Transmission of Quasi-Sovereign Default Risk: Evidence from Puerto Rico

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IMF OAP-PRI, Tokyo 4 Feb 2020

The views expressed do not necessarily reflect the position of the Federal Reserve Bank of Richmond or the Federal Reserve System.

Classic question

- How does risk of sovereign default affects domestic economy?
  - Substantial legal uncertainty, as no clear bankruptcy procedures for sov debt (unlike private/muni debt)
  - Difficult to isolate effects of default risk from concurrent banking/currency crisis risk
  - Difficult due to reverse causality

This paper

- Novel setting to *identify & isolate* effects of default risk: Puerto Rican debt crisis
  - PR debt is similar to sov debt: No clear bankruptcy procedures (no chap 9)
  - Effects of default risk isolated from banking/currency crisis risk (PR banks FDIC insured; PR is dollarized)
  - Detroit bankruptcy & non-bailout is exogenous shock to PR default risk
- We document strong evidence for government demand channel
  - Default risk disproportionately hurts industries dependent on gov demand

Main related literatures

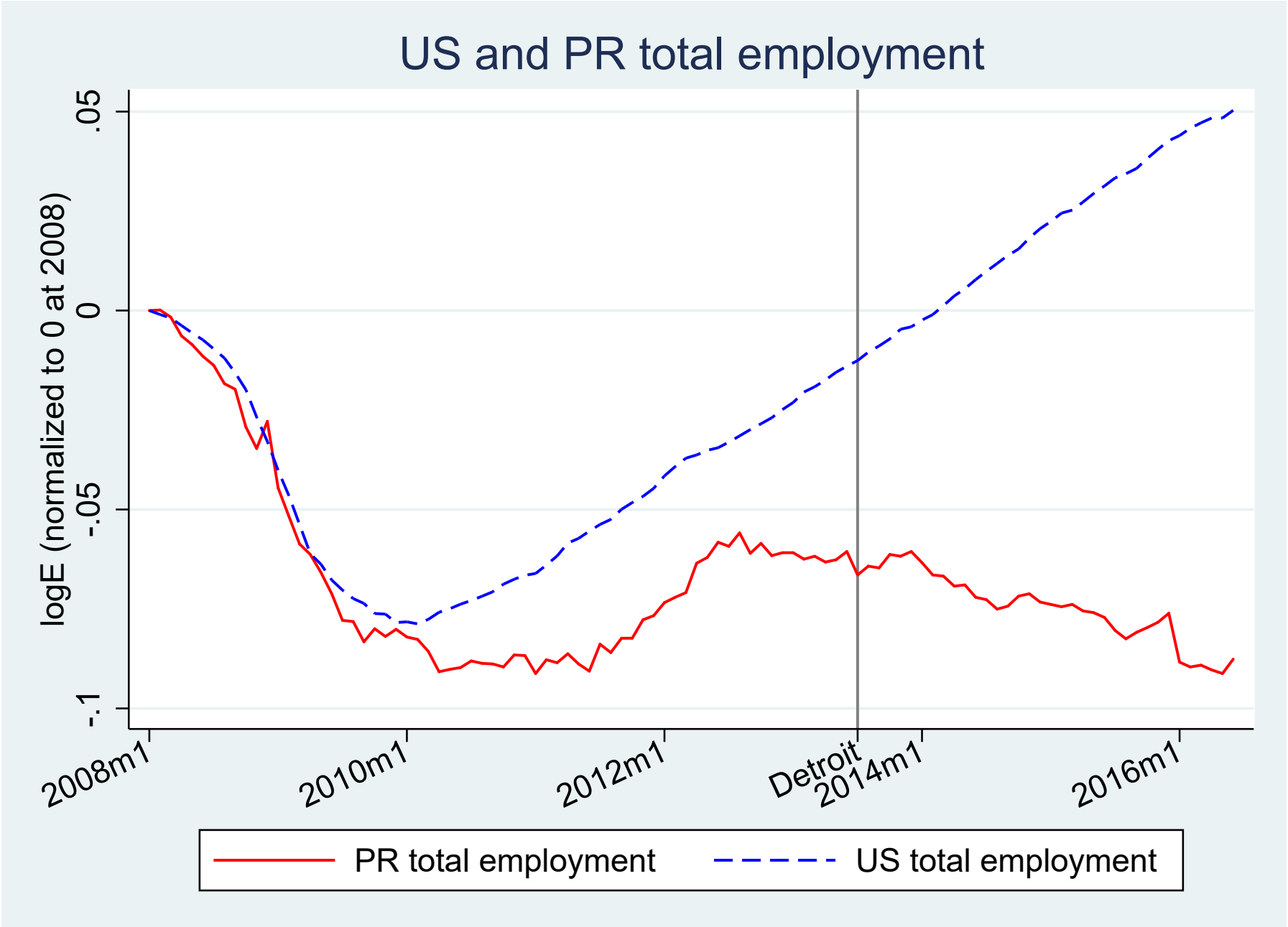
- On costs of sovereign debt crises, esp. empirical analyses: Borensztein Panizza (2009), Yeyati Panizza (2011), Zettelmeyer et. al. (2013), Cruces Trebesch (2013), Bocola (2016), Hébert Schreger (2017), Perez (2018), Acharya et al. (2018), Asonuma et al. (2019), Arellano et al. (2019), ...
  - Banking crises' effects on external-finance dependent sectors: Rajan Zingales (1998), Dell'Ariccia et al. (2008), ...
- On austerity & growth: Auerbach Gorodnichenko (2012), Blanchard Leigh (2014), Chari Henry (2015); House Tesar (2015), Jordà Taylor (2016), ...

