Working Paper Series

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WP 18-03R

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September 13, 2018

Abstract

Puerto Rico's unique characteristics as a U.S. territory allow us to examine the transmission of quasi-sovereign default risk to the real economy. We document a negative relationship between increased default probabilities and employment growth in government-demand-dependent industries. The negative relationship strengthens when the government undertakes austerity measures. In addition, fiscal austerity reduces output growth via a local fiscal multiplier effect. Overall, we provide evidence for a novel demand-driven transmission mechanism of sovereign default risk that operates through austerity risk and government demand dependence.

Keywords: Sovereign debt, default risk, government-demand dependence, employment, austerity risk.

JEL classifications: F3, F4, G15.

*We thank seminar participants at the Federal Reserve Board and conference participants at the Interdisciplinary Sovereign Debt Research and Management Conference (DebtCon) in Geneva for helpful comments and suggestions. We thank Mitu Gulati, Arantxa Jarque, Ju Hyun Kim, Jesse Schreger, Violeta Sosa, Christoph Trebesch, and John Walter for helpful discussions.

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1 Introduction

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 quasi-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 in Argentina in 2001, the sovereign default crisis was inextricably linked to a concurrent banking and currency crisis (Perez (2015); Hébert and Schreger (2017)). In 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 constitute 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 quasi-sovereign default can have real effects on the macroeconomy.

In addition, Puerto Rico has a constitution, and the ability to tax and create laws on

[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.

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 first 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)). We introduce multiple sectors with heterogeneous exposures to government demand. By negatively affecting the government's ability to finance spending 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

[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.

Rican manufacturing industries.[5] We analyze the employment effects of increases in quasi-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, to estimate the 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 data on quarterly call reports from the FDIC.

The main findings are as follows. First, there is a negative relationship between default probabilities on Puerto Rican government debt and 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 auster-

[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.

ity measures. Specifically, austerity measured by changes in the cyclically adjusted primary balance coincides with decreased employment in more exposed industries. A potential rationale for this result is that agents learn about future government policy when they observe how austerity measures respond to increased default risk.

Third, there is a negative relationship between default risk and fiscal austerity and output growth through a local fiscal multiplier effect. The cyclically adjusted primary balance 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 fiscal policy on output growth (Blanchard and Leigh (2014)). Our findings show that the relationship between output growth and austerity measures implemented by the Puerto Rican government is negative and highly statistically significant consistent with a local fiscal multiplier effect. Overall, the finding is 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 quasi-sovereign default risk and austerity.

Our benchmark regressions 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.

Indeed we find that there is a negative relationship between default probabilities and employment growth in industries in external finance dependent industries. 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. We also find that non-Puerto Rican banks do not step in to substitute for the reduced supply of local credit from Puerto Ri-

can banks. Evidence that a quasi-sovereign ceiling channel operates, further substantiates the existence of a credit crunch. Further, 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.

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 also relates to the earlier literature that uses data at lower frequencies. For example, see Borensztein and Panizza (2009), Tomz and Wright (2013), Reinhart and Trebesch (2016), Arteta and Hale (2008), Fuentes and Saravia (2011), Cruces and Trebesch (2013), and Livshits et al. (2014). In particular, Yeyati and Panizza (2011) suggest that output contractions tend to precede defaults indicating that default anticipations drives the costs of default. The paper is also related to the growing theoretical literature on sovereign debt, including, for example, Eaton and Gersovitz (1981), Bulow and Rogoff (1989), Aguiar and Gopinath (2006), Arellano (2008), Mendoza and Yue (2012), Perez (2015), Bocola (2016), and Phan (2016, 2017a,b,c).[7]

The paper is also related to existing studies on the effect of sovereign risk on bank loan supply (Popov and Van Horen (2015); De Marco (2016); Becker and Ivashina (2018); Bofondi et al. (2017)), and particularly the studies on the transmission of sovereign risk via reduced bank loan supply to the employment of affected firms (Balduzzi et al. (2015); Acharya et al. (2018)). Our paper adds to this literature by using the unique natural experiment of Puerto Rico and higher frequency monthly employment data.

[7]Also see the survey by Aguiar et al. (2014)).

