RIETI International Workshop

Long-term Growth and Secular Stagnation

Handout

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International Monetary Fund (IMF)

March 30, 2018

Research Institute of Economy, Trade and Industry (RIETI)
https://www.rieti.go.jp/en/index.html

Sovereign Debt Overhang, Expenditure Portfolio and Debt Restructurings

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IMF and WSU

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Disclaimer

- The views expressed herein are those of the authors and should not be attributed to the IMF, its Exercutive Board, or its management.

New data on public expenditure portfolio

- 179 privately-held external debt restructurings in 1978–2010 (Asonuma and Trebesch 2016)
- New dataset on public expenditure portfolio
  - Public consumption (public sector wage bills and consumption on final goods and service)
  - Public transfers
  - Public investment
  - Public capital (assets)
- Sources of our dataset
  - IMF Staff Reports from the IMF archives (more than 500 reports)
  - IMF FAD and WEO
  - WB WDI

Our new dataset

Table 1: Public Consumption, Investment, Transfers and Capital for Restructurings in 1978–2010[1/]

	Observation	Mean	Median	Std Dev.	Max	Min
Restructuring episodes	179					
			Percent of GDP			
Public consumption, average[2/]	124	12.4	10.9	8.2	77.6	0.5
Public investment, average[2/]	151	4.1	3.1	3.7	28.1	0.1
Public transfers, average[2/]	124	4.4	2.4	5.4	30.8	0.0
Public capital, average[2/]	152	75.5	58.2	50.6	259.8	1.7

[1/]For all components of public expenditure, our dataset has both series in real and level (constant 2011 US dollars), and in percent of GDP. [2/]For each restructuring episode, we take an average of public expenditure series from 3 years before the start of restructurings to the end of restructurings. We take an average of the obtained statistics across restructuring observations.

Stylized facts on restructurings

- **Stylized Fact 1**: Public investment experiences a severe decline and slow recovery, while public consumption and transfers experience short-lived declines and quick recovery.

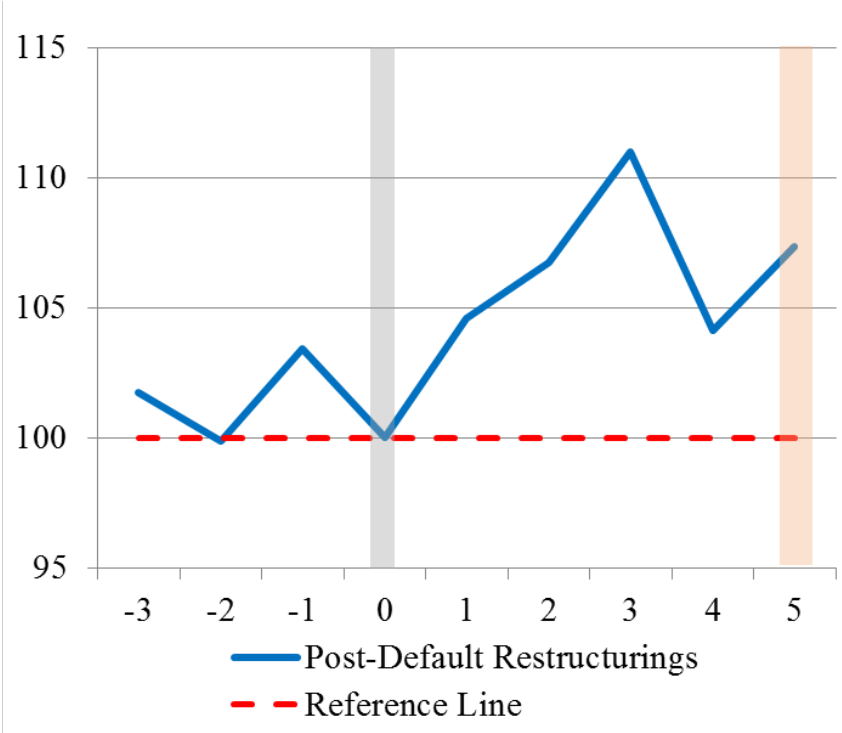


Figure: Public consumption (level, start=100)

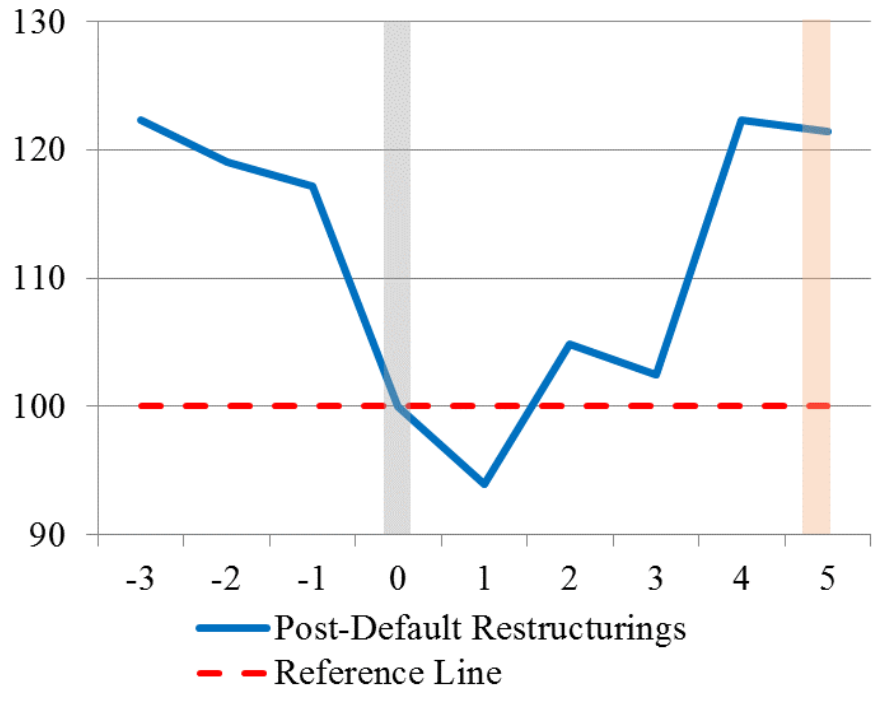


Figure: Public investment (level, start=100)

Stylized facts on restructurings (cont.)

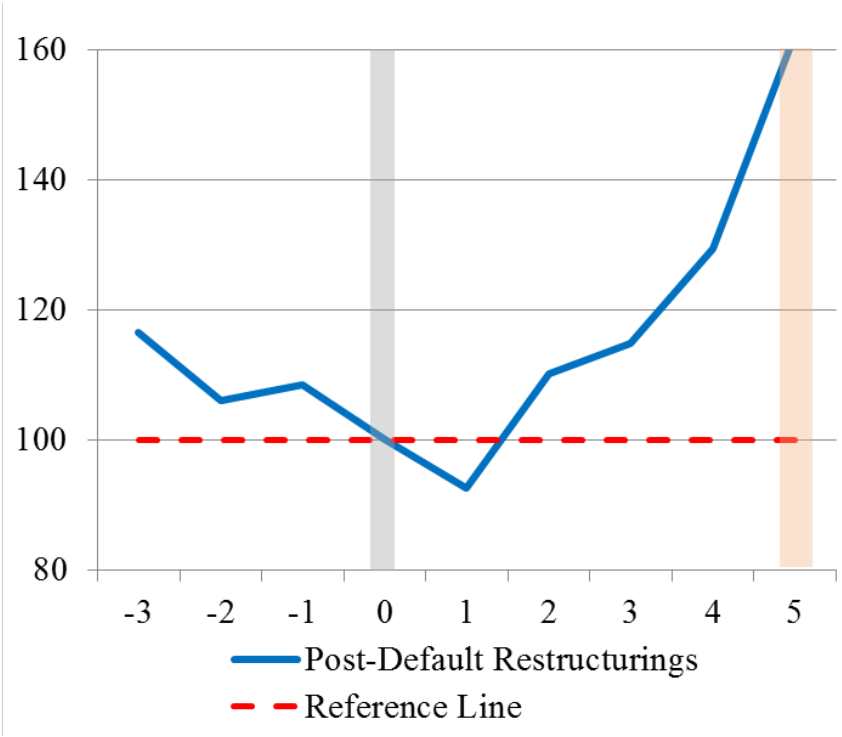


Figure: Public transfer (level, start=100)

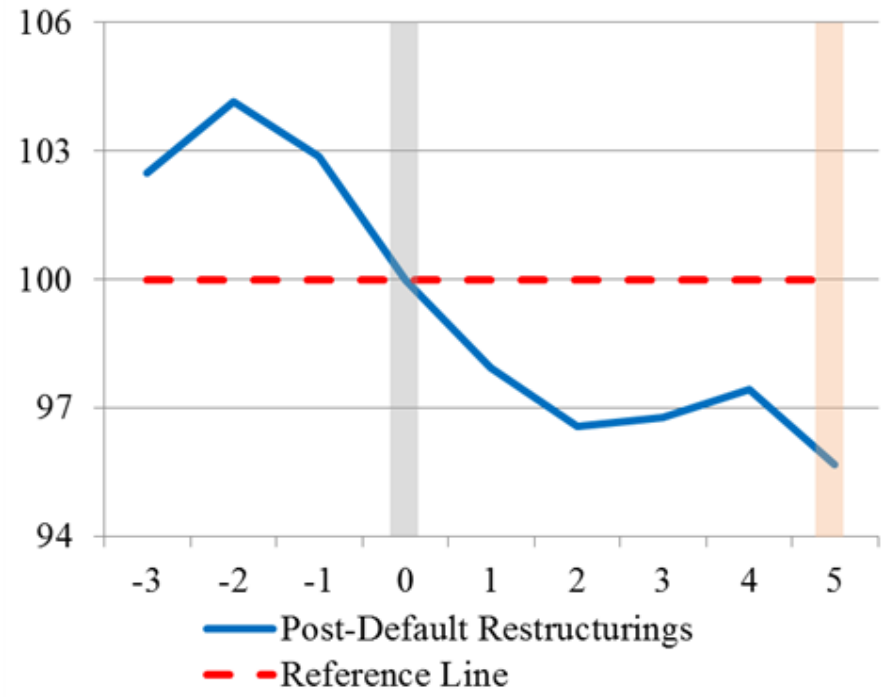


Figure: GDP per capita (level, start=100)

Stylized facts on restructurings (cont.)

- Public consumption and investment are procyclical with significance, while transfers are acyclical.