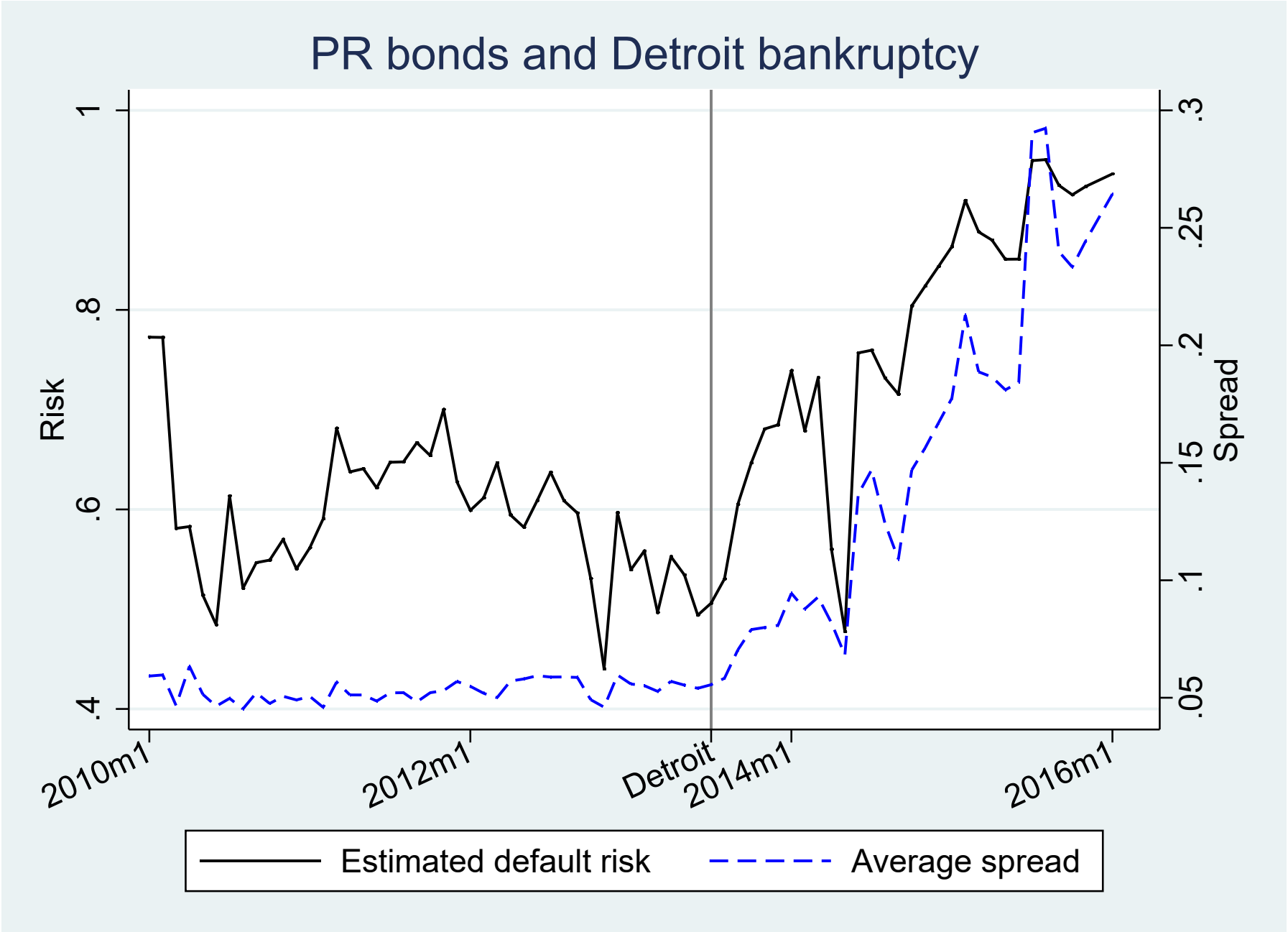
Background

