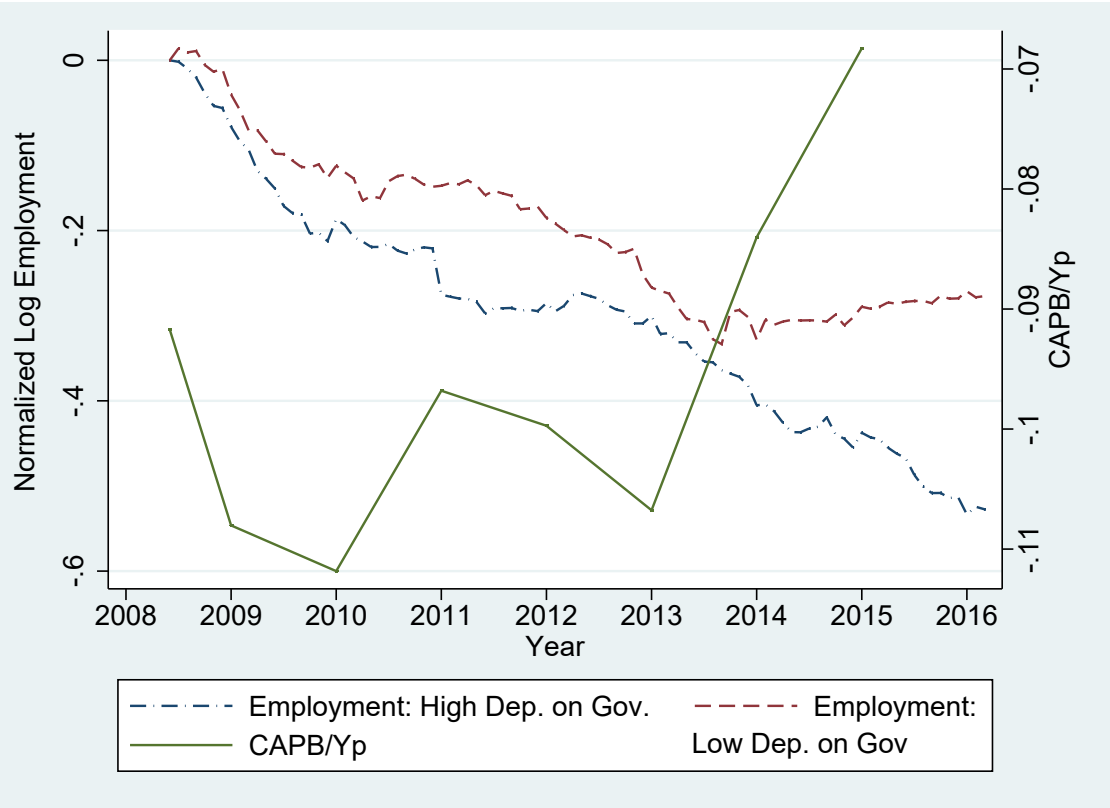


Figure 6: Marginal Effects of Austerity and Default Risk

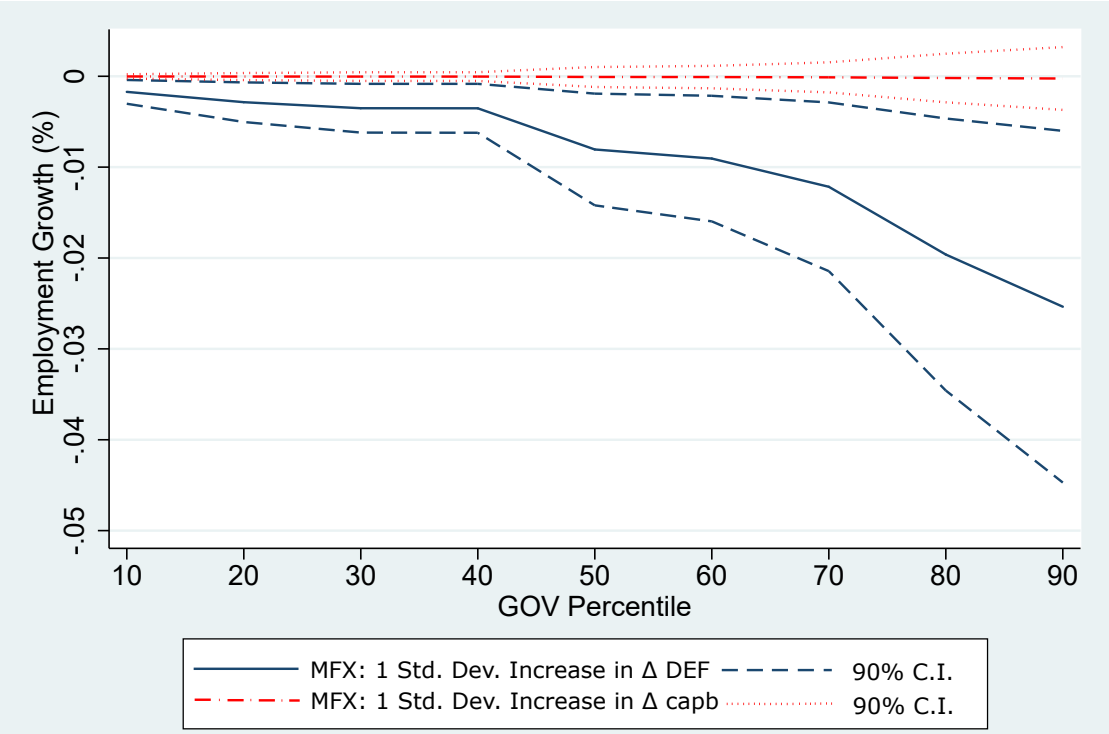


Figure 7: Marginal Effects of Default Risk Across Austerity

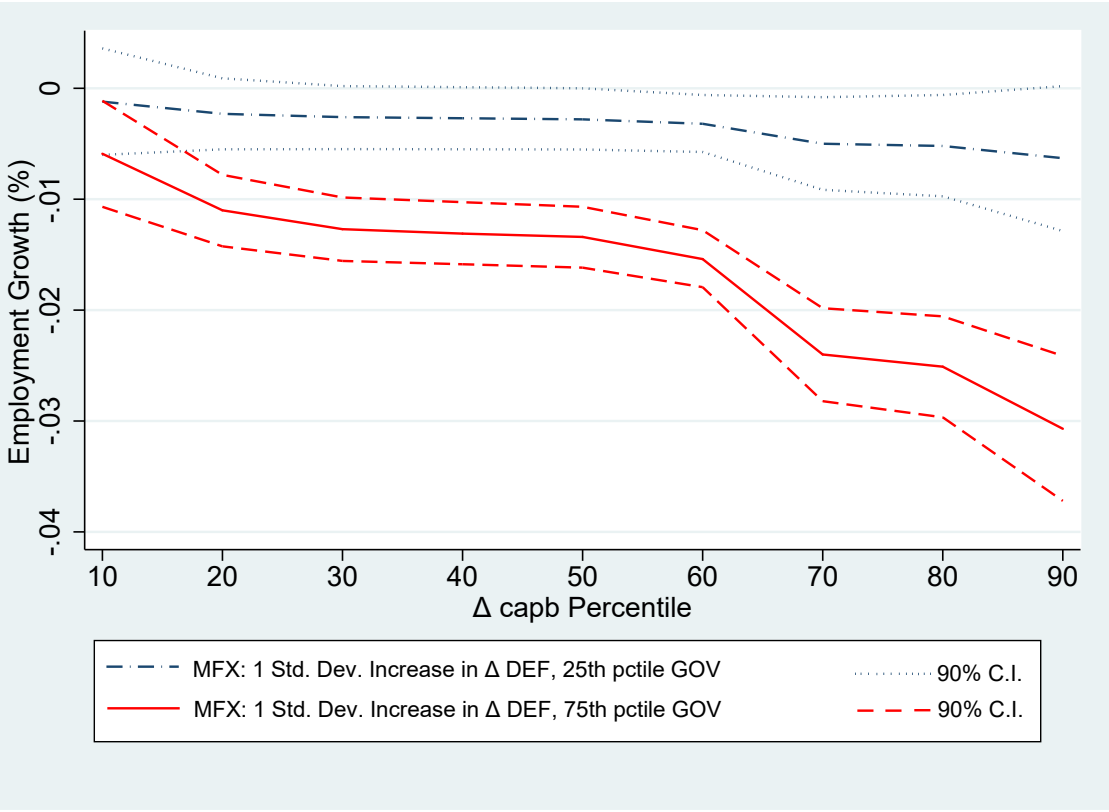


Figure 8: Marginal Effects of Austerity Across Default Risk

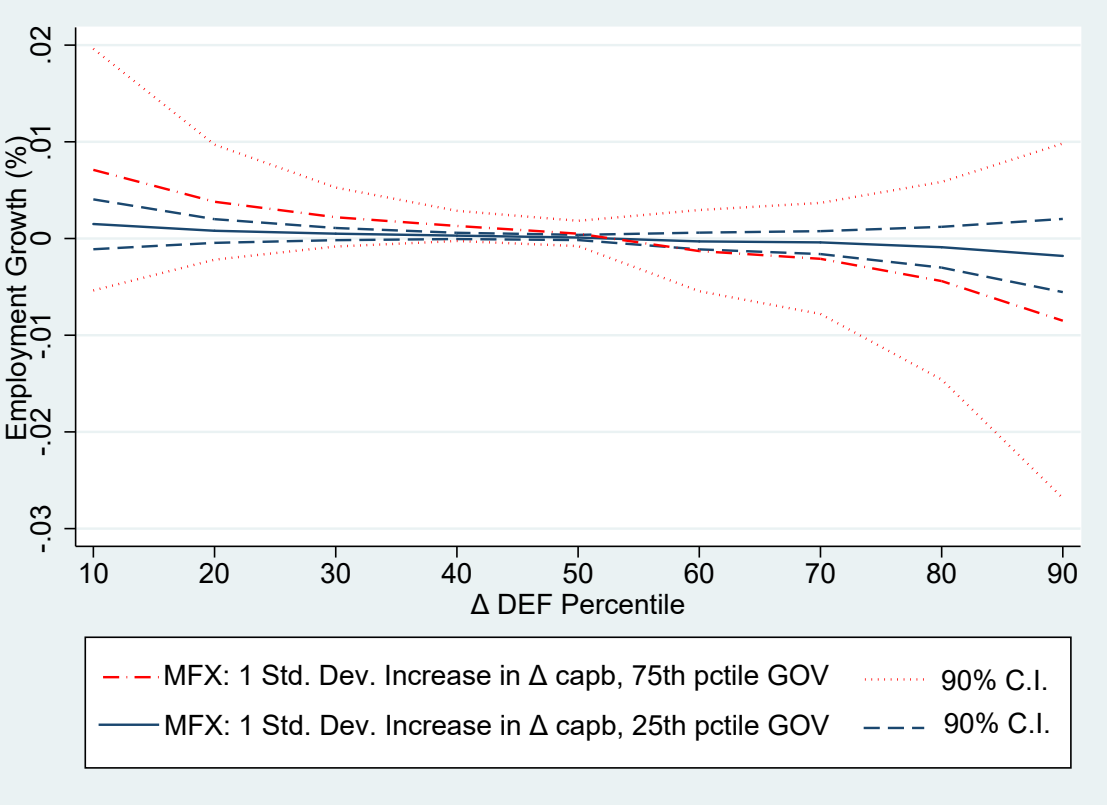


Figure 9: Employment by Dependence on External Finance and Default Probability

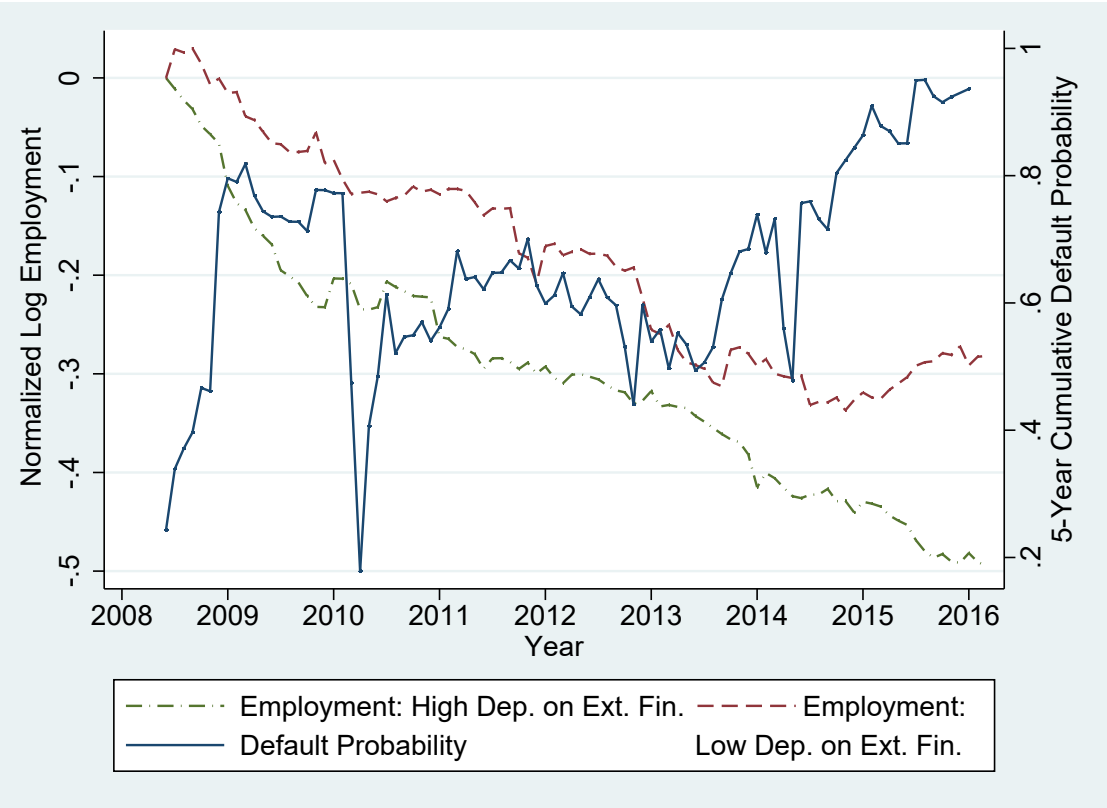


Figure 10: Puerto Rican Banking and Puerto Rico's Crisis

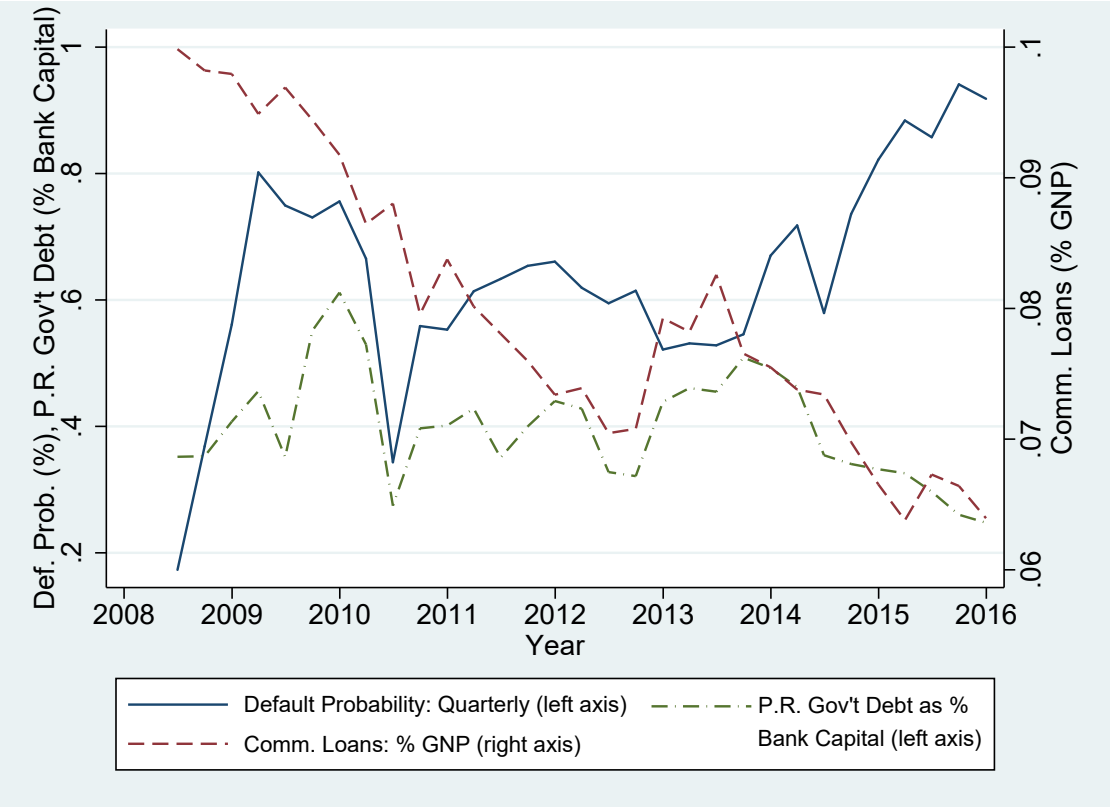
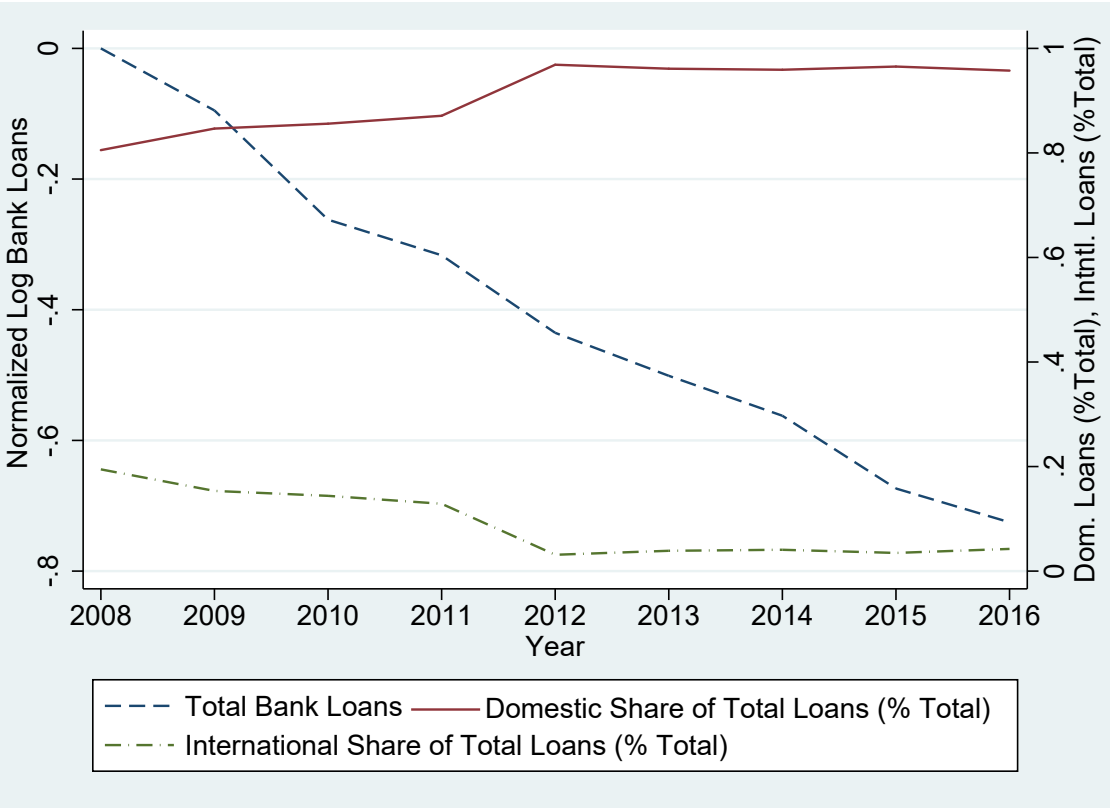


Figure 11: International Banking and Puerto Rico's Crisis



Appendix A Data Construction

A.1 Government Demand Dependence Rankings

Table A.1 shows industry medians of dependence on external finance and the share of sales to the Puerto Rican government for each three-digit NAICS manufacturing industry.

Table A.1: External Finance Dependence and Government Demand Dependence

NAICS Code	Industrial Sector	External Dependence	Government Dependence
311	Food Manufacturing	-0.6711	0.0030
312	Beverage and Tobacco Product Manufacturing	0.1276	0.0049
315	Apparel Manufacturing	-1.171	0.0061
316	Leather and Allied Product Manufacturing	-1.0902	
321	Wood Product Manufacturing	-0.723	0.0058
322	Paper Manufacturing	-0.2329	0.0148
323	Printing and Related Support Activities	-1.1321	0.0338
324	Petroleum and Coal Products Manufacturing	-0.4441	0.0692
325	Chemical Manufacturing	1.5617	0.0061