	Pre-restructuring	During restructuring
	(1)	(2)
	coef/se	coef/se
Public consumption, deviation from trend (percent, current)[1/]	10.05***	11.03***
	(2.89)	(1.77)
Public investment, deviation from trend (percent, current)[1/]	1.29**	3.00***
	(0.65)	(0.49)
Public transfers, deviation from trend (percent, current)[1/]	-0.15	-0.06
	(1.75)	(0.67)
Constant	0.84***	-0.06
	(0.29)	(0.22)
Episode-specific fixed effects	No	No
Number of restructuring episodes	63	76
Number of observations	169	405
Wald χ^2	21.2	80.8
R^2	0.11	0.17

Notes: The table shows results from random effects generalized least square (GLS) regressions. The dependent variable is GDP per capita deviation from the trend. The main explanatory variables are public consumption, investment, and transfers (all measured as deviations from the trend). In column 1, the sample covers observations in pre-restructuring periods. In column 2, the sample covers observations during restructurings. Significance levels denoted by *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$, respectively. Robust standard errors clustered on the episode level in parentheses. We obtain the same results with random effects ordinary least square (OLS) estimation.
[1/] A deviation from the trend is a percentage deviation from the trend obtained by applying a Hodrick-Prescott (HP) filter to annual series with filter of 6.25.

Stylized facts on restructurings (cont.)

- **Stylized Fact 2**: Sovereigns decelerate public capital accumulation during restructurings.

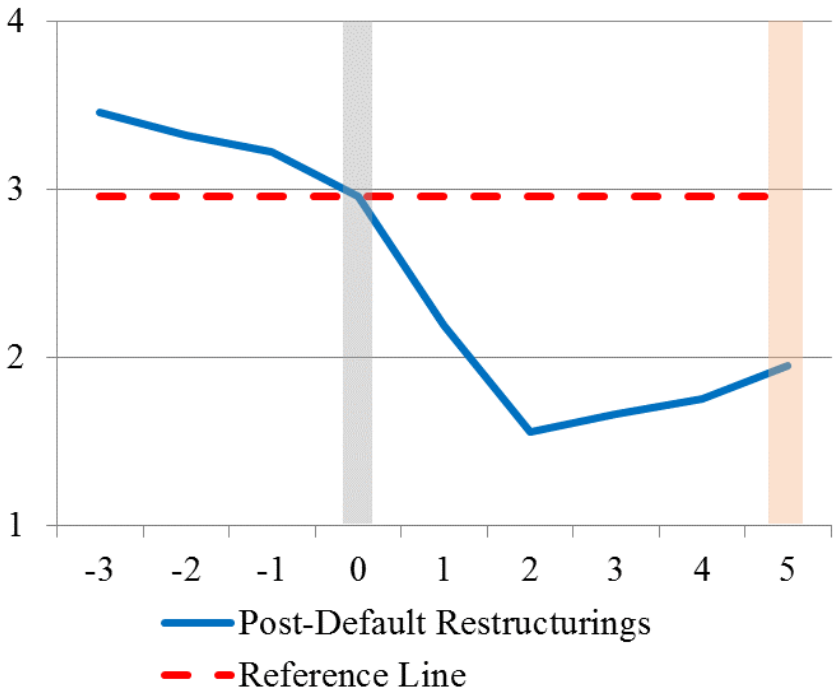


Figure: Public capital (growth rate%)

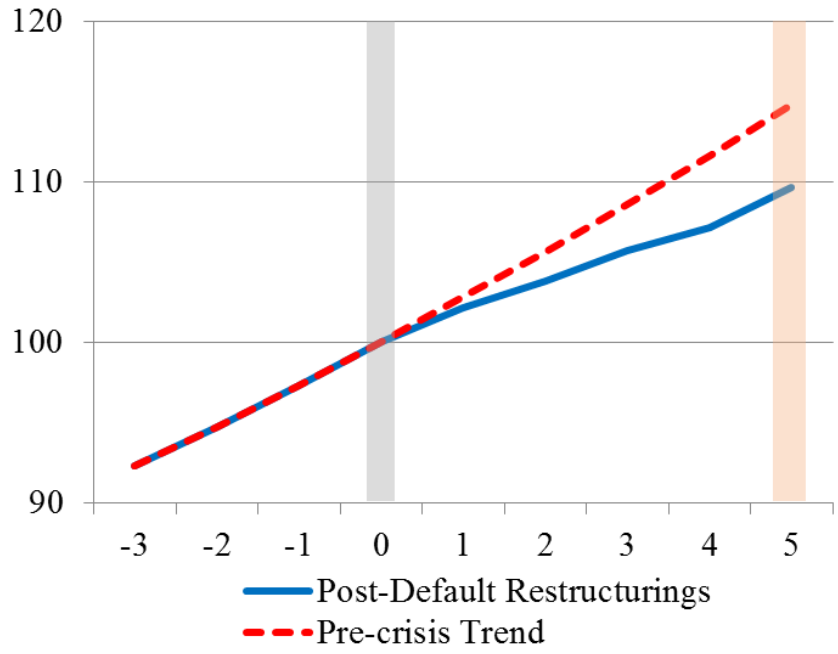


Figure: Public capital (level, start=100)

Stylized facts on restructurings (cont.)

	Public capital growth	Public capital deviation from trend[2/]
	(current, percent)	(current)
	(1)	(2)
	coef/se	coef/se
Pre-restructuring period (current, dummy)[1/]	1.33***	0.04***
	(0.21)	(0.005)
GDP per capita, deviation from trend (current, percent)[2/]	0.08***	-0.001**
	(0.02)	(0.0005)
Constant	2.19***	0.01***
	(0.11)	(0.002)
Episode-specific fixed effects	Yes	Yes
Number of restructuring episodes	94	95
Number of observations	754	762
F-statistics	8.55	8.34
R^2	0.082	0.086

Notes: The table shows results from fixed effects OLS regressions. The dependent variables are public capital growth rate in column (1) and public capital deviation from the trend in column (2). The main explanatory variable is a dummy variable for pre-restructuring periods. Significance levels denoted by *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$, respectively. All regressions include episode-specific fixed effects. Robust standard errors clustered on the episode level in parentheses.

[1/] A dummy variable for the pre-restructuring period is set 1 prior to the start of restructurings and 0 during restructurings.

[2/] A deviation from the trend is a percentage deviation from the trend and annual change in the trend obtained by applying a Hodrick-Prescott (HP) filter to annual series with filter of 6.25.

Stylized facts on restructurings (cont.)

- **Stylized Fact 3**: Public investment is negatively associated with public external debt with significance, but neither public consumption nor transfers is.

	Public consumption	Public investment	Public transfers
	(current, % of GDP)	(current, % of GDP)	(current, % of GDP)
	(1)	(2)	(3)
	coef/se	coef/se	coef/se
PPG external debt (lagged, percent of GDP)[1/]	-0.002	-0.005***	-0.001
	(0.003)	(0.002)	(0.001)
GDP per capita, deviation from trend (current, percent)[2/]	0.001	0.05**	-0.007***
	(0.05)	(0.02)	(0.02)
Constant	12.3***	3.93***	3.10***
	(0.31)	(0.13)	(0.14)
Episode-specific fixed effects	Yes	Yes	Yes
Number of restructuring episodes	84	90	84
Number of observations	593	696	593
F-statistics	38.41	15.31	30.35
R^2	0.038	0.027	0.036

Notes: The table shows results from fixed effects OLS regressions. The dependent variables are public consumption (column 1), public investment (column 2), and public transfers (column 3). The main explanatory variable is lagged PPG external debt. Significance levels denoted by *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$, respectively. All regressions include episode-specific fixed effects. Robust standard errors clustered on the episode level in parentheses.

[1/] Public and publicly guaranteed external debt. Lagged level in terms of GDP.

[2/] A deviation from the trend is a percentage deviation from the trend obtained by applying a Hodrick-Prescott (HP) filter to annual series with filter of 6.25.

Stylized facts on restructurings (cont.)

- **Stylized Fact 1**: Public investment experiences a severe decline and slow recovery, while public consumption and transfers experience short-lived declines and quick recovery. (Both consumption and investment are procyclical, while transfers are acylical.)
- **Stylized Fact 2**: Sovereigns decelerate public capital accumulation during restructurings.
- **Stylized Fact 3**: Public investment is negatively associated with public external debt with significance, but neither public consumption nor transfer is.

Main questions

- **Main questions**
  - Why do the sovereign debtors experience a severe decline and slow recovery in public investment (i.e. deceleration of public capital accumulation) around debt restructurings?
  - In contrast, why do they experience short-lived declines and quick recovery in public consumption and transfers?

- **Question on the big puzzle in the literature**
  - How does public capital influence sovereign debtors' decision to default, to delay the renegotiations, and to agree on settlement?

Implications of the paper

- New dataset on public expenditure portfolio and new stylized facts on debt overhang, expenditure portfolio and restructurings:
  - A severe decline in public investment, while short-lived declines in public consumption and transfers.
  - Deceleration of public capital accumulation.
  - Negative association between public investment and external debt.
- Theoretical model with (i) public expenditure portfolio, (ii) public capital accumulation, and (iii) multi-round debt renegotiation rationalizes these facts:
  - A severe decline in public investment, while a short-lived decline in public consumption/transfers.
  - Deceleration of public capital accumulation.
  - Negative association between public investment and external debt.
- The data confirms the main prediction of the theoretical model.

Intuition: Main mechanism and drivers

- **Prior to restructurings:** Low productivity, high debt payments, and consumption-smoothing motive.
  - On the one hand, sovereigns opt to smooth both private and public consumption (through transfers and public consumption).
  - On the other hand, sovereigns distortionally reduce public investment.
- **During restructurings:** Deceleration of public capital accumulation and lengthy negotiations.
  - Public capital accumulation is slow due to low productivity and no external borrowing.
  - Sovereigns opt to delay the settlement since they prioritize investment to public capital (high MPK).
  - Sovereigns choose to settle with debt repayments after public capital accumulation (low MPK).