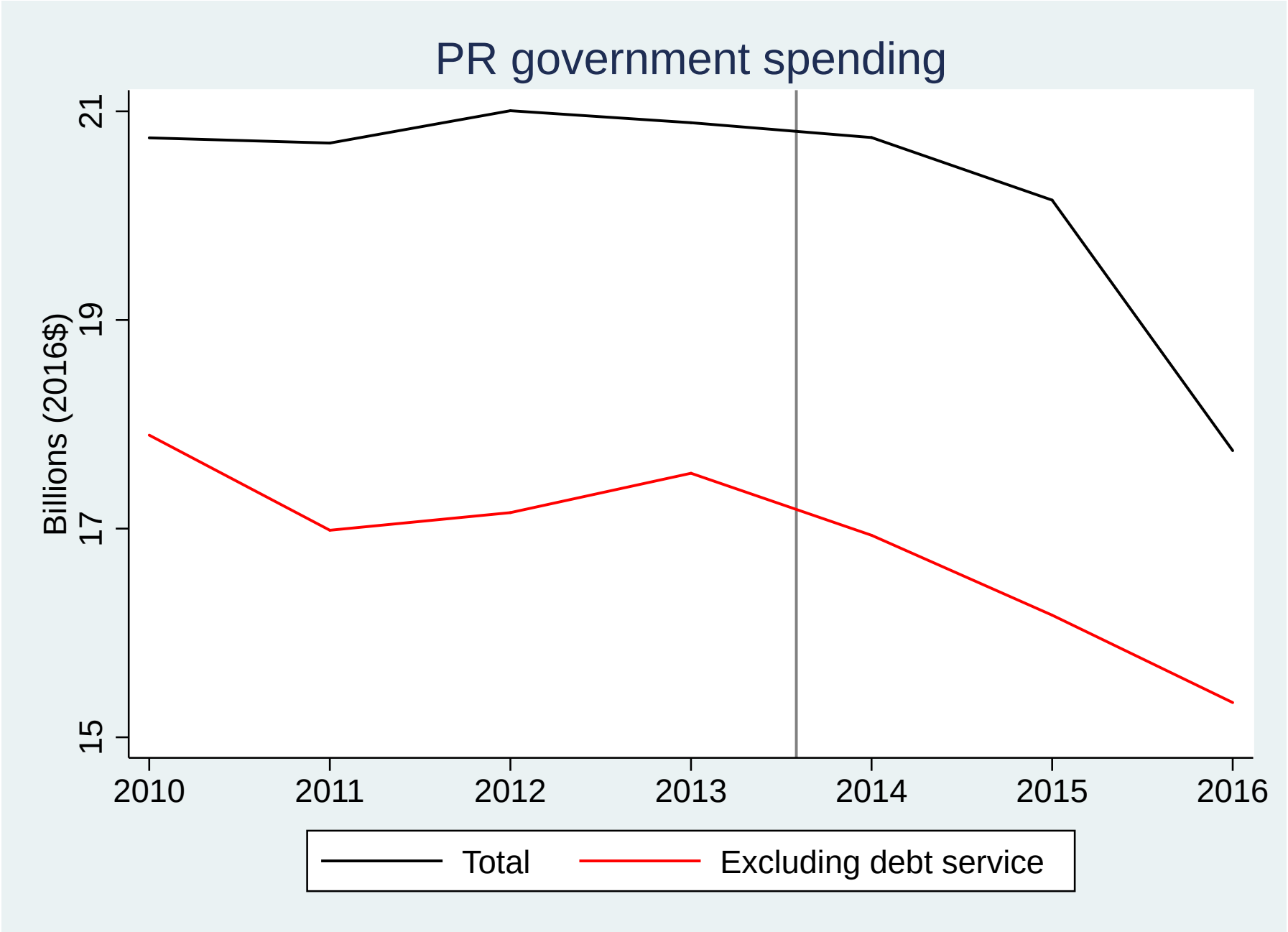
$\text{Pop}_{2010} \approx 3.7m, > 22$ states