326	Plastics and Rubber Products Manufacturing	-0.6572	0.0139
327	Nonmetallic Mineral Product Manufacturing	-0.5215	0.0422
331	Primary Metal Manufacturing	-0.3813	0.0156
332	Fabricated Metal Product Manufacturing	-0.4496	0.0281
333	Machinery Manufacturing	-0.3021	0.0027
334	Computer and Electronic Product Manufacturing	0.0108	0.0089
335	Electrical Equipment_ Appliance_ and Component Manufacturing	-0.5638	0.0044
336	Transportation Equipment Manufacturing	-0.5637	0.0209
337	Furniture and Related Product Manufacturing	-0.1022	0.0437
339	Miscellaneous Manufacturing	-0.2014	
Average		-0.3951	0.0191
Correlation			-0.1461

A.2 Construction of Industry Level Dependence on External Finance

Following Rajan and Zingales (1998), we base our calculation of industry-level dependence on external finance on firm-level data from Compustat. Given our benchmark sample period of 2008-2015 and our sample period used in robustness checks of 2001-2015, we calculate dependence on external finance for 2005-2015 and 2000-2015. We use the 2000-2015 calculation period in our benchmark results as this extended period reduces fluctuations related to the financial crisis. For an additional robustness check, we also calculate dependence on external

finance for the years 1995-2005, capturing pre-crisis dependence on external finance. As a first step, we merge the Compustat annual fundamentals database with the CRSP database based on firm cusip numbers and years. Following Rajan and Zingales (1998), we use CRSP SIC codes to classify each firm's industry.[42] Then, we match each four-digit SIC code in the merged Compustat-CRSP database with NAICS three-digit industry codes using the concordance tables provided by the Census. If four-digit SIC codes are not matched, we match them at the three-digit and then the two-digit level. With each firm matched with one or more NAICS three-digit industries, we calculate each firm's dependence on external finance using the following formula:

$$EXTFIN = \frac{CAPX - CFOPER}{CAPX} \tag{17}$$

where $CAPX$ is total capital expenditures and $CFOPER$ is total cash flows from operations of a given firm over each of the periods of calculation discussed above. The calculation of $CAPX$ and $CFOPER$ follow Rajan and Zingales (1998). Finally, we take the median value of $EXTFIN$ for U.S. firms in each NAICS three-digit industry. Table A.2 shows industry medians of dependence on external finance for each three-digit NAICS manufacturing industry for which we have Puerto Rican employment data, ranked using the benchmark period 2000-2015. Note that average dependence on external finance is lowest during the periods 2000-2015 and 2005-2015, which include the financial crisis, indicating a tendency for firms to retain cash flow from operations rather than invest in capital expenditures. However, note the ranking of industries by dependence on external finance is fairly stable, and that the measure is highly correlated across the three calculation periods.