Literature review

- Sovereign debt overhang
  - Krugman (1989), Sach (1989), Aguiar et al. (2009), Ostry et al. (2014), Reinhart et al. (2012)
- Public expenditure portfolio
  - Arellano and Bai (2016), Cuadra et al. (2010), Hatchondo et al. (2017), Bianchi et al. (2017), Azzimonti (2015), Mendoza et al. (2014)
- Sovereign defaults and renegotiations (multi-round)
  - Benjamin and Wright (2009), Kovrijnykh and Szentes (2007), Bai and Zhang (2012), Bi (2008), Asonuma and Joo (2017)
- Sovereign debt and capital
  - Gordon and Guerron-Quantina (2017), Park (2017)

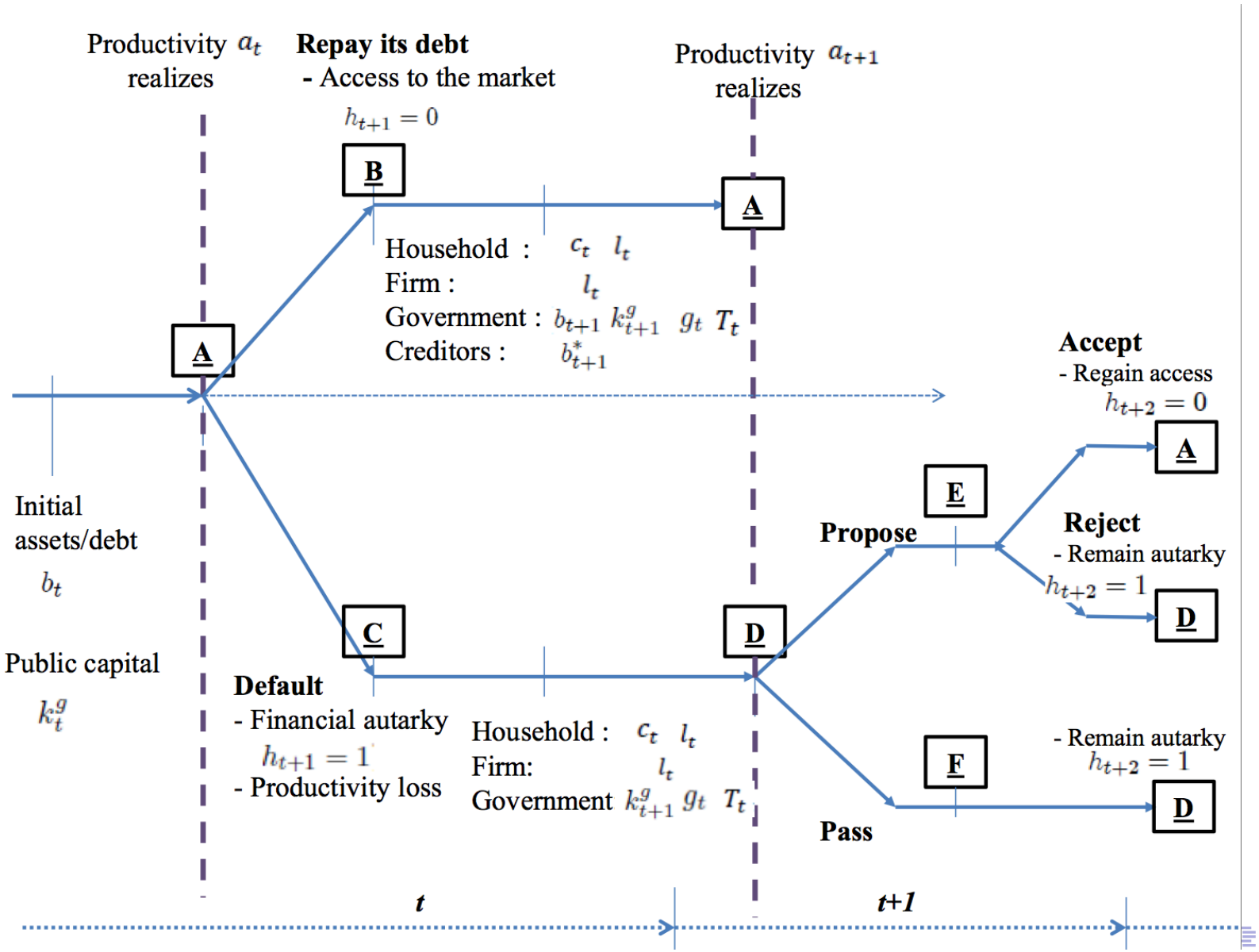
Model: General features

- Sovereign debt in a dynamic small open economy model:
  - Public expenditure portfolio,
  - Public capital accumulation,
  - Production with labor and public capital,
  - Multi-round debt renegotiation.

Model: General features (Cont.)

- A risk averse sovereign debtor, a household, a private firm and risk-neural creditors
- A stochastic TFP shock a_t
- Public expenditure choice: consumption, investment, transfers and debt repayments
- Public capital accumulation and elastic labor supply
- Credit record h_t : indicating status of market access
- Incomplete capital market: one-period zero-coupon bonds
- One-side commitment
- Multi-round renegotiation upon the default choice

Model: Timing



Model: Household's problem

- Household maximization problem

$$\max_{c_t, l_t} E_0 \sum_{t=0}^{\infty} \beta^t U(c_t, l_t, g_t) \tag{1}$$

$$s.t. \quad (1+\tau)c_t = w_t l_t + \pi_t^F + T_t \tag{2}$$

  where $U(c_t, l_t, g_t) = (1-\lambda)u(c_t, l_t) + \lambda v(g_t)$

- Optimality condition of household

$$\frac{u_l(c_t, l_t)}{u_c(c_t, l_t)} = \frac{w_t}{1+\tau} \tag{3}$$

Model: Firm's problem

- Production function

$$y_t = a_t (l_t)^{\alpha_l} (k_t^g)^{\alpha_k} (\bar{k}^p)^{1-\alpha_l-\alpha_k} \tag{4}$$

where $\bar{k}^p = 1$

(Mendoza and Yue 2012, Azzimonti 2015)

- Private firm's profit maximization problem:

$$\max_{l_t} \pi_t^F = a_t (l_t)^{\alpha_l} (k_t^g)^{\alpha_k} (\bar{k}^p)^{1-\alpha_l-\alpha_k} - w_t l_t \tag{5}$$

- Optimality condition of the private firm

$$w_t = \alpha_l a_t (l_t)^{\alpha_l - 1} (k_t^g)^{\alpha_k} (\bar{k}^p)^{1-\alpha_l-\alpha_k} \tag{6}$$

Model: Sovereign's problem (cont.)

- Case of good credit record (market access - $h_t = 0$)
- If the sovereign has debt ($b_t < 0$)

$$V(b_t, k_t^g, 0, a_t) = \max\left[V^R(b_t, k_t^g, 0, a_t), V^D(b_t, k_t^g, 0, a_t)\right] \tag{12}$$

- Sovereign's value of repayment

$$V^R(b_t, k_t^g, 0, a_t) = \max_{g_t, b_{t+1}, k_{t+1}^g, T_t} (1-\lambda)u(c_t, l_t) + \lambda v(g_t)$$
$$+\beta \int_A V(b_{t+1}, k_{t+1}^g, 0, a_{t+1}) d\mu(a_{t+1}|a_t) \tag{7'}$$

$$s.t. \quad g_t + k_{t+1}^g + T_t + q(b_{t+1}, k_{t+1}^g, 0, a_t)b_{t+1} = \tau c_t + (1-\delta^g)k_t^g - \frac{\Omega}{2}\left(\frac{k_{t+1}^g - k_t^g}{k_t^g}\right)^2 k_t^g + b_t \tag{8}$$

$$T_t \geq 0 \tag{9}$$

$$\frac{u_l(c_t, l_t)}{u_c(c_t, l_t)} = \frac{\alpha_l a_t (l_t)^{\alpha_l - 1} (k_t^g)^{\alpha_k} (\bar{k}^p)^{1-\alpha_l-\alpha_k}}{1+\tau} \tag{10}$$

$$(1+\tau)c_t = y_t + T_t \tag{11}$$

Model: Sovereign's problem (cont.)

- Sovereign's value of defaulting (restructuring)

$$V^D(b_t, k_t^g, 0, a_t) = \max_{g_t, b_{t+1}, k_{t+1}^g, T_t} (1-\lambda)u(c_t, l_t) + \lambda v(g_t)$$

$$+\beta \int_A V((1+r^*)b_t, k_{t+1}^g, 1, a_{t+1}) d\mu(a_{t+1}|a_t) \tag{13}$$

$$s.t. \quad g_t + k_{t+1}^g + T_t = \tau c_t + (1-\delta^g)k_t^g - \frac{\Omega}{2}\left(\frac{k_{t+1}^g - k_t^g}{k_t^g}\right)^2 k_t^g \tag{8'}$$

$$T_t \geq 0 \tag{9}$$

$$\frac{u_l(c_t, l_t)}{u_c(c_t, l_t)} = \frac{\alpha_l \tilde{a}_t (l_t)^{\alpha_l - 1} (k_t^g)^{\alpha_k} (\bar{k}^p)^{1-\alpha_l-\alpha_k}}{1+\tau} \tag{10'}$$

$$(1+\tau)c_t = \tilde{y}_t + T_t \tag{11'}$$

- Case of bad credit record (loss in access - $h_t = 1$)

$$V(b_t, k_t^g, 1, a_t) = \Gamma(b_t, k_t^g, a_t) \tag{14}$$

Model: Renegotiation problem

- Strategies of the proposer i and the other party j (for $i, j = B, L$) depending on state (b_t, k_t^g, h_t, a_t) and current offer:

$$\theta_i = \{1 \quad (propose)\} \quad \& \quad \theta_j = \{1 \quad (accept)\}$$

$$\theta_i = \{0 \quad (pass)\} \quad \& \quad \theta_j = \{0 \quad (reject)\}$$

- Case when the borrower B is the proposer
- If B proposes and the proposal is

$$V^{PRO}(b_t, k_t^g, a_t) = \max_{g_t, k_{t+1}^g, T_t} (1-\lambda)u(c_t, l_t) + \lambda v(g_t) + \beta \int_A V(0, k_{t+1}^g, 0, a_{t+1}) d\mu(a_{t+1}|a_t) \tag{18}$$

$$s.t. \quad g_t + k_{t+1}^g + T_t = \tau c_t + (1-\delta^g)k_t^g - \frac{\Omega}{2}\left(\frac{k_{t+1}^g - k_t^g}{k_t^g}\right)^2 k_t^g + \delta_t^B b_t \tag{8"}$$

$$T_t \geq 0 \tag{9}$$

$$\frac{u_l(c_t, l_t)}{u_c(c_t, l_t)} = \frac{\alpha_l \tilde{a}_t (l_t)^{\alpha_l - 1} (k_t^g)^{\alpha_k} (\bar{k}^p)^{1-\alpha_l-\alpha_k}}{1+\tau} \tag{10'}$$

$$(1+\tau)c_t = \tilde{y}_t + T_t \tag{11'}$$

$$V^{*ACT}(b_t, k_t^g, a_t) = -\delta_t^B b_t \tag{19}$$

Model: Renegotiation problem (cont.)