Context

- Became U.S. territory since Spanish-American war 1898. Subject to U.S. contracts clause, usage of USD.
- Industrialization & catch-up growth, esp. after passage of Section 936 of Tax Reform Act 1976 (tax exemptions for U.S. firms on income originating from PR).
  - Manufacturing roughly 46% GDP and 69% GNP 2007-2016.
- But Section 936 phased out in 1996, fully repealed by 2006. Recession & rapid accumulation of public debt.
- Structural break in default risk 2013m7: Detroit bankruptcy $\rightarrow$ downward shift in expectation of federal gov bailout.
- PR gov announced default 2015m6, but cannot access Chap 9 procedures.
  - US congress passed Puerto Rico Oversight, Management & Economic Stability Act (PROMESA) 2016m6.


US and PR total employment
logE (normalized to 0 at 2008)
.05
0
-.05
-.1
2008m1
2010m1
2012m1
Detroit
2014m1
2016m1
PR total employment
US total employment


PR bonds and Detroit bankruptcy
Risk
1
.8
.6
.4
Spread
.3
.25
.2
.15
.1
.05
2010m1
2012m1
Detroit
2014m1
2016m1
Estimated default risk
Average spread


PR government spending
Billions (2016$)
21
19
17
15
2010
2011
2012
2013
2014
2015
2016
Total
Excluding debt service

Simple Model

- Two-period NK SOE (Galí Monacelli 2005 + Benigno 2015)
- Add sovereign borrowing
- Add multiple sectors w. heterogeneous exposure to gov demand.