[42] Although CRSP does provide NAICS codes, they are only available beginning in 2004.

Table A.2: External Finance Dependence Across United States Manufacturers

NAICS Code	Industrial Sector	External Dependence 2000-2015	External Dependence 2005-2015	External Dependence 1995-2005
315	Apparel Manufacturing	-1.1710	-1.5495	-0.5531
323	Printing and Related Support Activities	-1.1321	-1.5563	-0.4805
316	Leather and Allied Product Manufacturing	-1.0902	-1.5862	-0.2819
321	Wood Product Manufacturing	-0.7230	-0.8197	-0.2726
311	Food Manufacturing	-0.6711	-0.7194	-0.4889
326	Plastics and Rubber Products Manufacturing	-0.6572	-0.9288	-0.2062
335	Electrical Equipment_ Appliance_ and Component Manufacturing	-0.5638	-0.6961	-0.0826
336	Transportation Equipment Manufacturing	-0.5637	-0.8203	-0.1092
327	Nonmetallic Mineral Product Manufacturing	-0.5215	-0.6989	-0.1295
332	Fabricated Metal Product Manufacturing	-0.4496	-0.6718	0.1046
324	Petroleum and Coal Products Manufacturing	-0.4441	-0.5795	-0.2895
331	Primary Metal Manufacturing	-0.3813	-0.7437	-0.2090
333	Machinery Manufacturing	-0.3021	-1.0246	0.2885
322	Paper Manufacturing	-0.2329	-0.5081	0.4896
339	Miscellaneous Manufacturing	-0.2014	-0.7525	0.4058
337	Furniture and Related Product Manufacturing	-0.1022	-0.7456	0.4691
334	Computer and Electronic Product Manufacturing	0.0108	-1.0150	0.5639
312	Beverage and Tobacco Product Manufacturing	0.1276	-0.3693	0.5041
325	Chemical Manufacturing	1.5617	1.1730	1.4019
Average		-0.3951	-0.7691	0.0592
Correlation with 2000-2015			0.9140	0.9268

A.3 Tax Adjustment

We compute the tax-adjusted yield using the following formula:

$$1 - \tau = (1 - \tau^{fed})(1 - \tau^{state-weighted})(1 - PRshare) + (1 - \tau^{PR})(PRshare) \tag{18}$$

$$y_{it}^{TA} = \frac{y_{it}}{1 - \tau} \tag{19}$$

where τ^{fed} is the federal top marginal income tax rate, $\tau^{state-weighted}$ is the population and incentive weighted average state top marginal income tax rate, τ^{PR} is Puerto Rico's top

marginal income tax rate, y_{it} is the raw yield on the Puerto Rican security, and y_{it}^{TA} is the tax-adjusted yield on a Puerto Rican security. The first term adjusts for the fact that state income tax payments are deductible from federal taxable income for residents of U.S. states (see Schwert (2017)). Puerto Rican residents do not pay federal income tax, so the second term does not contain a correction for this deduction. In order to arrive at the tax-adjusted yield, we need assumptions regarding the residence of holders of Puerto Rico's debt and their tax rates.

First, we compute the average top marginal state income tax rate of mainland U.S. residents holding Puerto Rican debt. As we do not have data on geographical holdings of Puerto Rican debt, we assume that Puerto Rican debt is held by mainland residents according to each state's population and tendency to hold tax exempt debt, which enjoys the same tax benefits as Puerto Rican debt held in each state using the following formula:

$$\tau^{state-weighted} = \sum_{i=1}^{50} t_i w_i \tag{20}$$

$$w_i = \frac{Pop_i s_i}{\sum_{i=1}^{50} Pop_i s_i} \tag{21}$$

where t_i is the top marginal income tax rate in state i, Pop_i is the population of state i and s_i is the share of the total municipal debt of state i held by state funds from Babina et al. (2017). We find $\tau^{state-weighted} = 6.86\%$.

We also need an assumption regarding the share of Puerto Rican municipal debt held by Puerto Rican residents ($PRshare$). We do not have any data on this share, so we assume Puerto Rican residents hold 50.58% of Puerto Rican municipal debt. This figure follows Babina et al. (2017), who find that state funds hold an average of 50.58% of state debt held by all funds in the U.S. states with the highest state income tax rates and hence the greatest incentives to hold local debt. Puerto Rico's top marginal income tax rate of 33% would make it the state with the highest top marginal income tax rate. The federal income tax top marginal tax rate was 35% from the beginning of the sample through 2012, and 39.6% thereafter. For robustness, we repeat the benchmark results assuming that all Puerto

Rican municipal debt is held by mainland investors in the state with the highest income tax (California 13.3%), by investors in a state with an income tax rate of 0%, of which there are several, and by Puerto Rican residents. The results are robust to all of these alternatives.

A.4 External Finance Channel: Dis-aggregated Lags

Table A.3: Increased Default Probability is Associated with Statistically Significant Lower Employment Growth in Industries More Dependent on External Finance

	(1)	(2)	(3)
Constant	-0.0037***	0.0110**	0.0189**
	(0.0009)	(0.0044)	(0.0078)
SH_{t-1}	0.0301	-2.3129***	-2.7585***
	(0.0877)	(0.7042)	(0.7085)
$EXTFIN^{US} * \Delta DEF_{t-1}$			0.0295
			(0.0441)
$EXTFIN^{US} * \Delta DEF_{t-2}$			-0.0147
			(0.0133)
$EXTFIN^{US} * \Delta DEF_{t-3}$			-0.0339***
			(0.0114)
$EXTFIN^{US} * \Delta DEF_{t-4}$			-0.0069
			(0.0212)
$EXTFIN^{US} * \Delta DEF_{t-5}$			-0.0187*
			(0.0104)
$EXTFIN^{US} * \Delta DEF_{t-6}$			-0.0008
			(0.0092)
$EXTFIN^{US} * \Delta DEF_{t-7}$			0.0051
			(0.0202)
$EXTFIN^{US} * \Delta DEF_{t-8}$			-0.0029
			(0.0028)
$EXTFIN^{US} * \Delta DEF_{t-9}$			0.0109
			(0.0138)
$EXTFIN^{US} * \Delta DEF_{t-10}$			-0.0183
			(0.0237)
$EXTFIN^{US} * \Delta DEF_{t-11}$			0.0117
			(0.0079)
$EXTFIN^{US} * \Delta DEF_{t-12}$			0.0077
			(0.0068)
Observations	1,501	1,501	1,501
Industry Fixed Effects	N	Y	Y
Time Fixed Effects	N	N	Y
F test $EXTFIN^{US} * \Delta DEF$ jointly significant			25.90***
Prob>F			0.0000

Notes: This table presents disaggregated coefficients on all 12 lags on the $EXTFIN^{US}$ variable interacted with ΔDEF. Table 1 presents the summation of the coefficients on the 12 lags. ΔDEF is the change in the monthly average of the five-year cumulative default probability for the Commonwealth of Puerto Rico. $EXTFIN^{US}$ is the Rajan and Zingales (1998) measure of sector-level dependence on external finance, calculated for the 2000-2015 period. SH_{t-1} is the lagged sector-level share of total private employment. The model is estimated using OLS. ***,**,and * indicate significance at the 1%, 5%, and 10% levels, respectively. Standard errors are in parentheses and are clustered by industry.