The paper proceeds as follows. Section 2 provides a brief historical background and discusses a timeline 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.[8] At the same time, the Puerto Rican government granted foreign subsidiaries a tax exemption 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 (Serrato (2018)).

[8] See Collins et al. (2007).

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,[9] and on June 29, 2015, Standards and Poors (2015) downgraded the general obligation bonds of Puerto Rico to 'CCC-' and wrote, "The downgrades are 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

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

framework for Puerto Rico to restructure its debt. Puerto Rico formally defaulted the next day, missing $779 million 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 1 and 2 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 2 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.[10] 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

[10] 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.

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 online 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 shocks specific to Puerto Rico, 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. The model, which is deliberately simple and abstract, highlights how an increase in the Puerto Rican default risk negatively affects the island government's 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 $1 + r^*$.[11] 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 of an imported foreign good C_f, and from the public good G provided by the government. Their utility is given by:

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

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

[11] 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 $1 + r^*$.

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

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

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

$$\begin{aligned} X_j &= \zeta P_j^{-\rho}, \\ X_j' &= \zeta' P_j^{'-\rho} \end{aligned}$$

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.[12] 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 are needed in this process. This is a stark way to model the fact that some sectors in the domestic economy, represented here by sector m, are more exposed to government demand than others.[13] 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

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

[13] We could more flexibly assume that the provision of the public good requires inputs from both sectors m and l but at different intensities, 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.

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 payoff $\underline{V}$.[14] 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 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 be 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

[14] 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.

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 reducing 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, which is more exposed to government demand. Specifically, a negative shock to the default value*[15] $\underline{V}$ *raises* $\Pr(def)$ *and reduces* h_l *and especially* h_m*:*

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

[15] 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.

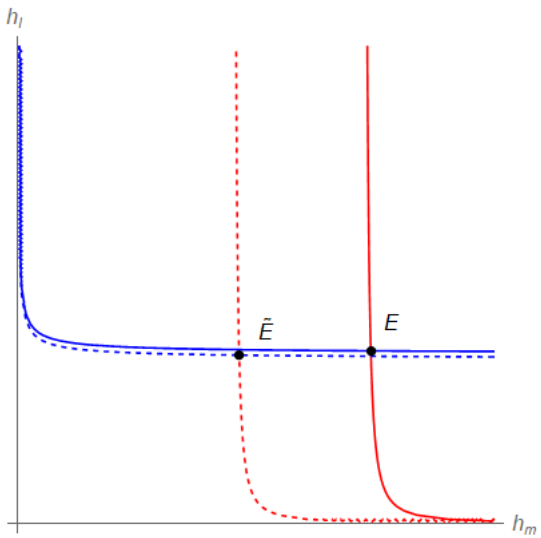

Figure 1: Effect of a negative shock to sovereign borrowing ($qB \downarrow$): short-run equilibrium moves from point E to point $\tilde{E}$.

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 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.[16] The economic activity index is also available from 2006:Q1 to 2016:Q2 and tracks the behavior of four 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 ($CAPB$)

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

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.[17] 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.

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

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 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. Online Appendix A 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 are adjusted for inflation to 2016 U.S. dollars using the 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 online Appendix A for a more detailed description of the construction of $EXTFIN$. Online Appendix A 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.[18] 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.[19] 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 contract

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

[19]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.

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.[20] 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

[20]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.[21]

5 Default Risk, Austerity, and Employment

Section 2 provides suggestive evidence that an increase in the risk of default is associated with a 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. However, these data are only available at the industry level. Thus, we adopt a difference-in-difference approach used by Rajan and Zingales (1998) to study the effects of finance on growth and subsequently an approach used by Dell'Ariccia et al. (2008) to study the real effects of banking crises.

We evaluate the hypothesis that an increase in quasi-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

[21]The time to maturity is matched using a cubic spline interpolation of the Treasury yield curve. See online Appendix A 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.[22]

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 constitutes 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 default probability increases by 0.92 percentage points in an average month.

Figure 3 presents normalized log employment in manufacturing industries above and below the median of dependence on government demand and default probability. Figure 3 shows that employment in manufacturing industries more dependent on government demand declines relatively more than employment in other industries, 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 4 presents normalized log employment in manufacturing industries above and below the median of dependence on government demand and *capb*. Figure 4 shows that an increased austerity measure (increased *capb*) also seems to coincide with decreased employment in more sensitive industries.