Setup

- SOE, representative hh, benevolent gov

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

- Domestic economy has two sectors
  - m: more exposed to gov demand
  - l: less exposed to gov demand
  - f: foreign imported good

$$\begin{aligned} C &= \left[(C_m)^{1-\lambda}(C_l)^{\lambda}\right]^{1-\chi}(C_f)^{\chi} \\ C' &= \ldots \end{aligned}$$

- Nominal wage is:
  - fixed at $\overline{W}$ in $t = 0$ ("short run")
  - but flexible in $t = 1$ ("long run")

Labor market

- Competitive firms in sector $j \in \{m, l\}$ maximize profit:

$$\begin{aligned} \Pi_j &= \max_{h_j} P_j A h_j^{\alpha} - \overline{W} h_j \\ \Pi_j' &= \cdots \end{aligned}$$

- Aggregate labor demand:

$$\begin{aligned} h &= h_m + h_l \\ h' &= h_m' + h_l'. \end{aligned}$$

- HH supply labor inelasticaly up to $\bar{h}$. In equilibrium:
  - $t = 0$: $h \leq \bar{h}$ (due to sticky wage)
  - $t = 1$: $h' = \bar{h}$ (flexible wage)

Import/Export

- Imported good price:

$$P_f = P_f' = 1$$

  - Law of one price: $P_f = eP_f^*$
  - Fixed exchange rate $e = 1$
  - Normalize $P_f^* = 1$

- Export: exogenous foreign demand X_j for domestic goods $j \in \{m, l\}$

$$\begin{aligned} X_j &\equiv \zeta P_j^{-\rho} \\ X_j' &\equiv \zeta' P_j'^{\rho}. \end{aligned}$$

- HH budget:

$$\begin{aligned} P_m C_m + P_l C_l + P_f C_f &= \overline{W} h + \Pi - T \\ P_m' C_m' + P_l' C_l' + P_f' C_f' &= W' \bar{h} + \Pi' - T' \end{aligned}$$

Gov spending & asymmetry

- Gov provides public good G, with input only from domestic sector m:

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

- Financed by lump-sum tax + borrowing + exogenous federal transfer

$$\begin{aligned} P_m G_m &\leq T + qB + F \\ P'_m G'_m &\leq T' - (1 - def)B + \underbrace{F'}_{\text{stochastic}} . \end{aligned}$$

- $t = 1$: After seeing F', gov chooses def.
  - If $def = 1$, gov receives cont. payoff V^{def}.
- $t = 0$: Competitive bond price:

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

Competitive Equilibrium

- Given gov policies G, G', B, and def, a *competitive equilibrium* consists of P's & Q's that satisfy the optimization of HHs, firms, labor market conditions & good market clearing conditions.
- Given competitive equilibrium P's & Q's as functions of its policies, gov chooses
  - Short run: G, B
  - Long run: G', def

  to maximize utility of HH.

Proposition

A negative shock (first-order stochastic dominance) to future federal transfer F' raises $\Pr(def)$, reduces h_l and especially h_m:

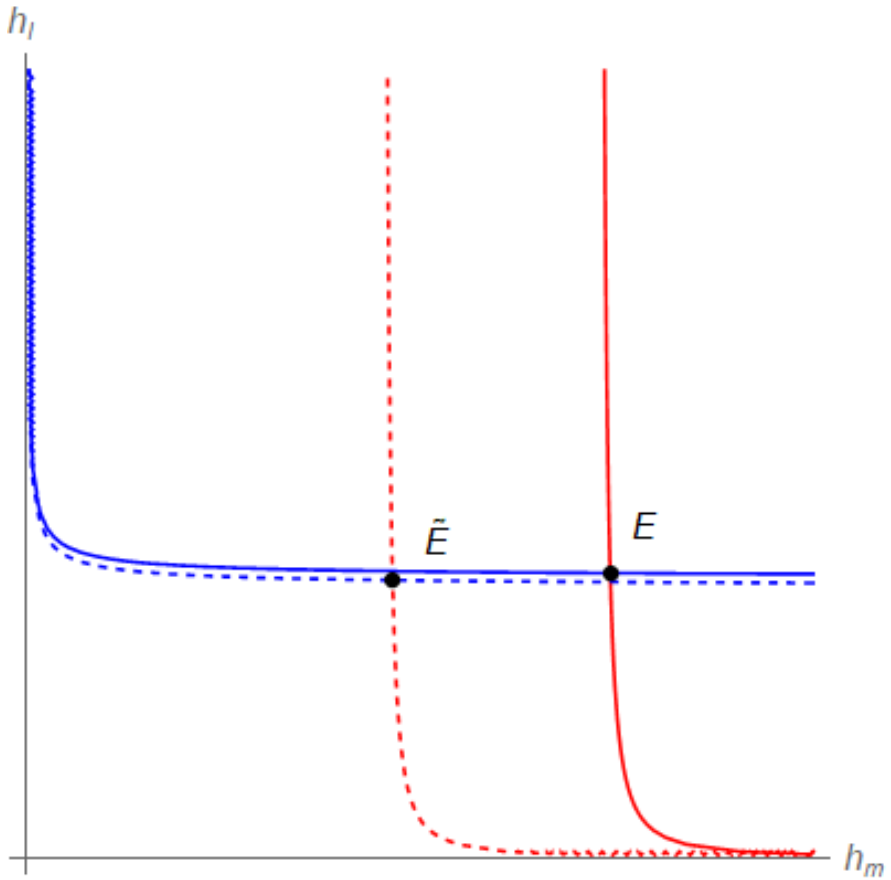
$$\Delta h_m < \Delta h_l < 0.$$

- More generally, an increase in the default risk (e.g., $\uparrow V^{def}$, $\downarrow A'$) reduces short-run employment, with effect stronger on more government-demand-dependent sector m.
- Intuitively, G has asymmetric effects on short-lun labor market:

$$\begin{aligned} C_m + \zeta P_m^{-\rho} \quad + G \quad &= A h_m^{\alpha} \\ C_l + \zeta P_l^{-\rho} \quad\quad\;\; &= A h_l^{\alpha} \end{aligned}$$

Heterogeneous effects of shock to default risk

- $F' \downarrow \Longrightarrow \; q \downarrow \Longrightarrow q\, B(q) \downarrow \Rightarrow$ austerity
- Austerity $\Rightarrow$ employment $\downarrow$ esp. in more exposed sector m



Empirics

Key Datasets

- **Macro Data**
  - PR fiscal balance: PR financial statements 2000-2016
  - PR GNP: Government Development Bank 2000-2016
- **Manufacturing Industry Data**
  - Employment 3-digit NAICS: BLS 1990m1-2016June (73 industries)
  - Output 3-digit NAICS: PR Planning Board 2002-2015 (19 industries)
  - Share of sales to PR gov: Economic Census of Island Areas 2012 (2007)
  - Banking balance sheet data for PR banks: FDIC Call Reports
  - External finance-dependence: Compustat/CRSP 2000-2015
- **Financial Market Data**
  - CDS spreads: JP Morgan Markit 2008-2016
  - Extrapolate Pr(def) from 5-year CDS (White 2013, Hébert Schreger 2017) ▸ Details

Basic DiD

$$\log E_{it} = \alpha + \beta \, HighGOV_i * PostDetroit_t + \rho \log E_{it-1} + \gamma_i + \gamma_t + \varepsilon_{it}$$

- E_{it}: employment of industry i in month t (seasonally adjusted)
- $HighGov_i = 1$ if GOV_i above median
- $PostDetroit_t = 1$ if $t \geq 2013m7$
- Window: 2 years before and after Detroit (2011m8-2015m6)
- Theory predicts $\beta < 0$

Basic DiD

$$\log E_{it} = \alpha + \beta\, HighGOV_i * PostDetroit_t + \rho \log E_{it-1} + \gamma_i + \gamma_t + \varepsilon_{it}$$

	(1)
HighGOV*PostDetroit	-0.01**
	(0.01)
GOV*PostDetroit	
EXTFIN*PostDetroit	
GOV*P^{def}	
L.logE	0.92***
	(0.01)
Constant	0.64***
	(0.10)
0 Industry f.e.	Y
Time f.e.	Y
Ind. spec. trend	N
Observations	893
Adjusted R2	0.89

Note: $\beta = -1\%$ vs. ave monthly growth of PR manu employment 2010-2016 of -0.3%.