A.5 Government Demand Channel: Dis-aggregated Lags

Table A.4: Increased Default Probability and Austerity are Associated with Statistically Significant Lower Employment Growth in Industries More Dependent on Government Demand

	(1)	(2)	(3)
Constant	0.0116	0.0024	0.0154*
	(0.0076)	(0.0035)	(0.0086)
SH_{t-1}	-2.2381***	-0.3906	-2.2528***
	(0.6420)	(0.4102)	(0.6194)
$GOV * \Delta capb_{prioryear}$		-4.1315**	2.1801
		(1.7557)	(1.9881)
$GOV * \Delta DEF_{t-1}$	-0.5352		-0.8477*
	(0.3883)		(0.4273)
$GOV * \Delta DEF_{t-2}$	-1.3099**		-2.4579**
	(0.5517)		(0.9241)
$GOV * \Delta DEF_{t-3}$	0.3883		0.1233
	(0.5235)		(0.7205)
$GOV * \Delta DEF_{t-4}$	-0.9426		-1.8671***
	(0.5887)		(0.6350)
$GOV * \Delta DEF_{t-5}$	0.5832**		0.0415
	(0.2345)		(0.3918)
$GOV * \Delta DEF_{t-6}$	-1.0592		-1.1126
	(0.7718)		(0.7054)
$GOV * \Delta DEF_{t-7}$	-0.5001		0.0907
	(0.4634)		(0.7654)
$GOV * \Delta DEF_{t-8}$	-0.3141		-0.1884
	(0.3053)		(0.2785)
$GOV * \Delta DEF_{t-9}$	0.0909		-0.2080
	(0.6757)		(0.5577)
$GOV * \Delta DEF_{t-10}$	-0.0580		-0.6486
	(0.5809)		(0.7644)
$GOV * \Delta DEF_{t-11}$	-0.1724		-0.2171
	(0.5049)		(0.6867)
$GOV * \Delta DEF_{t-12}$	0.4416		0.4816
	(0.3930)		(0.3401)
$GOV * \Delta DEF_{t-1} * \Delta capb_{prioryear}$			-15.1763
			(48.7624)
$GOV * \Delta DEF_{t-2} * \Delta capb_{prioryear}$			-126.9472*
			(63.0551)
$GOV * \Delta DEF_{t-3} * \Delta capb_{prioryear}$			-8.2246
			(69.0388)
$GOV * \Delta DEF_{t-4} * \Delta capb_{prioryear}$			-79.4172
			(46.1591)
$GOV * \Delta DEF_{t-5} * \Delta capb_{prioryear}$			-44.1985
			(44.3249)
$GOV * \Delta DEF_{t-6} * \Delta capb_{prioryear}$			-6.2832
			(36.0750)
$GOV * \Delta DEF_{t-7} * \Delta capb_{prioryear}$			91.8706
			(90.3562)
$GOV * \Delta DEF_{t-8} * \Delta capb_{prioryear}$			6.6506
			(19.6297)
$GOV * \Delta DEF_{t-9} * \Delta capb_{prioryear}$			-23.1996
			(54.0526)
$GOV * \Delta DEF_{t-10} * \Delta capb_{prioryear}$			-83.9926
			(66.4269)
$GOV * \Delta DEF_{t-11} * \Delta capb_{prioryear}$			10.8382
			(25.3079)
$GOV * \Delta DEF_{t-12} * \Delta capb_{prioryear}$			-5.8934
			(25.8329)
Observations	1,343	2,907	1,343
Industry Fixed Effects	Y	Y	Y
Time Fixed Effects	Y	Y	Y
F test $GOV * \Delta DEF$ jointly significant	5.67***		9.95***
Prob> F	0.0009		0.0000
F test $GOV * \Delta DEF * \Delta CAPB_{prioryear}$ jointly significant			108.47***
Prob> F			0.0000

Notes: This table presents disaggregated coefficients on all 12 lags on the GOV variable. Table 6 presents the summation of the coefficients on the GOV variable interacted with ΔDEF. ΔDEF is the change in the monthly average of the five-year cumulative default probability for the Commonwealth of Puerto Rico and runs from June 2008 to November 2015. GOV measures sector-level dependence on government sales from the 2012 Economic Census. $\Delta CAPB_{prioryear}$ is the prior year first difference in the cyclically adjusted primary balance, expressed as a percentage of potential output. SH_{t-1} is the lagged sector-level share of total private employment. The model is estimated using OLS. ***,**,and * indicate significance at the 1%, 5%, and 10% levels, respectively. Standard errors are in parentheses and are clustered by industry.

Appendix B Diverging Growth Rates between Puerto Rico and the U.S. Mainland

In this section, we examine real economic growth in Puerto Rico relative to the U.S. mainland. US mainland growth provides a useful comparison as the data suggest that Puerto Rico's economy is highly dependent on mainland growth and is subject to similar macroeconomic shocks. We first observe and then formally test whether the data support the hypothesis that the cointegrating relationship between Puerto Rico and the U.S. mainland breaks down post-2012.

Figure 2 plots Puerto Rico's real GNP growth along with U.S. real GNP growth, Puerto Rico's debt-to-GNP ratio, and its credit rating. The figure suggests that the island's economic growth correlates with that of the mainland. However, the spike in Puerto Rican yields beginning in 2013 coincides with a decline in the island's growth and constitutes a divergence from its close correlation with the U.S. mainland prior to that. A more detailed examination of the figure also shows that beginning in 2006, Puerto Rico's economic growth slowed down significantly as investment in Puerto Rico declined following the full repeal of Section 936. Puerto Rico's GNP growth continued its decline through 2008 and with the compounding shock of the U.S. financial crisis reached a trough in 2009. Despite the dual shocks of the repeal of Section 936 and the U.S. financial crisis, Puerto Rico's GNP growth rate began increasing from 2010 to 2012, reaching a positive growth rate in 2012 for the first time since 2006. However, in 2012 Puerto Rico's debt surpassed 100% of GNP with subsequent years marked by continued downgrades of Puerto Rico's credit rating, which reached junk status in 2014. Post-2012, GNP growth rates turned negative once again. The continuing contraction was a striking divergence from the continued recovery of U.S. GNP growth, which Puerto Rico was tracking. Overall, the figure suggest that Puerto Rico's credit deterioration coincides with a divergence of Puerto Rico's close ties to U.S. real economic activity.

Figure 3 uses Puerto Rican and U.S. monthly private employment along with the raw

yield on five-Year Puerto Rican general obligation debt to present a closer look at Puerto Rico's recovery from the dual shocks of the repeal of section 936 and the U.S. financial crisis. Similar to Figure 2, this more granular plot shows that Puerto Rico began to recover from the expiration of Section 936 and the U.S. financial crisis in 2010. Puerto Rican normalized log private employment appears to track U.S. private employment into 2012. However, in 2012 and 2013, private employment stagnates while yields on Puerto Rican debt increased. In mid-to-late 2013, yields spiked and employment began a sharper decline. It appears that the increase in Puerto Rican yields coincides with a drop in Puerto Rican private employment. This reduction in Puerto Rican employment seems to break the cointegrating relationship with U.S. employment that existed before the period of increased yields. Puerto Rican yields continued to rise in 2014 and 2015, making it more costly for Puerto Rico to roll over its debt and indicating an increased risk of default.