Regression analysis: In the benchmark specification, we regress employment growth in industry i in month t on twelve lags of changes in quasi-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

[22]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 affects the sectors dependent on such spending.

employment.[23,24] 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 average 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 correlation. 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.

[23]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.

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

We include twelve lags of the interaction terms as the effects are insignificant beyond the twelfth lag. For robustness, we include three lags of the industry-level employment growth rate (ΔE_{it}).[25] 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.[26] 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 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

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

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 twelve 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.[27] 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 twelve months and SH_{t-1} is at its sample average, monthly employment growth for industries at the 25th percentile of 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 twelve months. Thus, if ΔDEF is at the 25th percentile for the prior twelve months, employment growth is predicted to be 0.15 per-

[27] Online Appendix A shows the full specification.

centage 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 twelve 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 for 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 the 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 $\Delta capb$, 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 5. Figure 5 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 5 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 6 and 7. Figure 6 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 6 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

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 an alternative explanation that the literature on sovereign debt has explored in detail: the external finance channel.

6.1 An Alternative Explanation: The External Finance Channel

In this section we explore an alternative explanation that an increase in quasi-sovereign default risk disproportionately affects industries that are more dependent on external finance. $EXTFIN$ is the measure of external finance dependence ranked by industry.[28] Figure 8 shows that employment in manufacturing industries with above median dependence on external finance declines relatively more than employment in below median industries and that employment in all manufacturing industries declines overall.

Regression analysis: We regress employment growth in industry i in month t on twelve lags of changes in quasi-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 twelve lags of changes in quasi-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. The specification also includes industry and month fixed effects to capture any time-invariant industry characteristics and any

[28]See online appendix A for details about constructing the measure. Also See Klingebiel et al. (2006).

industry-invariant month effects. Standard errors are clustered by industry. We estimate the following regression:

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

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; $EXTFIN_i^{US}$ 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 $t-1$.

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 if external finance dependent industries are also 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.

Table 6 presents the results. Column 1 shows that there is a negative relationship between increased default risk is associated and employment growth in external finance dependent industries. This is a counter-intuitive result given Puerto Rico's access to U.S. lending. Column 2 shows that the interaction between local demand dependence and the change in monthly default probabilities is negative and jointly significant at the 1% level suggesting that increased default risk is associated with relatively lower employment growth local demand-dependent industries. The negative and significant coefficient on the $EXTFIN$ variable suggests that increased default probability disproportionately affects employment in external finance dependent industries via a reduced *supply* of credit through the bank lending channel.

In column 3, we control for twelve 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 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. 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.

6.1.1 The Role of Non-Puerto Rican Banks and the Quasi-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 quasi-sovereign ceiling channel.

To confirm the data are consistent with the hypothesis that increased default risk is correlated 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 9 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.[29] 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 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 10 shows that normalized log total loans and leases from banks operating in Puerto

[29] 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.

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 quasi-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.[30] 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 online Appendix D.

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. The event study on the online appendix provides additional supporting evidence that changes in sovereign default risk are transmitted to changes in the borrowing costs of banks and the public sector.

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

6.2 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.[31]

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 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 in-

[31]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.

crease 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.[32] We use the coefficients from these regressions as a measure of CYC_i and include twelve 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 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 twelve lags of U.S. growth of industrial production and employment in each industry in our benchmark models.[33] 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 make up a larger

[32]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.

[33]U.S. industrial production is only available for sixteen of the nineteen manufacturing industries in our benchmark sample. In addition, production in six of these industries is aggregated with another industry, providing only thirteen 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.

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 generate an indicator H_{GOV}, which takes the value of 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 twelve 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.

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.[34] 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.[35] Our benchmark results are robust.

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

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

Alternative lags of the dependent variable: We include three lags of the dependent variable in the benchmark specifications.[36] This approach controls for autocorrelation in employment growth rates and serial correlation in the benchmark errors. The benchmark results are qualitatively the same.