- If B passes,

$$V^{PASS}(b_t, k_t^g, a_t) = \max_{g_t, k_{t+1}^g, T_t} (1-\lambda)u(c_t, l_t) + \lambda v(g_t) + \beta \int_A V((1+r^*)b_t, k_{t+1}^g, 1, a_{t+1}) d\mu(a_{t+1}|a_t) \quad (20)$$

$$s.t. \quad g_t + k_{t+1}^g + T_t = \tau c_t + (1-\delta^g)k_t^g - \frac{\Omega}{2}\left(\frac{k_{t+1}^g - k_t^g}{k_t^g}\right)^2 k_t^g \quad (8')$$

$$T_t \geq 0 \quad (9)$$

$$\frac{u_l(c_t, l_t)}{u_c(c_t, l_t)} = \frac{\alpha_l \tilde{a}_t (l_t)^{\alpha_l - 1} (k_t^g)^{\alpha_k} (\bar{k}^p)^{1-\alpha_l-\alpha_k}}{1+\tau} \quad (10')$$

$$(1+\tau)c_t = \tilde{y}_t + T_t \quad (11')$$

$$V^{*REJ}(b_t, k_t^g, a_t) = \frac{1}{1+r^*} \int_A \Gamma^*((1+r^*)b_t, k_{t+1}^g, 1, a_{t+1}) d\mu(a_{t+1}|a_t) \quad (21)$$

- Equilibrium

$$\delta_t^{B*} = argmax V^{PRO}(b_t, k_t^g, a_t)$$
$$s.t. \quad V^{PRO}(b_t, k_t^g, a_t) \geq V^{PASS}(b_t, k_t^g, a_t)$$
$$V^{*ACT}(b_t, k_t^g, a_t) \geq V^{*REJ}(b_t, k_t^g, a_t) \tag{22}$$

- If both parties reach an agreement,

$$\Gamma^B(b_t, k_t^g, a_t) = V^{PRO}(b_t, k_t^g, a_t) \tag{23}$$
$$\Gamma^{B*}(b_t, k_t^g, a_t) = V^{*ACT}(b_t, k_t^g, a_t) \tag{24}$$

- Otherwise,

$$\Gamma^B(b_t, k_t^g, a_t) = V^{PASS}(b_t, k_t^g, a_t) \tag{23'}$$
$$\Gamma^{B*}(b_t, k_t^g, a_t) = V^{*REJ}(b_t, k_t^g, a_t) \tag{24'}$$

Equilibrium

Definition

A recursive equilibrium is defined as a set of functions for (a) the sovereign's value function, pubic consumption, transfers, capital, assets/debt, default set, (b) the household's consumption and labor supply, (c) the firm's labor demand, (d) the sovereign's and the creditors' decision functions, payoffs, two sets of recovery rates, and (e) sovereign bond prices such that
[1]. the sovereign government's value function, public consumption, capital, transfers, assets/debt, and default set satisfy its optimization problem (7)–(15);
[2]. the household's consumption and labor supply satisfy his optimization problem (1)–(3);
[3]. the firm's labor demand satisfies its optimization problem (4)–(6);
[4]. both parties' decisions, payoffs and recovery rates solve the multi-round debt renegotiation problem (16)–(33);
[5]. sovereign prices satisfy the foreign creditors' optimization problem (34)–(35).

Quantitative analysis - Parameters

- TFP process -AR(1) process:

$$\log(a_t) = \rho \log(a_{t-1}) + \epsilon_t, \tag{41}$$

- Household utility function - GHH, CRRA:

$$u(c_t, l_t) = \frac{(c_t - \frac{l_t^{1+\psi}}{1+\psi})^{1-\sigma}}{1-\sigma}, \qquad v(g_t) = \frac{g_t^{1-\sigma_g}}{1-\sigma_g} \tag{40}$$

Parameter	Value	Source
Risk aversion for private consumption	$\sigma = 3$	Previous studies
Risk aversion for public consumption	$\sigma_g = 3$	Hatchondo et al. (2017)
Risk-free interest rate	$r^* = 0.01$	US Treasury Bill
Labor elasticity	$\psi = 0.48$	Mendoza (1991)
Labor income share	$\alpha^L = 0.64$	Gordon and Guerron-Quintana (2017)
Public capital income share	$\alpha^K = 0.058$	Argentine public and private capital (1993–2005)
Public capital depreciation rate	$\delta = 0.04$	US BEA (1999)
Effective consumption tax rate	$\tau = 0.33$	Argentine tax revenues (1993–2005)
Auto-correlation of productivity shock	$\rho = 0.85$	Computed Argentine GDP- MECON
Standard deviation of productivity shock	$\sigma^a = 0.017$	Computed Argentine GDP- MECON
Direct productivity loss	$\lambda_d = 0.02$	Computed
Weight on public consumption	$\lambda = 0.8$	Computed
Public capital adjustment costs	$\Omega = 2.5$	Computed
Discount rate	$\beta = 0.90$	Computed
Bargaining power	$\phi = 0.75$	Computed

Quantitative analysis - Steady-state dist.

- Sovereign's choice among repayment, delay and settlement

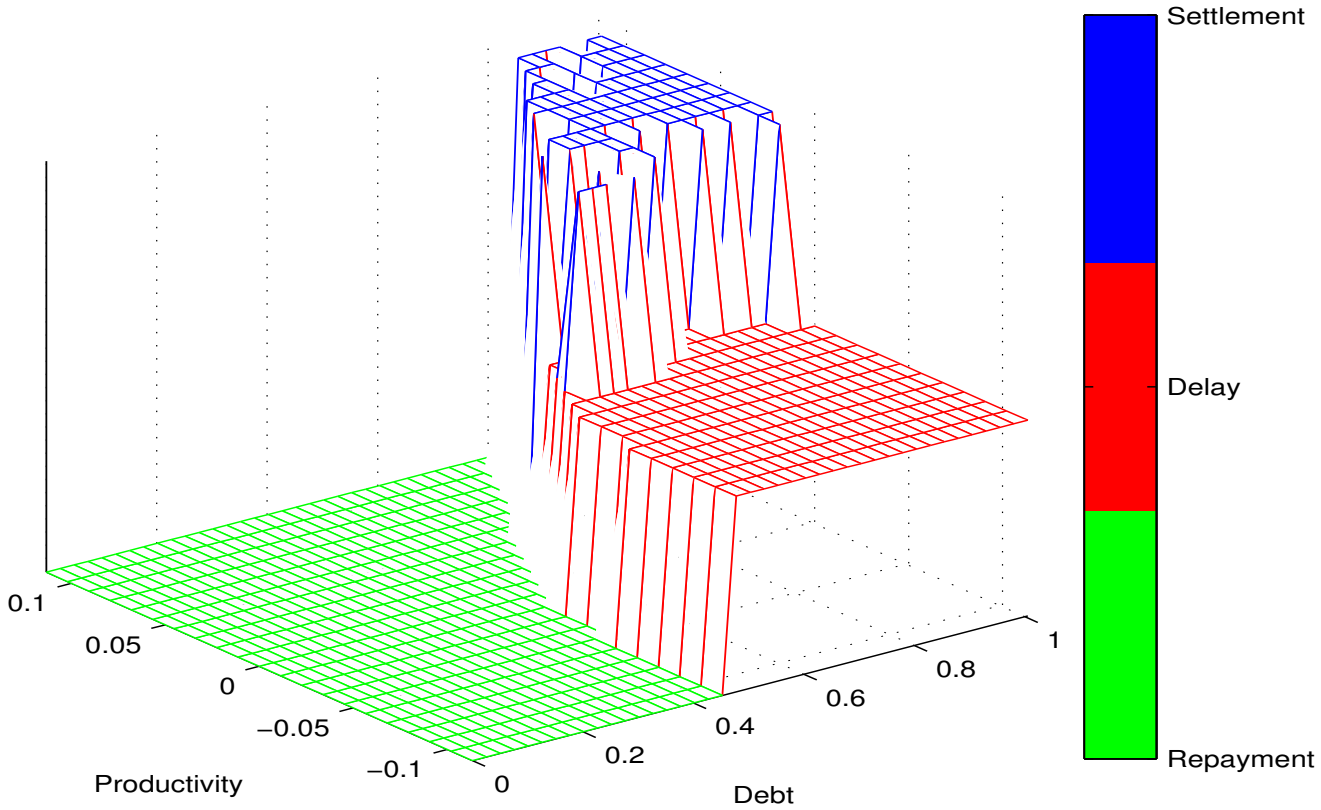


Figure: Mean public capital

Quantitative analysis - Steady-state dist. (cont.)

- Sovereign's choice among repayment, delay and settlement

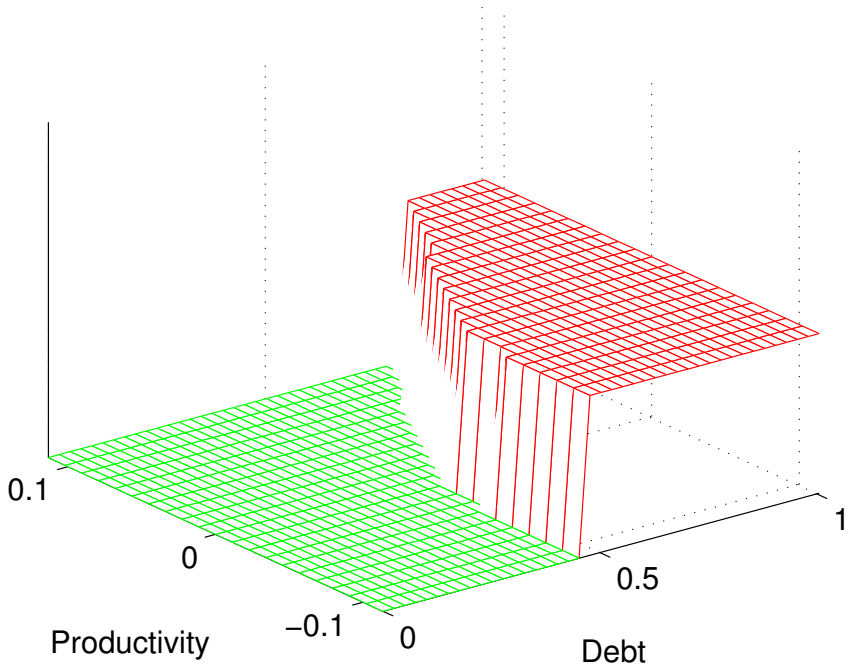


Figure: Low public capital

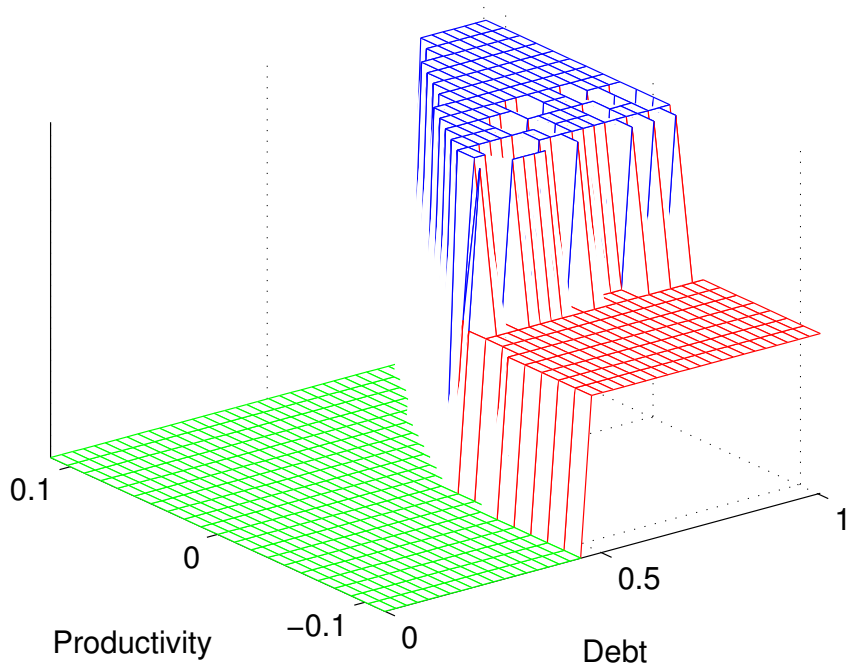


Figure: High public capital

Quantitative analysis - Steady-state dist. (cont.)