DiD with all manufacturing industries

$$\log E_{it} = \alpha + \beta\, GOV_i * PostDetroit_t + \rho \log E_{it-1} + \gamma_i + \gamma_t + \varepsilon_{it}$$

	(1)	(2)
HighGOV*PostDetroit	-0.01**	
	(0.01)	
GOV*PostDetroit		-0.24**
		(0.11)
EXTFIN*PostDetroit		
GOV*P^{def}		
L.logE	0.92***	0.95***
	(0.01)	(0.01)
Constant	0.64***	0.38***
	(0.10)	(0.09)
Industry f.e.	Y	Y
Time f.e.	Y	Y
Ind. spec. trend	N	N
Observations	893	799
Adjusted R2	0.89	0.92

DiD with industry-specific trend (full sample)

$$\log E_{it} = \alpha + \beta\, GOV_i * PostDetroit_t + \rho \log E_{it-1} + \gamma_i + \gamma_t + \theta_i(\alpha_i * t) + \varepsilon_{it}$$

	(1)	(2)	(3)
HighGOV*PostDetroit	-0.01**		
	(0.01)		
GOV*PostDetroit		-0.24**	-0.19**
		(0.11)	(0.09)
EXTFIN*PostDetroit			
GOV*P^{def}			
L.logE	0.92***	0.95***	0.97***
	(0.01)	(0.01)	(0.00)
Constant	0.64***	0.38***	0.26***
	(0.10)	(0.09)	(0.04)
Industry f.e.	Y	Y	Y
Time f.e.	Y	Y	Y
Ind. spec. trend	N	N	Y
Observations	893	799	5185
Adjusted R2	0.89	0.92	0.99

Rajan Zingales: dependence on external finance

$$\log E_{it} = \alpha + \beta\, GOV_i * PostDetroit_t + \delta\, EXTFIN_i^{US} * PostDetroit + \rho \log E_{it-1} + \gamma_i + \gamma_t + \varepsilon_{it}$$

	(1)	(2)	(3)	(4)
HighGOV*PostDetroit	-0.01**			
	(0.01)			
GOV*PostDetroit		-0.24**	-0.19**	-0.28**
		(0.11)	(0.09)	(0.12)
EXTFIN*PostDetroit				-0.01
				(0.00)
GOV*P^{def}				
L.logE	0.92***	0.95***	0.97***	0.95***
	(0.01)	(0.01)	(0.00)	(0.01)
Constant	0.64***	0.38***	0.26***	0.36***
	(0.10)	(0.09)	(0.04)	(0.09)
Industry f.e.	Y	Y	Y	Y
Time f.e.	Y	Y	Y	Y
Ind. spec. trend	N	N	Y	N
Observations	893	799	5185	799
Adjusted R2	0.89	0.92	0.99	0.92

Interaction with Default Risk

$$\log E_{it} = \alpha + \beta\, GOV_i * P_t^{def} + \rho \log E_{it-1} + \gamma_i + \gamma_t + \varepsilon_{it}$$

	(1)	(2)	(3)	(4)	(5)
HighGOV*PostDetroit	-0.01**				
	(0.01)				
GOV*PostDetroit		-0.24**	-0.19**	-0.28**	
		(0.11)	(0.09)	(0.12)	
EXTFIN*PostDetroit				-0.01	
				(0.00)	
GOV*P^{def}					-1.05**
					(0.47)
L.logE	0.92***	0.95***	0.97***	0.95***	0.95***
	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
Constant	0.64***	0.38***	0.26***	0.36***	0.41***
	(0.10)	(0.09)	(0.04)	(0.09)	(0.09)
Industry f.e.	Y	Y	Y	Y	Y
Time f.e.	Y	Y	Y	Y	Y
Ind. spec. trend	N	N	Y	N	N
Observations	893	799	5185	799	799
Adjusted R2	0.89	0.92	0.99	0.92	0.92