7 Conclusion

This paper uses Puerto Rico's debt crisis to develop an identification strategy to extract the real costs of quasi-sovereign default risk. Puerto Rico's special characteristics as a U.S. territory allow us to examine a novel channel through which quasi-sovereign default risk can have real effects on the macroeconomy.

Puerto Rico's quasi-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.

Using a New Keynesian model of Puerto Rico as a small open economy we conjecture that 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. 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 po-

[36] 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.

tential 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. In addition, we find that increased default probabilities drive 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.

Online Appendix

For the online appendix, please visit `https://bit.ly/2p2LSsG`.

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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 twelve lags of the $EXTFIN^{US} * \Delta DEF$ variable and $\Delta capb_{prioryear} * \Delta DEF$. Appendix Table A4 presents the dis-aggregated coefficients on the twelve 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 twelve 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 twelve 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 1: Puerto Rico GNP vs. U.S. GNP

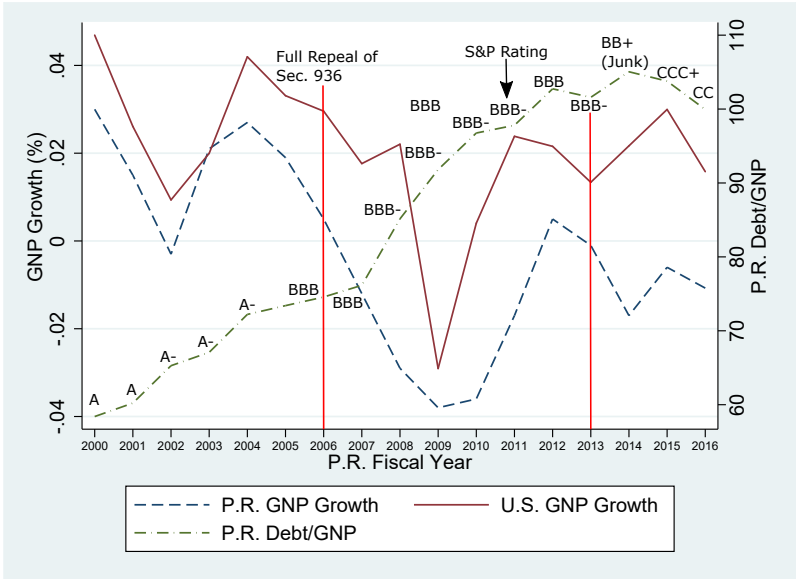

Figure 2: Employment and Yields

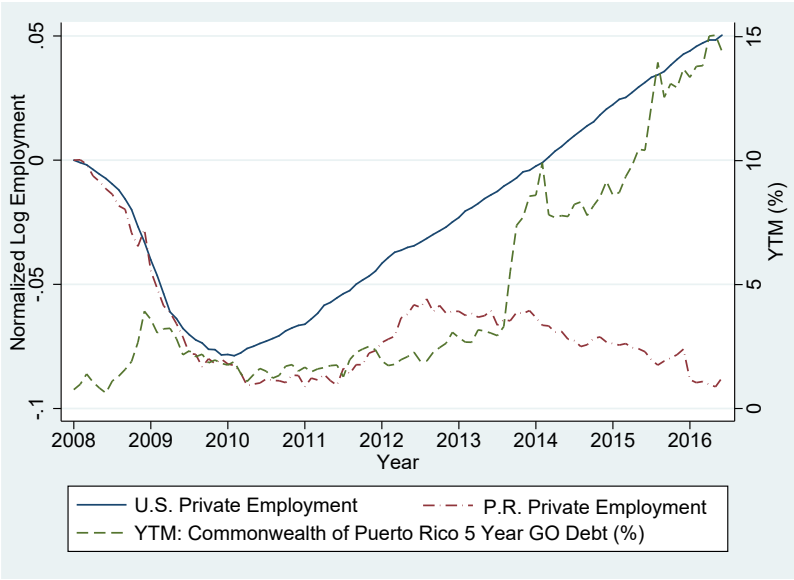

Figure 3: Employment by Dependence on Government Demand and Default Probability

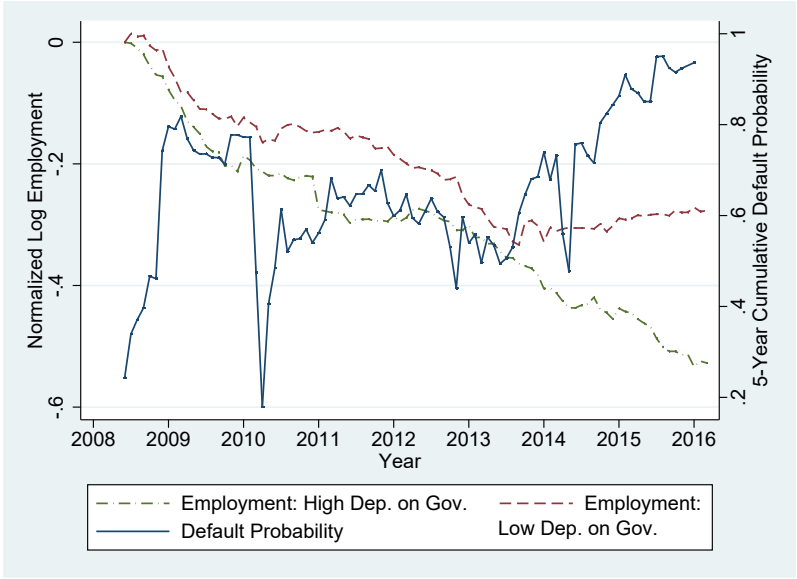

Figure 4: Employment by Dependence on Government Demand and Austerity

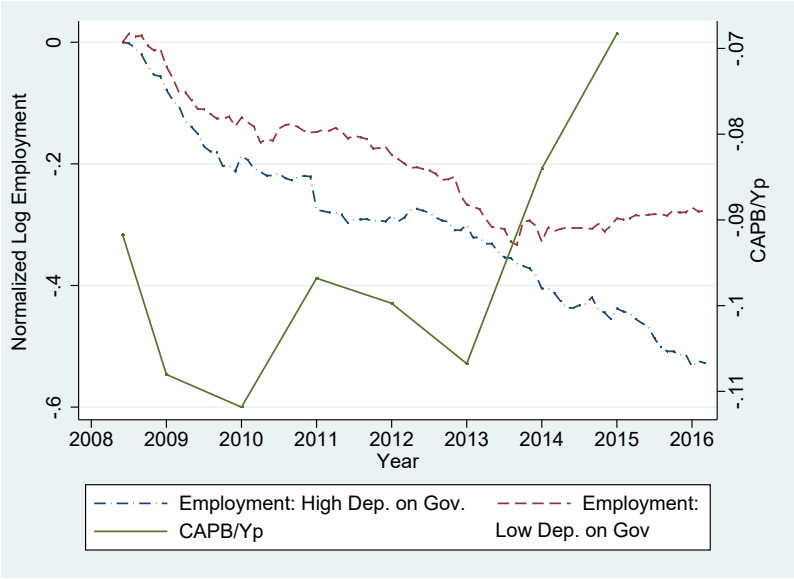