- Public consumption/transfers – Mean public capital

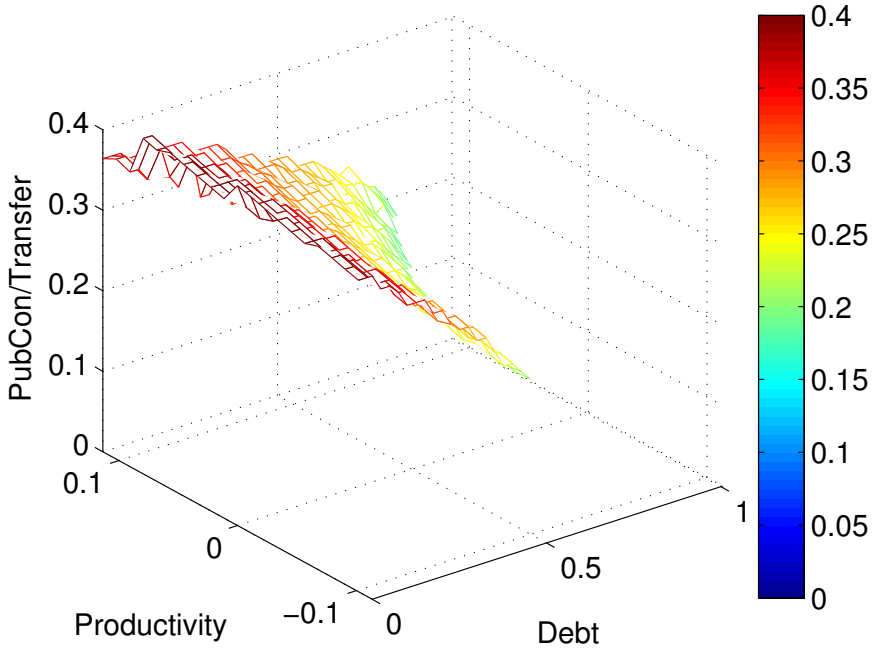


Figure: "Repayment" Region

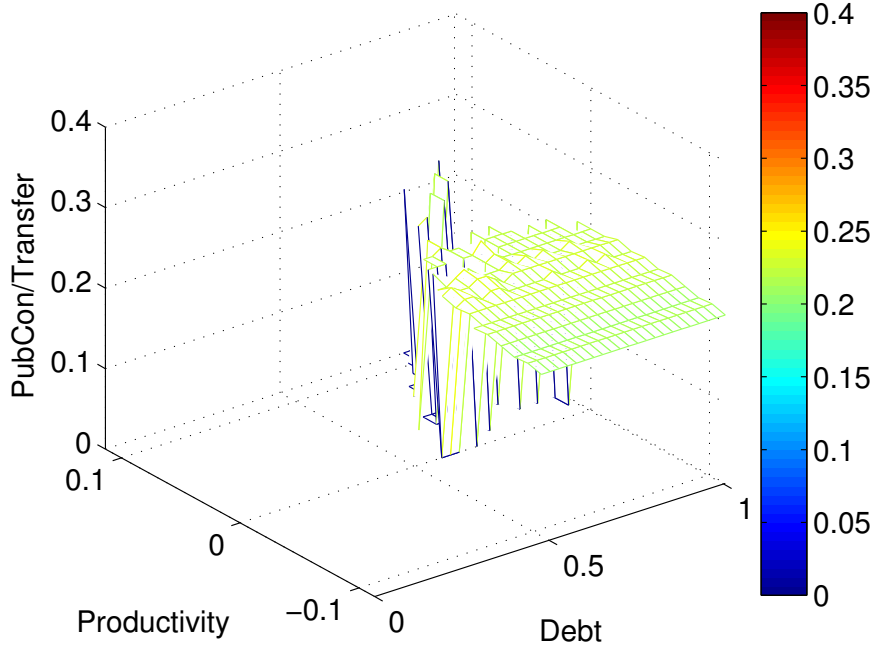


Figure: "Settlement" and "Delay" Region

Quantitative analysis - Steady-state dist. (cont.)

- Public investment – Mean public capital

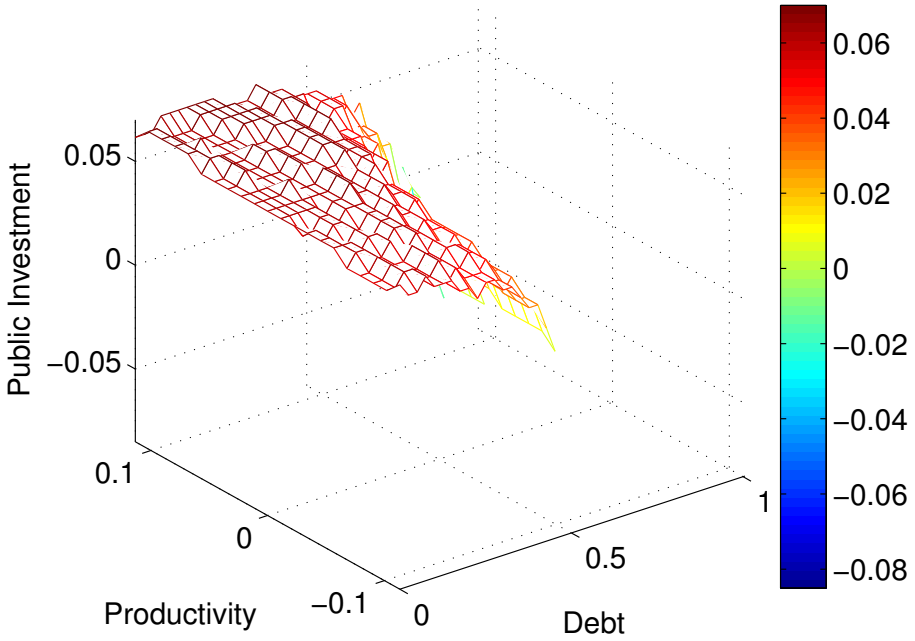


Figure: "Repayment" Region

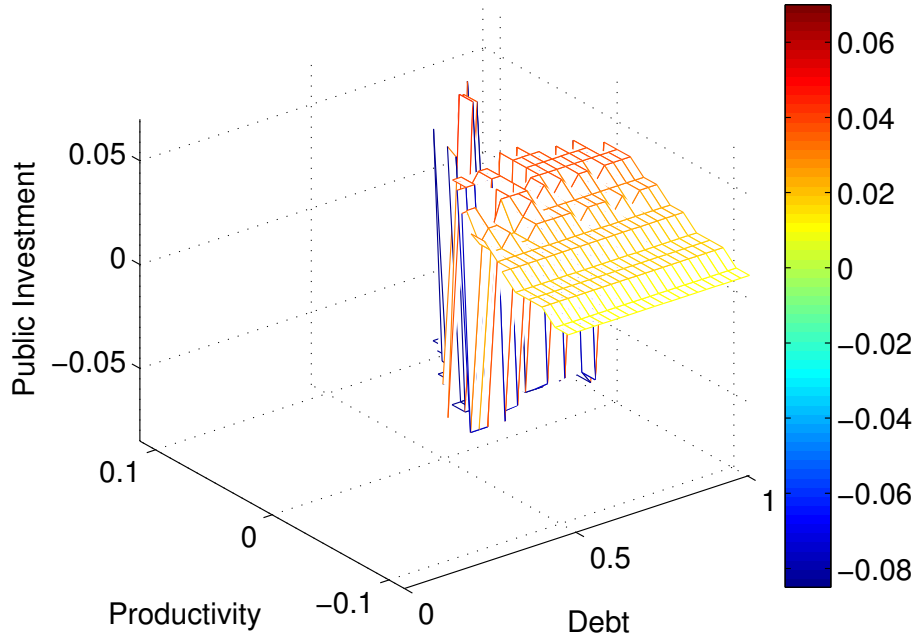


Figure: "Settlement" and "Delay" Region

Quantitative analysis - Simulation

(i) Business Cycle Statistics - Debtor

	Data	Model	Arellano (2008)	Yue (2010)
Target statistics				
Average public consumption & transfers/GDP ratio (%)	20.0	23.4		
Public investment (std dev.)/output (std dev.) (%)	5.1	4.2		
Non-target statistics				
Pre-default periods				
Private sector				
Private consumption (std dev.)/output (std dev.)	1.11	1.06	1.10	1.04
Trade balance/output: std dev. (%)	0.36	1.02	1.75	2.81
Corr.(trade balance, output)	-0.87	-0.06	-0.1	-0.16
Public sector				
Public consumption & transfers (std dev.)/output (std dev.)	1.26	1.07		
Corr.(public consumption & transfers, output)	0.52	0.94		
Average public investment/GDP ratio	1.31	1.37		
Corr.(public investment, output)	0.51	0.37		
Renegotiation periods				
Private sector				
Private consumption (std dev.)/output (std dev.)	1.17	1.08		
Trade balance/output: std dev. (%)	0.45	0.00		
Corr.(trade balance, output)	-0.97	0.00		
Public sector				
Public consumption & transfers (std dev.)/output (std dev.)	0.99	1.18		
Corr.(public consumption & transfers, Output)	0.99	0.86		
Average public investment/GDP ratio	1.19	1.20		
Average public investment/GDP ratio (downward trend)/1	0.73	0.28		
Average public investment/GDP ratio (upward trend)/1	1.64	1.37		
Corr.(public investment, output)	0.99	0.86		

Quantitative analysis - Simulation (Cont.)