IV: Detroit shock → PR default risk → PR employment

$GOV_i * PostDetroit_t$ as instrument for $GOV_i * P_t^{def}$

$$\log E_{it} = \alpha + \beta \widehat{GOV_i * P_t^{def}} + \rho \log E_{it-1} + \gamma_i + \gamma_t + \varepsilon_{it}$$

	(1)	(2)	(3)	(4)	(5)	(6)
HighGOV*PostDetroit	-0.01**					
	(0.01)					
GOV*PostDetroit		-0.24**	-0.19**	-0.28**		
		(0.11)	(0.09)	(0.12)		
EXTFIN*PostDetroit				-0.01		
				(0.00)		
GOV*P^{def}					-1.05**	-1.69**
					(0.47)	(0.81)
L.logE	0.92***	0.95***	0.97***	0.95***	0.95***	0.95***
	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)
Constant	0.64***	0.38***	0.26***	0.36***	0.41***	0.43***
	(0.10)	(0.09)	(0.04)	(0.09)	(0.09)	(0.10)
Industry f.e.	Y	Y	Y	Y	Y	Y
Time f.e.	Y	Y	Y	Y	Y	Y
Ind. spec. trend	N	N	Y	N	N	N
Observations	893	799	5185	799	799	799
Adjusted R2	0.89	0.92	0.99	0.92	0.92	

Conclusion

- Novel setting to identfy & isolate effects of default risk: PR debt crisis
- Theory & evidence for government demand channel
  - Increased default risk disproportionately affects industries dependent on government demand

Calculating Pr(def) from CDS data

- Follow White (2013), Hébert Schreger (2017)
- Calculate hazard rate from Markit CDS par spread data

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

  - S_5: payment for 5 years of insurance against PR default
  - R: average recovery rate reported by dealers contributing to Markit.
- DEF:

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

  - Average up to monthly frequency.
  - $\Delta DEF_t = DEF_t - DEF_{t-1}$.

Back

Robust standard errors

	(1)	(2)	(3)	(4)	(5)
HighGOV*PostDetroit	-0.01*				
	(0.00)				
GOV*PostDetroit		-0.17*	-0.20***	-0.20**	
		(0.08)	(0.06)	(0.08)	
EXTFIN*PostDetroit				-0.00	
				(0.00)	
GOV*P(def)					-1.00**
					(0.40)
L.logE	0.95***	0.97***	0.98***	0.97***	0.96***
	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
Constant	0.40***	0.29***	0.25***	0.29***	0.32***
	(0.12)	(0.09)	(0.05)	(0.09)	(0.09)
Industry f.e.	Y	Y	Y	Y	Y
Time f.e.	Y	Y	Y	Y	Y
Ind. spec. trend	N	N	Y	N	N
Observations	1368	1224	5287	1224	1207
Adjusted R2	0.93	0.95	0.99	0.95	0.95

GOV_i average 2007-2012 censuses

	(1)	(2)	(3)	(4)	(5)	(6)
HighGOV7*PostDetroit	-0.01**					
	(0.00)					
GOV7*PostDetroit		-0.20*	-0.23**	-0.25**		
		(0.12)	(0.10)	(0.12)		
EXTFIN*PostDetroit				-0.00		
				(0.00)		
GOV7*P(def)					-1.00**	-1.31*
					(0.44)	(0.69)
L.logE	0.95***	0.97***	0.98***	0.97***	0.96***	0.96***
	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)
Constant	0.39***	0.29***	0.24***	0.29***	0.33***	0.36***
	(0.07)	(0.07)	(0.04)	(0.07)	(0.08)	(0.07)
Industry f.e.	Y	Y	Y	Y	Y	Y
Time f.e.	Y	Y	Y	Y	Y	Y
Ind. spec. trend	N	N	Y	N	N	N
Observations	1425	1125	4710	1125	1080	1380
Adjusted R2	0.94	0.95	0.99	0.95	0.95	