Figure 5: Marginal Effects of Austerity and Default Risk

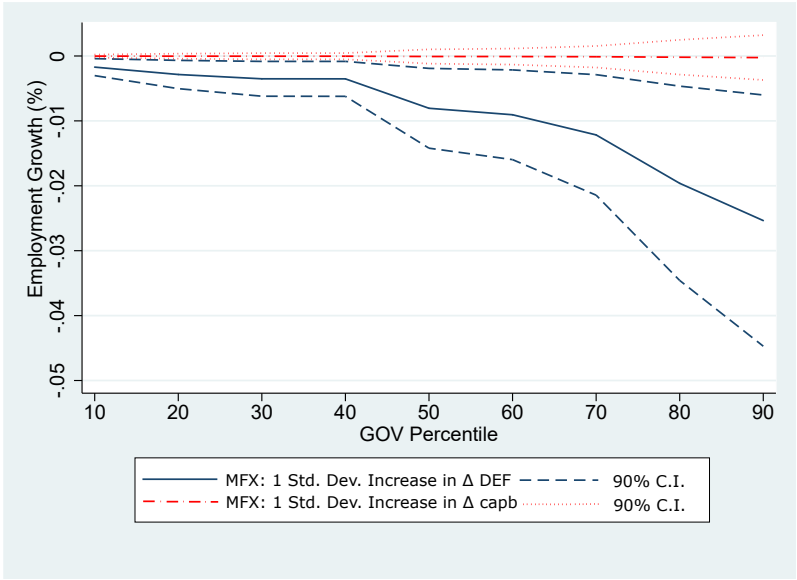

Figure 6: Marginal Effects of Default Risk Across Austerity

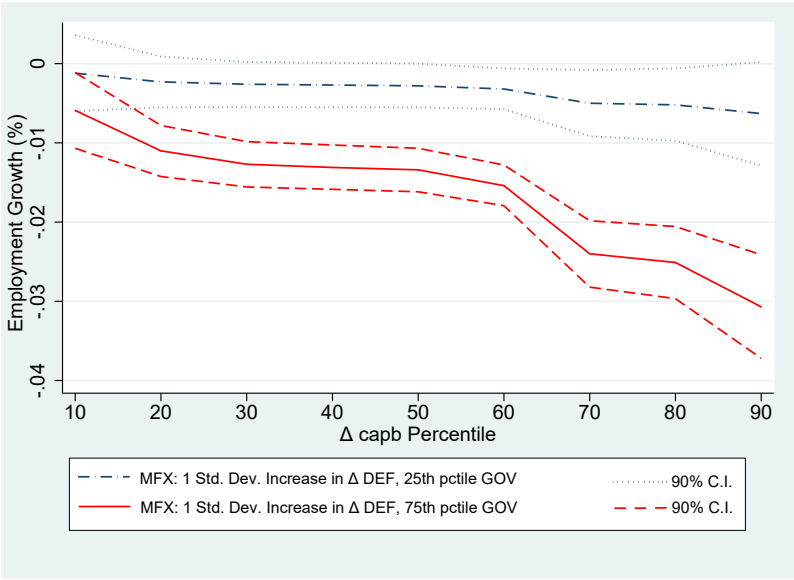

Figure 7: Marginal Effects of Austerity Across Default Risk

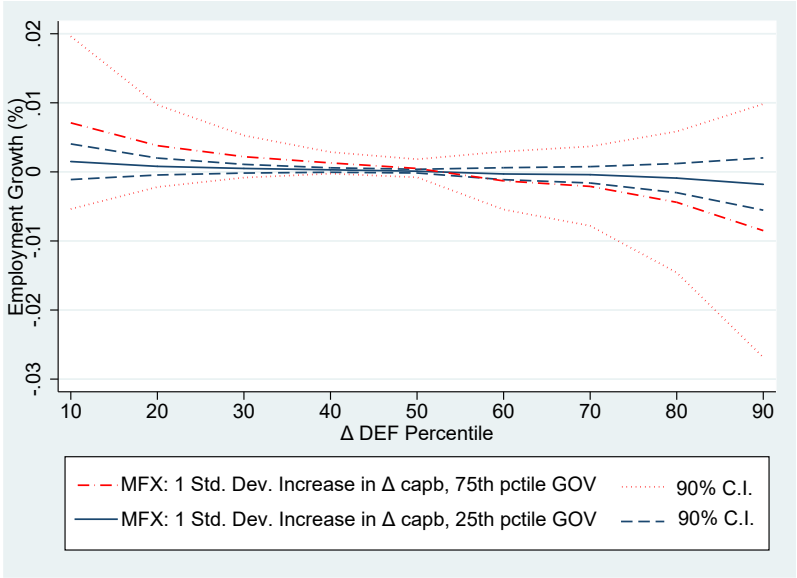

Figure 8: Employment by Dependence on External Finance and Default Probability

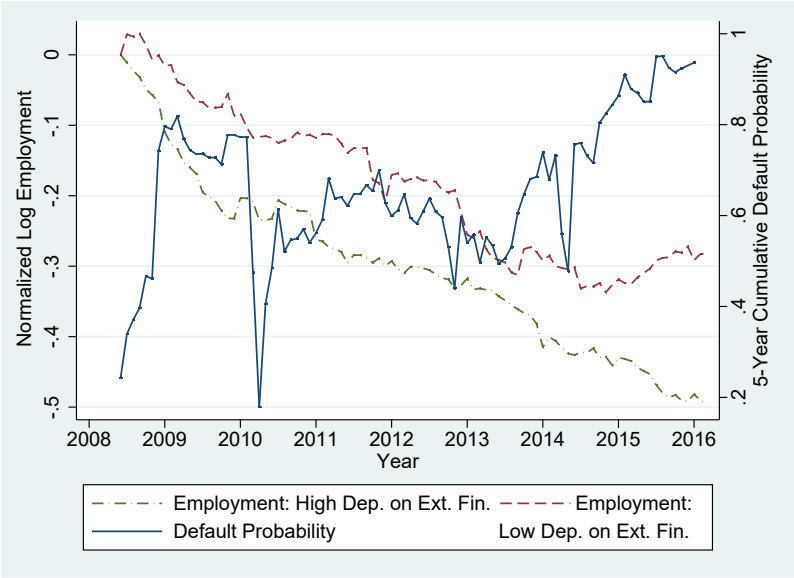

Figure 9: Puerto Rican Banking and Puerto Rico's Crisis

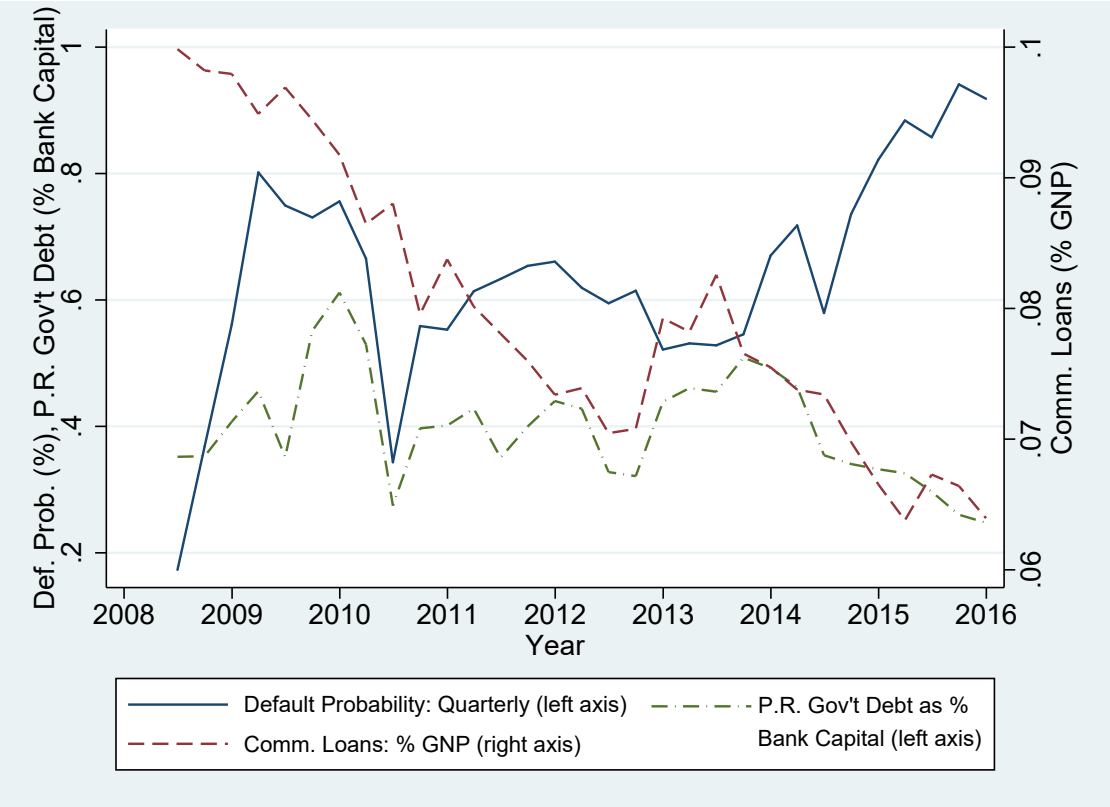

Figure 10: International Banking and Puerto Rico's Crisis