(ii) Non-business Cycle Statistics

	Data	Model	Arellano (2008)	Yue (2010)
Target statistics				
Default probability (%)	3.26	4.90	3.00	2.67
Average recovery rate (%)	25.0	36.1	-	27.3
Average debtor output deviation during debt renegotiation	-4.45	-4.91	-	-
Pre-default periods				
Average debt/GDP ratio (%)	45.4	40.1	5.95	10.10
Bond spreads: average (%)	9.4	0.17	3.6	1.9
Bond spreads: std dev. (%)	7.6	0.3	6.4	1.6
Corr.(spreads, output)	-0.88	-0.26	-0.29	-0.11
Corr.(debt/GDP, spreads)	0.92	0.31	-	-
Corr.(debt/GDP, output)	-0.97	-0.67	-	-
Renegotiation periods				
Average debt/GDP ratio (%)	130.5	47.5	-	-
Corr.(debt/GDP, output)	-0.95	-0.99	-	-
Duration of renegotiation/ exclusion (quarters)	14.0	8.5	-	2.0
Debtor output deviation (diff. btw start and end, %)/2	8.7	19.21	-	-
Public capital (percent change from the trough to the end)	2.31	2.15	-	-

Testing the model predictions

	Public capital growth (cumulative since the start)		Public investment deviation from trend	
	Simple model	Full model	Simple model	Full model
	(1)	(2)	(3)	(4)
	coef/se	coef/se	coef/se	coef/se
Public capital, cumulative growth rate (lagged, percent)[1/]	0.005*	0.005*	-	-
	(0.003)	(0.003)		
Public investment, deviation from the trend (lagged, percent)[2/]	-	-	0.289*	0.349*
			(0.170)	(0.195)
PPG external debt (lagged, percent of GDP)[3/]	-0.002*	-0.003**	-0.002	-0.003**
	(0.001)	(0.002)	(0.001)	(0.002)
GDP, deviation from trend (current, percent)[2/]	0.103	0.551	-	-0.036
	(0.822)	(0.866)		(0.953)
GDP, trend growth rate (current, percent)[2/]	-0.054	-0.073	-	-0.046
	(0.043)	(0.045)		(0.043)
World GDP, growth rate (current, percent)	-	0.207***	-	0.207***
		(0.069)		(0.069)
LIBOR, 12-month average (current, percent)	-	-0.058**	-	-0.061**
		(0.024)		(0.024)
IMF-supported program, start (current, dummy)[4/]	-	-0.033	-	-0.042
		(0.146)		(0.145)
Constant	-0.673***	-0.713*	-0.741***	-0.694*
	(0.150)	(0.374)	(0.113)	(0.371)
Episode-specific fixed effects	No	No	No	No
Number of restructuring episodes	89	89	91	90
Number of observations	499	492	507	496
Wald χ^2	6.56	20.76	5.67	21.06
Prob.> χ^2	0.161	0.004	0.059	0.004

Notes: The table shows results from random effects multinomial probit regressions. The dependent variable is debt settlement (binary choice). The main explanatory variables are public capital cumulative growth rate and public investment deviation from the trend. Public capital cumulative growth rate, public investment deviation from the trend, and PPG external debt (percent of GDP) are lagged by one year. The other explanatory variables are in the current year. Significance levels denoted by *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$, respectively.

[1/] Cumulative growth of public capital since the start of restructurings.

[2/] A deviation from the trend and trend growth rate are a percentage deviation from the trend and annual change in the trend obtained by applying a Hodrick-Prescott (HP) filter to annual series with filter of 6.25.

[3/] Public and publicly guaranteed external debt. Lagged level in terms of GDP.

[4/] A dummy for an IMF-supported program is set to 1 when an IMF-supported program starts at the year of completion of debt restructurings and 0 otherwise.

Conclusion

- New dataset on public expenditure portfolio and new stylized facts on debt overhang, expenditure portfolio and restructurings
  - A severe decline in public investment, while short-lived declines in public consumption and transfers.
  - Deceleration of public capital accumulation.
  - Negative association between public investment and external debt.
- Theoretical model with (i) public expenditure portfolio, (ii) public capital accumulation, and (iii) multi-round debt renegotiation rationalizes these facts:
  - A severe decline in public investment, while a short-lived decline in public consumption/transfers.
  - Deceleration of public capital accumulation.
  - Negative association between public investment and external debt.
- The data confirms the main prediction of the theoretical model.

Stylized facts on restructurings (cont.)

- Different dynamics of private consumption and investment with those of public consumption and investment.

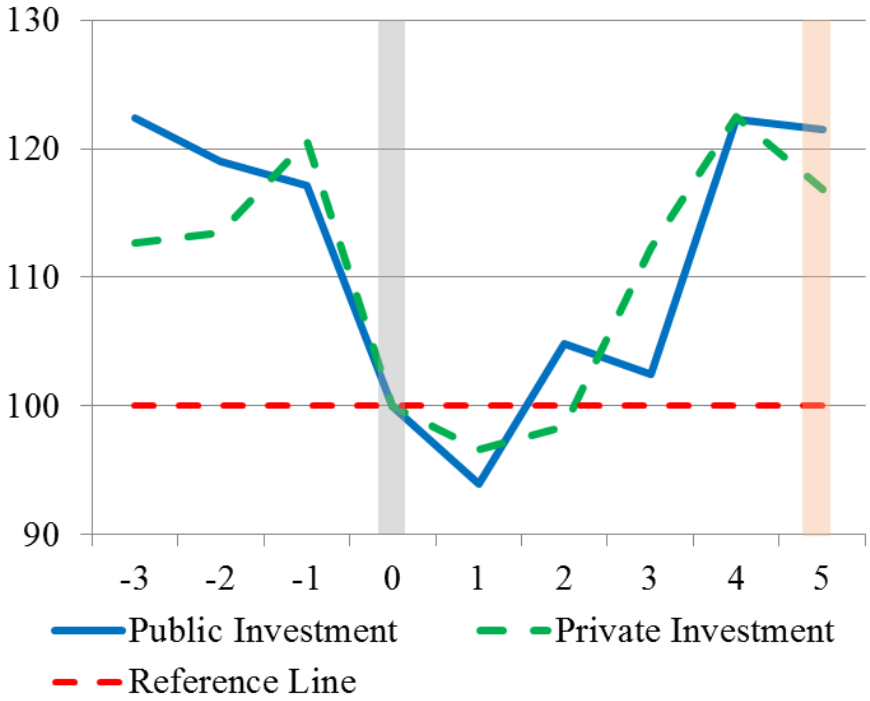


Figure: Public and private investment (level, start=100)

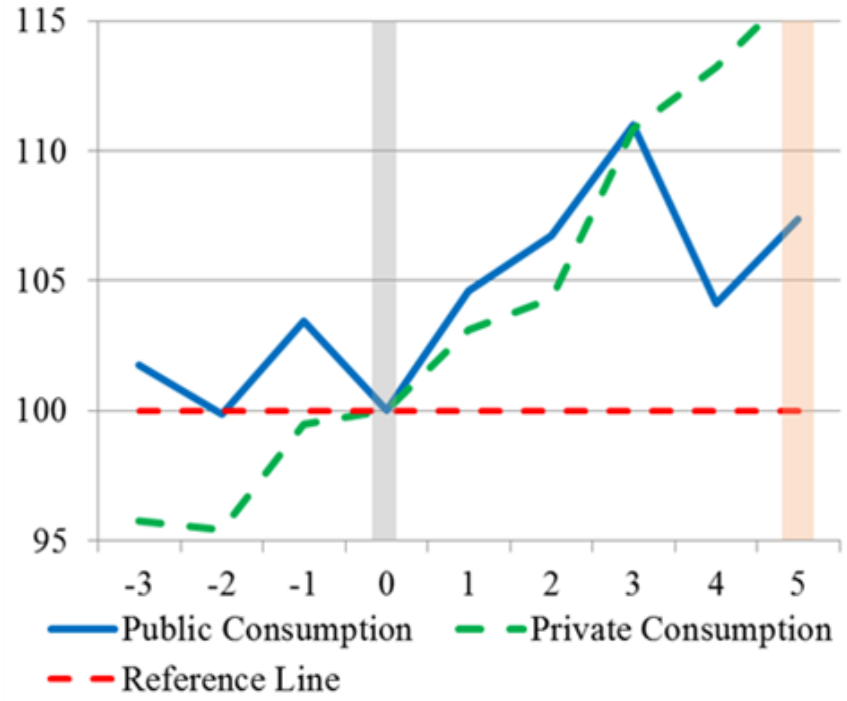


Figure: Public and private consumption (level, start=100)

Overview of the paper

- Empirical, theoretical and quantitative analysis of sovereign debt.
- Two main contributions to the literature on sovereign debt.
  - New dataset on public expenditure portfolio and new stylized facts on debt overhang, expenditure portfolio and restructurings.
  - New theoretical explanations on sovereign debt overhang and delays in debt restructurings.

Stylized facts on restructurings (cont.)

- **Stylized Fact 3**: Public investment is negatively associated with public external debt with significance, but neither public consumption nor transfers is.

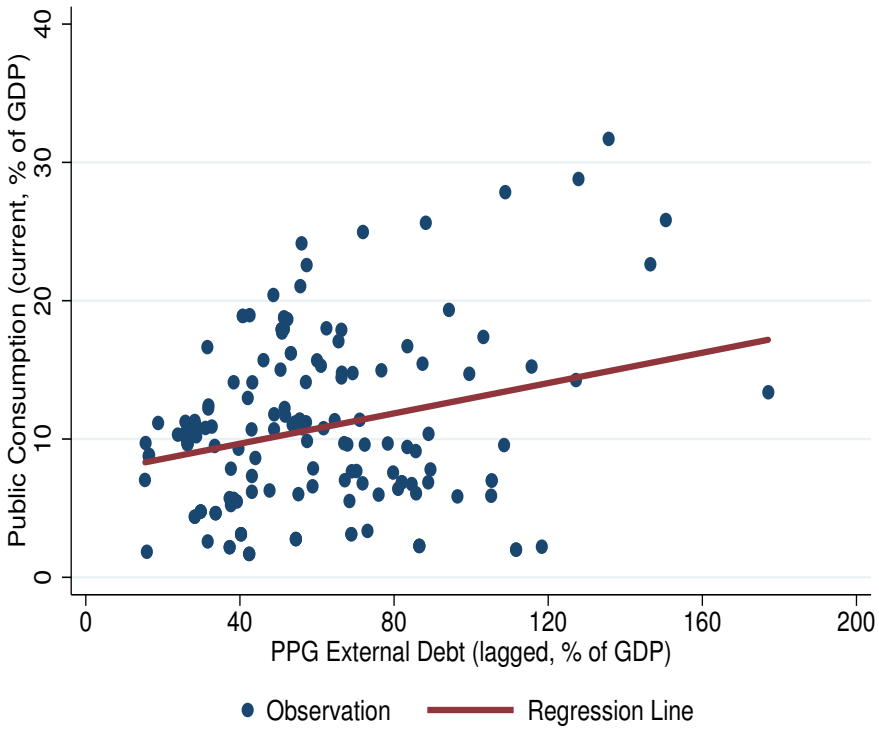


Figure: Public consumption (% of GDP)