Although Figures 2 and 3 merely provide visual hints that anticipation of Puerto Rico's default coincides with a decline in Puerto Rico's aggregate real activity, the data are suggestive of the hypothesis that Puerto Rico's economic decline was not a result of a mainland shock. Further, if the hypothesis that anticipation of Puerto Rico's default led to a decline in aggregate activity holds, we would expect that the timing of the divergence of Puerto Rico's activity from that of the U.S. mainland coincides with an increase in Puerto Rico's default risk. We can test whether the aggregate data are consistent with the hypothesis that anticipation of default coincides with a decline in real aggregate activity in Puerto Rico.

To do so, we conduct a difference-in-difference analysis of quarterly private employment growth, quarterly economic activity growth, and annual investment spending growth for 2006-2012 versus post-2012.[43] Our control group for the post-2012 period begins in 2006 as we attempt to identify the effect of Puerto Rico's increased default risk on the cointegrating relationship between Puerto Rico's economy and the U.S. economy following the repeal of Section 936. Therefore we limit the pre-2012 period to the years following the full repeal.

[43]As Section 4.1 describes, economic activity growth is quarterly real GDP growth for the U.S. and quarterly growth in the economic activity index from Puerto Rico's GDB for Puerto Rico.

Table B.1: Puerto Rico and U.S. Growth

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent Variable	P.R. Growth [2006-2012]	P.R. Growth [2013-]	Post-2012 Growth Relative to Pre-2012 Growth (P.R.)	U.S. Growth [2006-2012]	U.S. Growth [2013-]	Post 2012 Growth Relative to Pre-2012 Growth (U.S.)	Diff-in-Diff
Private Employment Growth	-.0034**	-.0021*	.0013	-.00004	.0054***	.0055***	-.0042***
	(.020)	(.061)	(.233)	(.978)	(.000)	(.000)	(.001)
N	28	14	14	28	14	14	14
Economic Activity Growth	-.0055***	-.0059***	-.0005	.0024*	.0053***	0.0029**	-.0034***
	(.000)	(.000)	(.674)	(.094)	(.000)	(.016)	(.008)
N	28	14	14	28	14	14	14
Investment Spending Growth	-.0149	-.0158**	-.0009	-.0038	.0097***	.0135***	-.0144**
	(.140)	(.042)	(.812)	(.690)	(.002)	(.001)	(.050)
N	7	3	3	7	3	3	3

Notes: Each column represents a regression of the variable listed on a constant. Column 1 shows the results of regressing either quarterly or annual log growth rates for 2006-2012 on a constant for P.R. Column 2 shows the results of the same exercise for 2013Q1-2016Q2 in the case of the first two variables, and 2013-2015 in the case of the third. Column 3 regresses the difference between the post-2012 growth rates and the pre-2013 average on a constant. I.e. a regression of the difference between the variable in column 2 and the average of the variable in column 1 on a constant. Columns 4-6 conduct an identical exercise for the U.S. Column 7 shows the difference in the difference for PR relative to the US or the difference between the variable in column 3 and the variable in column 6. P-Values are in parentheses.

***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

In columns 1 and 4 of Table B.1, we regress the growth rates of private employment, economic activity, and investment spending on a constant for the period 2006-2012 for Puerto Rico and the U.S. mainland, respectively.[44] The data indicate a substantial economic contraction in both Puerto Rico and the U.S. mainland for the 2006-2012 period. Columns 2 and 5 examine real activity in the post-2012 period.[45] The coefficient estimates suggest that while the U.S mainland began its recovery from the global financial crisis during this period, Puerto Rico's private employment, economic activity, and investment spending continued to contract. The estimates in Column 3 confirm that Puerto Rico's economic contraction continued in the post-2012 period. In contrast, the specification in Column 5 shows that the recovery in U.S. real GNP, private employment, and investment spending growth in the post-2012 period is highly statistically significant compared to the pre-2012 period.

Finally, Column 7 presents the difference-in-difference estimates for Puerto Rico less the U.S. mainland for all three variables. The results confirm that the difference in private quarterly employment growth in Puerto Rico and the U.S. mainland pre- and post-2012 is -0.42% and significant at the 1% level. That is, Puerto Rican employment growth from 2013Q1-2016Q2 was -0.42% lower than the rate predicted by its benchmark relationship with U.S. employment growth from 2006Q1-2012Q4. Similarly, Puerto Rican activity growth from 2013Q1-2016Q2 was -0.34% lower than the predicted rate from its relationship with U.S. activity growth from 2006Q1-2012Q4, significant at the 5% level. Puerto Rican investment growth post-2012 was -1.4% below the rate predicted by its relationship with U.S. investment growth pre-2012, significant at the 5% level.

The data confirm that in the post-2012 period, the cointegrating relationship of real activity in Puerto Rico and the U.S. mainland appears to break down. The data appear consistent with the hypothesis that the continued contraction in Puerto Rico's economy post-2012 was due to Puerto Rico specific shocks, rather than shocks originating from the U.S. mainland. Further, recall that in the post-2012 period there was a significant increase

[44]Data on employment growth and activity growth is quarterly, while investment spending growth is measured annually.

[45]The data are from 2013Q1 to 2016Q2 for private employment growth and economic activity growth, and the period from 2013 to 2015 for annual growth in investment spending.

in anticipation of a Puerto Rican default. In what follows, we investigate the potential channels through which increased default anticipation can have real effects on Puerto Rico's economy.

Appendix C Effects of Default Risk on Private and Public Borrowing Costs

The main analysis provides evidence in support of the hypotheses that an increase in the risk of sovereign default disproportionately affects industries that are more dependent on government demand or external finance. In this appendix we provide corroboratory evidence that changes in sovereign default risk are transmitted to changes in the borrowing costs of banks and the public sector.

First, we use an event study to test the hypotheses that a decline in the perceived creditworthiness of the Puerto Rican government is correlated with an increase in yields on government debt and an increase in the cost of capital for publicly traded Puerto Rican firms, 3 of 4 of which are Puerto Rican banks. In particular, we examine the reaction of spreads, yields, and stock returns to news about rating actions and legal events related to Puerto Rican credit risk with the assumption that markets are semi-strong form efficient.[46] To estimate the effect of rating and legal events on the cost of capital, we first calculate the expected return of all publicly traded Puerto Rican firms using the market return model with the log return on the S&P 500 as the benchmark market index.[47] With the parameters of the market model in hand, we compute cumulative abnormal returns for each firm over a three-day window. Similarly, we investigate the effect of our events on the tax-adjusted yield spreads of the general obligation debt of the Commonwealth of Puerto Rico. We compute

[46] See Mackinlay (1997) and Andrade et al. (2001).

[47] We estimate the market model from 2000 through 2005 for OFG, BPOP, and FBP and from the first available data on December 10, 2007, through December 4, 2009, (30 trading days before the first event in the sample) for GTS.

the change in the tax-adjusted spread for each maturity as:

$$\Delta S_{mt} = S_{mt} - S_{mt-1}, \tag{22}$$

where S_{mt} is the difference between the tax-adjusted yield on Puerto Rican general obligation bond m and a U.S. treasury of the same maturity on day t. For each bond m and event $j \in J$ where J is the set of legal and rating events.

C.0.1 Event Identification

To identify changes in the perceived creditworthiness of Puerto Rico, we study two types of events that convey news about Puerto Rico's creditworthiness. First, we identify rating actions on Puerto Rican government debt.[48] This includes general obligation (GO) debt of the Commonwealth of Puerto Rico as well as the debt of public companies which rely on the Commonwealth for financial support. General obligation debt is backed by the full faith and credit of the Commonwealth and the Puerto Rican constitution requires it to be paid before any other obligations.