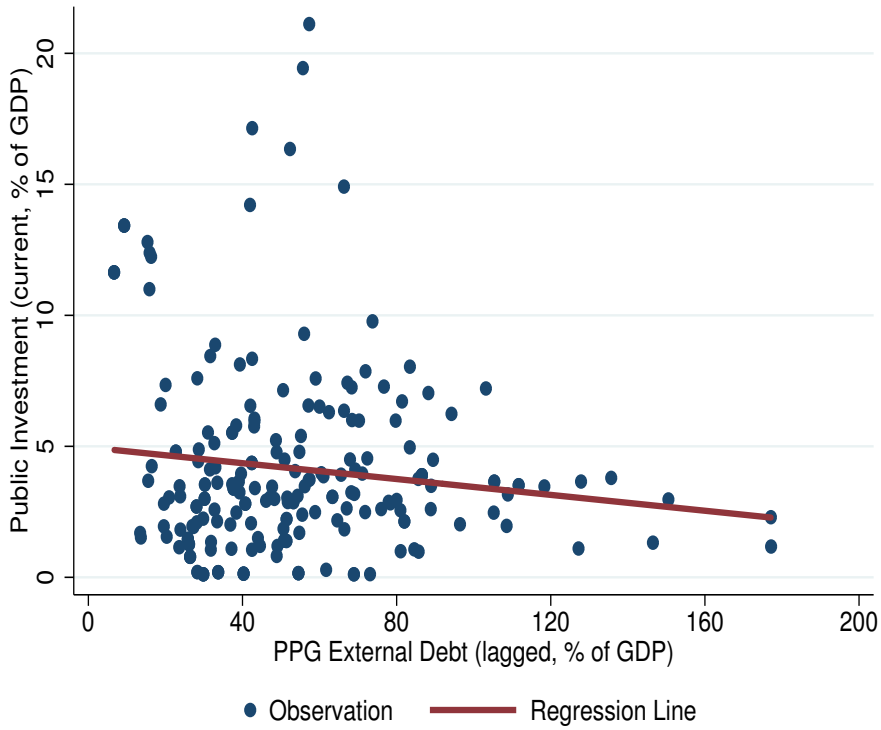


Figure: Public investment (% of GDP)

Stylized facts on restructurings (cont.)

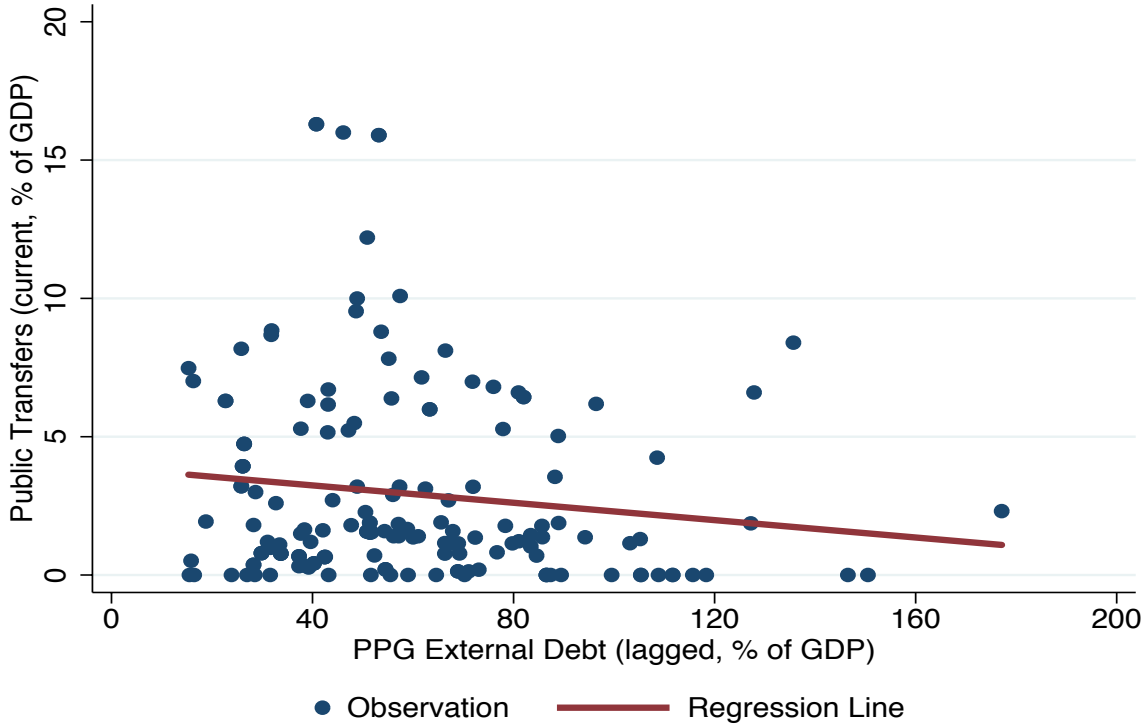


Figure: Public transfer (% of GDP)

- If the sovereign has saving ($b_t \geq 0$)

$$V(b_t, k_t^g, 0, a_t) = \max_{g_t, b_{t+1}, k_{t+1}^g, T_t} (1-\lambda)u(c_t, l_t) + \lambda v(g_t)$$
$$+\beta \int_A V(b_{t+1}, k_{t+1}^g, 0, a_{t+1}) d\mu(a_{t+1}|a_t) \quad (7)$$

$$s.t. \quad g_t + k_{t+1}^g + T_t + q(b_{t+1}, k_{t+1}^g, 0, a_t) b_{t+1} = \tau c_t + (1-\delta^g) k_t^g - \frac{\Omega}{2} \left(\frac{k_{t+1}^g - k_t^g}{k_t^g}\right)^2 k_t^g + b_t \quad (8)$$

$$T_t \geq 0 \quad (9)$$

$$\frac{u_l(c_t, l_t)}{u_c(c_t, l_t)} = \frac{\alpha_l a_t (l_t)^{\alpha_l - 1} (k_t^g)^{\alpha_k} (\bar{k}^p)^{1-\alpha_l-\alpha_k}}{1+\tau} \quad (10)$$

$$(1+\tau)c_t = y_t + T_t \quad (11)$$

Model: Creditor's problem

- Expected profit

$$\pi^c(b_{t+1}, k^g_{t+1}, 0, a_t) = \begin{cases} q(b_{t+1}, k^g_{t+1}, 0, a_t)b_{t+1} - \frac{1}{1+r^*} b_{t+1}, & \text{if } b_{t+1} \geq 0 \\ [\frac{1-p^D(b_{t+1}, k^g_{t+1}, 0, a_t)}{1+r^*} + \\ \frac{p^D(b_{t+1}, k^g_{t+1}, 0, a_t) \int_A \gamma(b_{t+1}, k^g_{t+1}, 1, a_t) d\mu(a_{t+1}|a_t)}{1+r^*}](-b_{t+1}) \\ -q(b_{t+1}, k^g_{t+1}, 0, a_t)(-b_{t+1}), & otherwise \end{cases} \tag{34}$$

- Equilibrium bond price

$$q(b_{t+1}, k^g_{t+1}, 0, a_t) = \begin{cases} \frac{1}{1+r^*} & \text{if } b_{t+1} \geq 0 \\ \frac{1-p^D(b_{t+1}, k^g_{t+1}, 0, a_t)}{1+r^*} \\ + \frac{p^D(b_{t+1}, k^g_{t+1}, 0, a_t) \int_A \gamma(b_{t+1}, k^g_{t+1}, 1, a_t) d\mu(a_{t+1}|a_t)}{1+r^*} & otherwise \end{cases} \tag{35}$$

- Default probability

$$p^D(b_{t+1}, k^g_{t+1}, 0, a_t) = \int_{D(b_{t+1}, k^g_{t+1})} d\mu(a_{t+1}|a_t), \tag{36}$$

- Expected recovery rates

$$\gamma(b_{t+1}, k^g_{t+1}, 1, a_t) = \int_A \gamma(b_{t+1}, k^g_{t+1}, 1, a_{t+1}) d\mu(a_{t+1}|a_t)$$

$$= \int_A \left[\begin{array}{c} \phi 1_{a_{t+1} \in R^B(b_{t+1}, k^g_{t+1})} \delta^{B*}_t(b_{t+1}, k^g_{t+1}, a_{t+1}) \\ +(1-\phi) 1_{a_{t+1} \in R^L(b_{t+1}, k^g_{t+1})} \delta^{L*}_t(b_{t+1}, k^g_{t+1}, a_{t+1}) \\ + \left(\begin{array}{c} \phi 1_{a_{t+1} \notin R^B(b_{t+1}, k^g_{t+1})} \\ +(1-\phi) 1_{a_{t+1} \notin R^L(b_{t+1}, k^g_{t+1})} \end{array} \right) \gamma(b_{t+2}, k^g_{t+2}, 1, a_{t+1}) \end{array} \right] d\mu(a_{t+1}|a_t) \tag{38}$$

- Probability of settling the deal

$$p^R(b_{t+1}, k^g_{t+1}, a_t) = \phi \int_{R^B(b_{t+1}, k^g_{t+1})} d\mu(a_{t+1}|a_t) + (1-\phi) \int_{R^L(b_{t+1}, k^g_{t+1})} d\mu(a_{t+1}|a_t) \tag{37}$$

- Sovereign bond spreads

$$s(b_{t+1}, k^g_{t+1}, 0, a_t) = \frac{1}{q(b_{t+1}, k^g_{t+1}, 0, a_t)} - (1 + r^*) \tag{39}$$

Quantitative analysis - Steady-state dist. (cont.)