The following notable public companies are agencies of the Commonwealth; the Puerto Rican Government Development Bank (GDB), the Puerto Rico Sales Tax Financing Corporation (COFINA), the Puerto Rican Electric Power Authority (PREPA), the Puerto Rican Aqueduct and Sewer Authority (PRASA), the Puerto Rican Highway and Transit Authority (PRHTA), the Puerto Rican Employees Retirement System (PRERS), the University of Puerto Rico (UPR), the Puerto Rican Public Finance Corporation (PRPFC), and the Puerto Rican Housing Finance Authority (PRHFA).[49] Rating actions on these agencies may be important for the perceived creditworthiness of the Commonwealth because they have

[48]Rating actions include affirmations of credit rating, changes in credit rating, and changes in outlook. A rating action is classified as negative if it is either a decrease in credit rating or a negative change in outlook and the opposite for positive changes. Neutral actions are no change in rating or outlook.

[49]These agencies would be classified as municipalities of Puerto Rico if it were a state and issue much of Puerto Rico's outstanding debt. Various smaller agencies also rely on the Commonwealth and rating actions on these always coincide with rating actions of one of the major agencies listed. Thus, no news events are omitted by restricting attention to these major agencies.

either explicit or implicit guarantees from the Commonwealth. Indeed, the rating agencies often downgrade the debt of these agencies and the Commonwealth simultaneously due to these guarantees.

Added to the rating actions, we identify legal events that are relevant to Puerto Rico's creditworthiness. These legal events include the passage of, and legal proceedings regarding, three laws. First, the "Puerto Rico Public Corporations Debt Enforcement and Recovery Act" was enacted by Puerto Rico on June 28, 2014, and attempted to create a legal framework for agencies of Puerto Rico to restructure their debt. The law was modeled after Chapter 9 of the U.S. bankruptcy code under which municipalities of U.S. states can declare bankruptcy and restructure their debt.[50] Second, the "Debt moratorium and Financial Recovery Act," enacted by Puerto Rico on April 6, 2016, attempted to allow Puerto Rico to suspend payment on its debt.

Third, the "Puerto Rico Oversight, Management, and Economic Stability Act" (PROMESA), enacted by the United States on June 30, 2016, and described above, creates a bankruptcy-like legal framework for Puerto Rico to restructure its debt. The passage of these three laws and events related to their litigation are relevant to the likelihood of a default because they are all related to creating a legal framework to allow Puerto Rico to restructure.[51] In Appendix C.1, we describe our system for classifying these three laws and related legal actions as credit positive, negative, or neutral. Finally, we identify bankruptcy filings, grantings, and dismissals for U.S. towns, cities, and counties that occur during our sample of rating actions as municipal events. In the online appendix, we list the rating, legal, and municipal

[50] As we discussed previously, the federal bankruptcy code both reserved this right for states and mandates that states can not pass laws binding creditors to accept losses. Puerto Rico argued unsuccessfully that its status as a nonstate, which proscribed it from using the former also exempted it from the latter.

[51] These events include passage of the laws, filings of suits against the laws, decisions to hear a case, oral arguments before the court, the court's decision, and other relevant proceedings. Minor legal events such as distribution of material for conference or the setting of an argument date are not included.

events.[52]

We calculate cumulative abnormal returns ($CARs$) for each firm i and each event j and changes in spreads (ΔS_{mt}) for each event j and bond m. We estimate the effect of each class of event on stocks by regressing CAR on a constant. Note that the rating and legal events we wish to study are common to all firms. Therefore we cluster the standard errors by firm. Similarly, we estimate the effect of the events on yield spreads by regressing $C\Delta S$ for all bonds in the dataset on a constant, clustering the standard errors by bond.

C.0.2 Results

The results are in Table C.1. The stock results are presented for all 4 firms and are then broken down for the 3 banks and the 1 non-bank firm, Triple-S Management Corp. The results of the event study for the full sample of events show a statistically significant cumulative abnormal return of -0.9% for all firms and a statistically significant cumulative change in spread of 12.21 basis points, indicating that the set of events is associated with an increase in the cost of capital for the Puerto Rican government and for Puerto Rican firms. The stock results are not significant for the non-bank. Further, negative events are associated with a statistically significant cumulative abnormal return of -1.6% for all firms and a statistically significant cumulative change in spread of 12 basis points. The stock results are also negative and significant for the bank and non-bank samples. Negative rating actions on non-general obligation debt are associated with an increase in spreads of 2.3 basis points and are only

[52]For the online appendix, please visit `https://www.dropbox.com/s/zg9eo3uzqkn6omq/The%20Costs%20of%20%28sub%29Sovereign%20Default%20Risk_Evidence%20from%20Puerto%20Rico_Online%20Appendix.pdf?dl=0`. We also document our system for classifying the sign and types of events and cases thereof in Appendix C.2. Section 6 discusses the effects reclassification on the benchmark results. The online appendix lists the full sample of events and their classifications. We use the most restrictive possible event window of one day for robustness in Section 6. Using three-day event windows creates a number of overlapping event windows due to events occurring with less than the required two trading days needed between them to prevent overlap. In such cases, we expand the three-day event windows to contain the overlapping events, until we obtain the smallest possible window which gives us one pre-event day and one post-event day in the enlarged window which does not overlap with the window of another event. In Section 6, we use two additional approaches for handling the overlap of the three-day event windows. The results are qualitatively the same as the benchmark results.

associated with a statistically significant cumulative abnormal return for the non-bank.[53]

In contrast, negative rating actions on general obligation debt are associated with a statistically significant cumulative abnormal return of -4.1% for all firms and a statistically significant cumulative change in spread of 21.6 basis points. The stock results are also negative and significant for the bank and non-bank samples. Similarly, negative legal events are associated with a statistically significant cumulative abnormal return of -3.8% for all firms and a statistically significant cumulative change in spread of 29 basis points. However, the sub-sample results are only significant for banks. Positive events are associated with statistically significant cumulative abnormal returns of 0.33% for all firms and statistically significant cumulative change in spread of 12.6 basis points. However, the sub-sample results are only significant for banks. The increase in spreads is not the expected result but is far smaller in magnitude than the increases seen for negative general obligation rating events and negative legal events. Neutral and mixed events show no significant effect on cumulative abnormal returns in any sample and are associated with a statistically significant cumulative change in spreads of about 12.4 basis points.

The results in this section confirm that adverse news about Puerto Rico's creditworthiness significantly increases the cost of capital for private companies. In particular, banks are consistently affected by adverse news. This finding supports our hypothesis that increased sovereign risk adversely affects the borrowing costs of banks. We also find some evidence that increased sovereign risk increases the cost of capital for non-banks. Finally, we find that adverse news about Puerto Rico's creditworthiness significantly increases the cost of capital for the Puerto Rican government. This supports our hypothesis that sovereign default risk is transmitted to public borrowing costs and thus constrains the government's finances.

[53]Note however, that general obligation rating actions often coincide with rating actions on agencies and are classified as general obligation rating actions.

C.1 Legal Event Classification

Unlike ratings actions, legal events are not by definition good or bad news for Puerto Rico's creditworthiness. The first step in classifying the legal events is to classify the laws themselves as good or bad news for Puerto Rico's creditworthiness. With these classifications, we then classify legal proceedings against a law by how they affect the expected outcome of the case. First, we classify the "Puerto Rico Public Corporations Debt Enforcement and Recovery Act" and the "Debt Moratorium and Financial Recovery Act" as credit negative events, or bad news about Puerto Rico's creditworthiness. We make this judgment for several reasons. First, Puerto Rico passed these laws intending to create a legal framework allowing Puerto Rico to default, signaling an inability to meet its obligations or unwillingness to do so. Further, the terms were of course relatively favorable for Puerto Rico. Second, the ratings agencies expressly downgraded Puerto Rican debt due to these laws. Third, major holders of Puerto Rico's debt sued to attempt to overturn these laws. The latter clearly indicates the belief of lenders that the laws were credit negative. With these classifications, we classify any filing of a legal case against these laws as credit positive, indicating news of an increased probability the laws will be overturned. Similarly, attempts by Puerto Rico to have rulings against the laws overturned via appeal and the decision of a court to hear an appeal are credit negative, indicating news of an increased probability that the laws will be upheld. Arguments before the court are judged based upon publicly available information, including the transcripts of the arguments and news coverage. If the questions asked by judges during oral arguments indicate they intend to overturn these laws or uphold a ruling against them, this is classified as credit positive and vice versa. We complement our own reading of oral arguments with contemporaneous opinions of legal scholars regarding what the arguments reveal about the likely outcome of the case. Regarding other important legal events such as filings by Puerto Rico, its creditors, and friends of the court, there is no objective way to determine the strength of the argument and hence their likely influence on the outcome of the case. Searches of news sources provided no meaningful contemporaneous legal opinions about the likely effect of these filings. These events are classified as neutral, meaning we do

not have a sign for the news conveyed by the event.

We classify the passage of PROMESA by the United States as credit positive for several reasons. First, the law received positive commentary from the funds that hold Puerto Rican debt, indicating they believe it improved their recovery rates. Second, Moody's reviewed it favorably in an issuer comment and considered it credit positive. Third, there is the law itself and its contrast with the Chapter 9 process undergone by insolvent mainland municipalities. Municipal bankruptcies under Chapter 9 of the bankruptcy code differ significantly from bankruptcies of private entities. Broadly, Chapter 9 is significantly more lenient for the debtor, stemming in part from the sovereign rights of states as defined in the Tenth Amendment to the United States Constitution. Under Chapter 9, assets of municipalities can not be seized and liquidated, nor can their operating decisions such as expenditures and raising of revenue be interfered with as part of a settlement or the litigation. Further, only the municipality itself may file a restructuring plan with the court. The process outlined in PROMESA is based on Chapter 9 of the bankruptcy code but is significantly more restrictive from the perspective of the debtor. PROMESA establishes a seven-member oversight board that has the sole authority to propose restructuring plans and has authority over Puerto Rico's budget. The board members were selected by the president, however PROMESA gave the right to the following individuals to create approved lists from which to select the following number of board members: speaker of the House, two members; Senate majority Leader, two members; House minority leader, one member; Senate minority leader, one member; president of the United States, one member. This gave effective control over a voting majority of the board members to the Republican party. Further, the court was only authorized to approve a restructuring plan if it was in the best interest of creditors. That is, if the presiding judge deemed that the bond holders could not achieve more favorable terms through other legal means. In summary, PROMESA allows an outside body with more than the debtor's interest in consideration to propose restructuring plans, control the debtor's fiscal process, and mandate the court to take a harder line against the debtor than under Chapter 9 and the similar "Recovery Act."

It is important to note that this law also placed a stay on any litigation against Puerto Rico relating to default and created a legal framework for restructuring where none existed before. On the surface, this may seem credit negative as without this law Puerto Rico had no legal right to restructure nor to avoid payment. However, note that the Puerto Rican governor stated his intent to prioritize public services over debt service regardless of this legal limbo. As in other sovereign crises, the threat of forcing repayment without restructuring is not credible nor espoused. Also note the statements of the speaker of the House promising some kind of restructuring plan. These stated intentions, among others, indicate a clear realization by all parties, especially following the Supreme Court's decision against Puerto Rico's Recovery Act, that some form of legislated restructuring framework was inevitable. Given this, we find the eventual form to be beneficial to creditors and thus credit positive.

C.2 Mixed Event Classification

We identify three scenarios that give us a priori reason to reclassify mixed events. First, as neutral ratings events signify no change, we classify combinations of signed (positive or negative) ratings actions and neutral ratings actions with the sign of the signed ratings action. Second, in cases where we have positive and negative ratings actions on the same day, we use the sign of a GO ratings action if present, as these are the most direct news about the commonwealth's creditworthiness. Third, in cases where signed legal events and signed ratings actions occur on the same day, we look at the relative importance of the events from a legal standpoint. We find four mixed events that fall into one of these groups and merit reclassification. The event window of the first begins 6/26/2015. The event includes the governor's statement that the debt was not payable and the nine associated ratings downgrades. The one included positive event is the affirmation by the 1st Circuit Court of Appeals of the earlier decision against Puerto Rico's Recovery Act. Although the event is certainly credit positive, questions asked by the three judges of the 1st Circuit during earlier oral arguments had already revealed apparently unanimous opposition to Puerto Rico's case. This, combined with the significance of Governor Padilla's statement that the debt was not

payable and its reception by the ratings agencies merits a credit negative classification for this series of events. We classify this as a ratings action. The second event window begins on 4/1/2016. This includes one credit positive event, a filing of a suit over GDB revenue diversion. It also includes two credit negative events, the passage of the Debt Moratorium Act by Puerto Rico's House and Senate. We classify the combined event as credit negative because the Debt Moratorium Act would have allowed Puerto Rico to delay payments on its debt. This is more significant for Puerto Rico's credit than the lawsuit over revenue diversion. The third window is a mixed rating action beginning 3/8/2013. It includes an improvement in the UPR credit rating and downgrades of GO and PREPA. We classify it by the GO rating action. Finally, the event window beginning June 25, 2014, includes the credit negative passage of the Recovery Act and a series of related ratings downgrades. All of these events are negative so the overall sign is negative. We classify the overall type as a legal event as the ratings actions directly resulted from the legal event. Section 6 shows the robustness of our benchmark results to these reclassifications.

Table C.1: Event Study: Three Day Window Benchmark

	CAR	CAR	CAR	$C\Delta S$	Observations
	All Firms	Banks Only	Non-Bank		
All Events	-0.0087**	-0.0091*	-0.0075	12.2123***	372:279:93:14,386
	(0.0016)	(0.0022)	(0.0051)	(1.5361)	
Negative Events	-0.0162***	-0.0167**	-0.0149*	11.9926***	200:150:50:8,150
	(0.0015)	(0.0020)	(0.0089)	(1.1218)	
Negative Non-GO Ratings Events	0.0042	0.0045	-0.0431**	2.3262**	108:81:18:4,378
	(0.0044)	(0.0061)	(0.0084)	(0.9263)	
Negative GO Ratings Events	-0.0408**	-0.0400*	-0.0431**	21.6317***	72:54:18:2,985
	(0.0072)	(0.0101)	(0.0192)	(1.6773)	
Negative Legal Events	-0.0384*	-0.0473*	-0.0114	29.2057***	20:15:5:787
	(0.0146)	(0.0162)	(0.0192)	(5.7168)	
Positive Events	0.0033**	0.0030*	0.0041	12.6265***	60:45:15:2,101
	(0.0006)	(0.0008)	(0.0077)	(3.5965)	
Neutral Events	-0.0019	-0.0005	-0.0060	12.4396***	80:60:20:2,944
	(0.0038)	(0.0050)	(0.0095)	(1.9856)	
Mixed Events	-0.0013	-0.0062	0.0135	12.4227***	32:24:8:1,191
	(0.0058)	(0.0042)	(0.0095)	(3.8259)	

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Each variable is a regression on a constant for the indicated stratum of events. Standard errors are clustered by firm for CAR except for the non-bank specification (which uses robust standard errors) and by bond for $C\Delta S$. CAR is expressed as the sum of log differences in stock price, and $C\Delta S$ is expressed in basis points.