- Public consumption/transfers

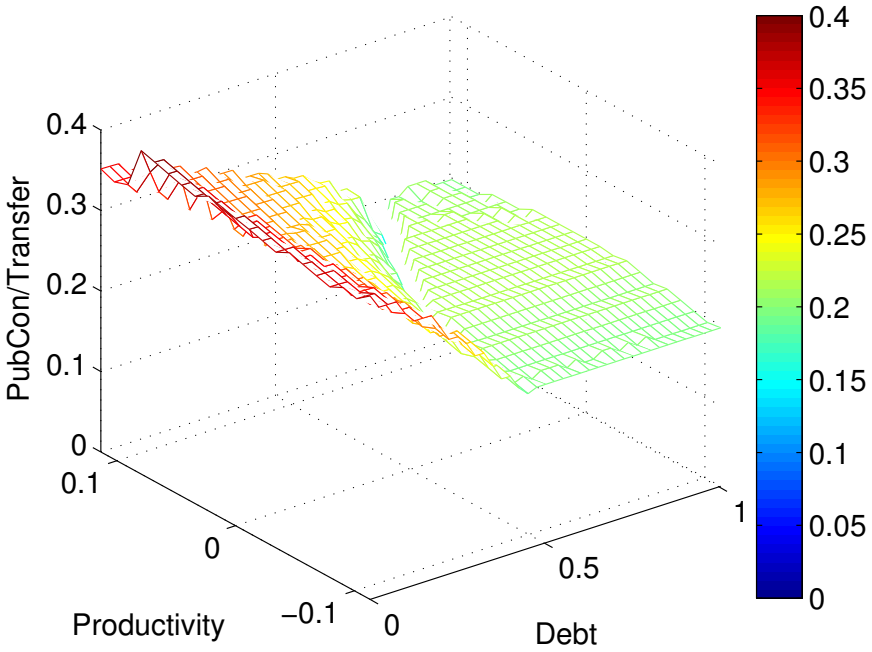


Figure: Low Public Capital

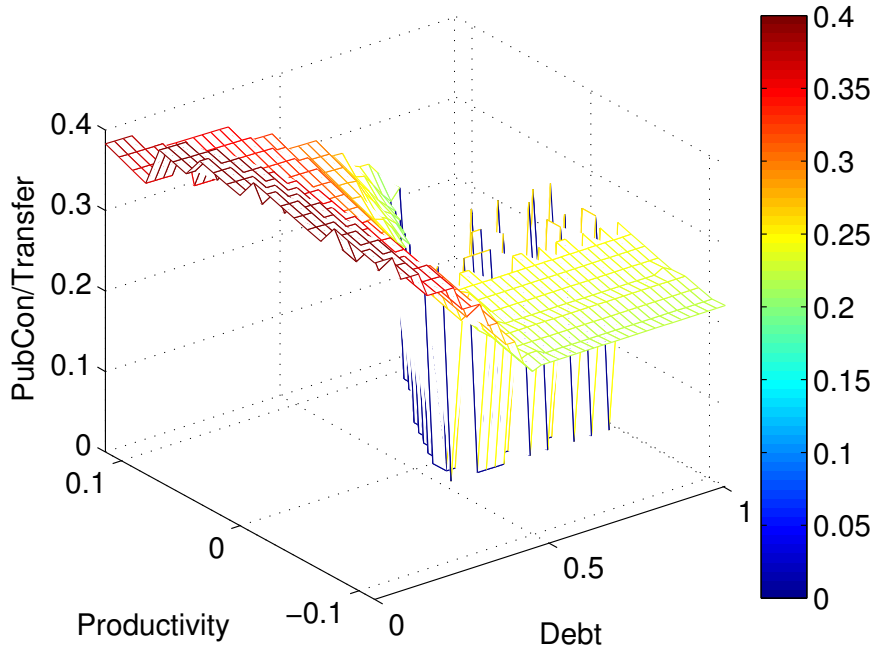


Figure: High Public Capital

Quantitative analysis - Steady-state dist. (cont.)

- Public investment

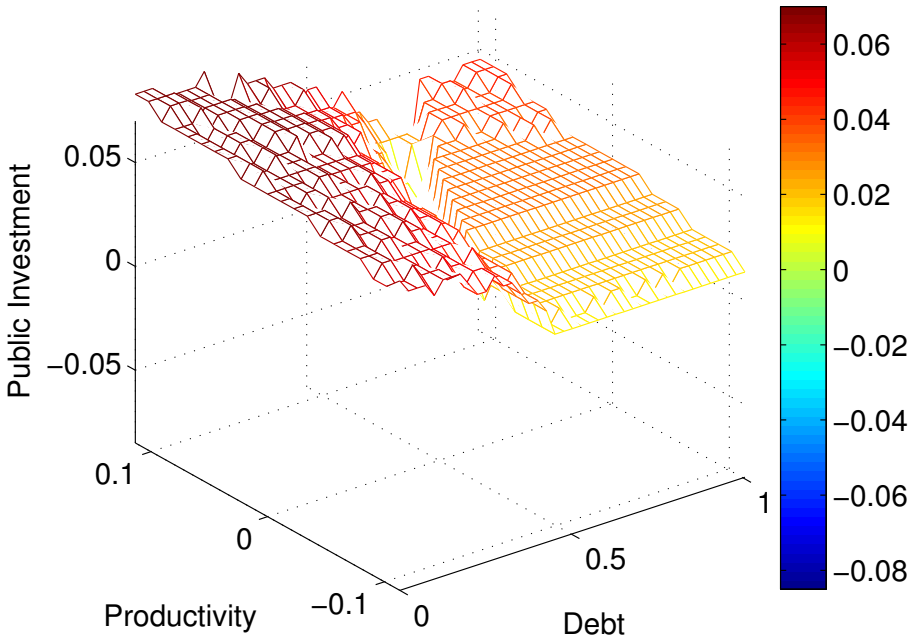


Figure: Low Public Capital

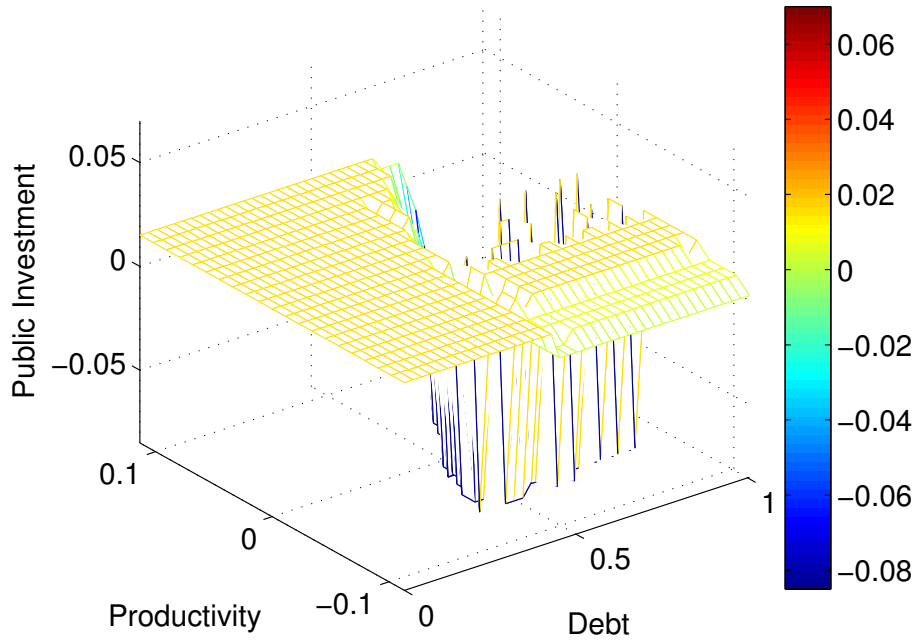


Figure: High Public Capital

Quantitative analysis - Steady-state dist. (cont.)

- Agreed recovery rates

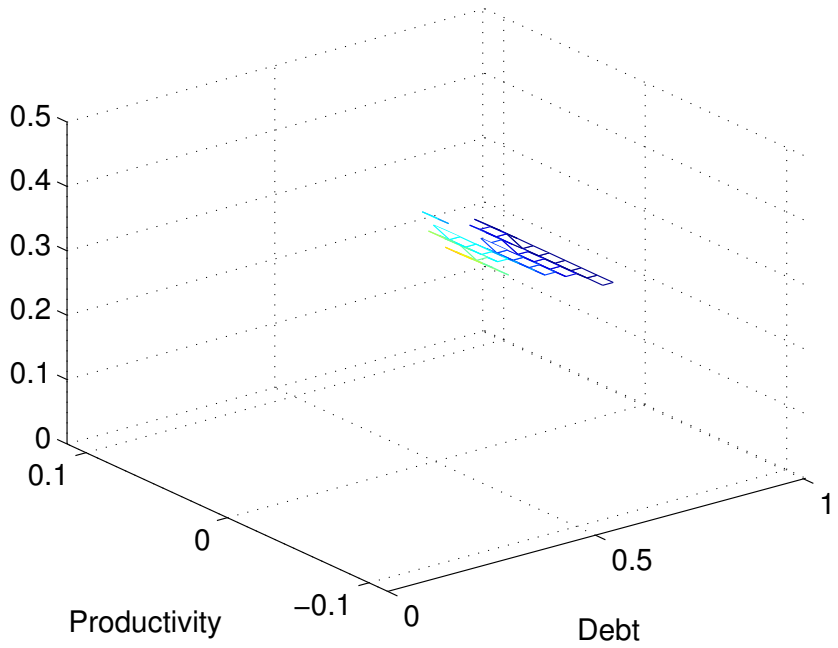


Figure: Mean Public Capital

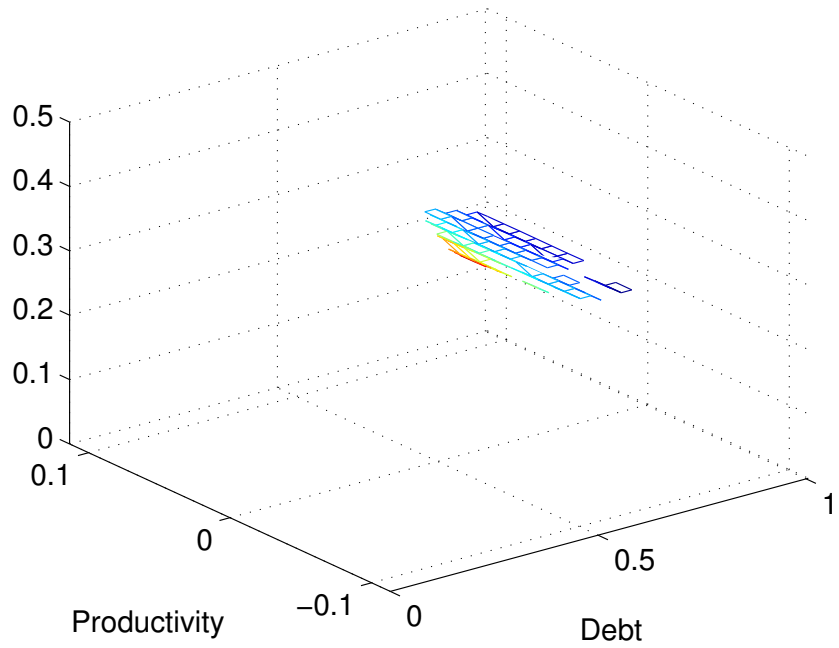


Figure: High Public Capital