

SOVEREIGN DEBT OVERHANG, EXPENDITURE COMPOSITION AND DEBT RESTRUCTURINGS

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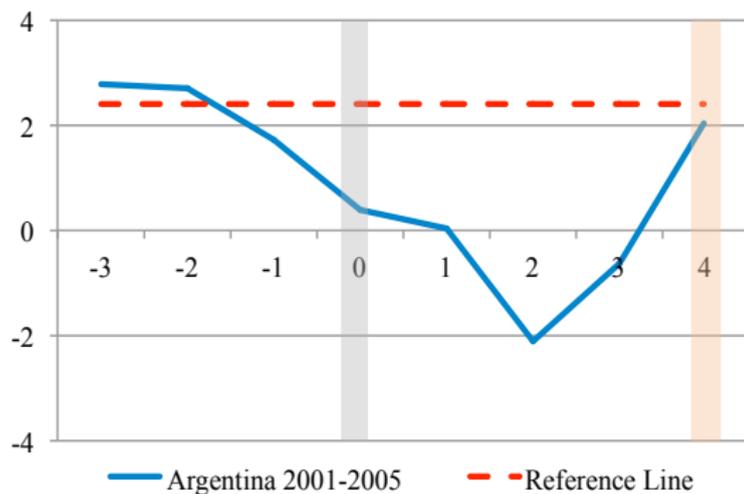
OVERVIEW OF THE PAPER

- Empirical, theoretical and quantitative analysis of sovereign debt
- Two main contributions to the literature on sovereign debt:
 - New dataset on public expenditure composition and new stylized facts on sovereign debt overhang and restructurings
 - New theoretical explanations on the role of public capital and debt overhang in sovereign debt crises and resolution

MOTIVATION

- Slow public capital accumulation
- Lengthy debt renegotiations (3.5 years)

(a) Public capital growth rate around Argentine debt restructuring 2001–05



NEW DATA ON PUBLIC EXPENDITURE COMPOSITION

- 179 privately-held external debt restructurings in 1978–2010 (Asonuma and Trebesch 2016)
- New dataset on public expenditure composition
 - 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 GDF

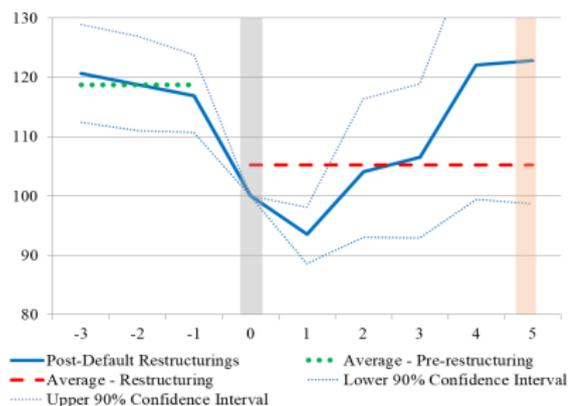
TABLE: Public Consumption, Investment, Transfers and Capital for Restructurings in 1978–2010

	Observation	Mean	Median	Std Dev.	Observation	Mean	Median	Std. Dev.
Restructuring Episodes	179				<i>Percent of GDP</i>			
		Pre-restructuring periods			Restructuring periods			
Public Consumption, average	124	13.1	11.2	9.4	124	12.0	10.6	7.4
Public Investment, average	151	4.7	3.4	4.3	151	3.7	3.0	3.3
Public Transfers, average	124	5.3	3.1	6.3	124	3.9	2.4	4.7
Public Capital, average	151	75.0	58.6	49.3	151	74.2	56.5	50.9
		Post-restructuring periods						
Public Consumption, average	124	11.7	10.1	7.5				
Public Investment, average	151	4.0	3.2	3.8				
Public Transfers, average	124	4.6	3.0	4.8				
Public Capital, average	151	74.9	61.7	48.4				

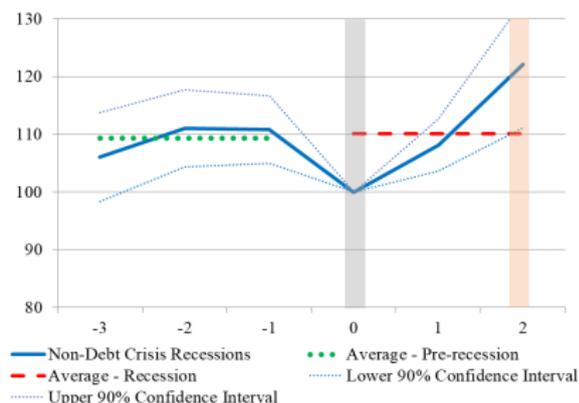
STYLIZED FACTS ON RESTRUCTURINGS

- **Stylized Fact 1:** Public investment experiences a severe decline and a slow recovery around restructurings
- **Stylized Fact 2:** The dynamics around restructurings differ from those around non-debt crisis recessions

(a) Around Start of Restructurings



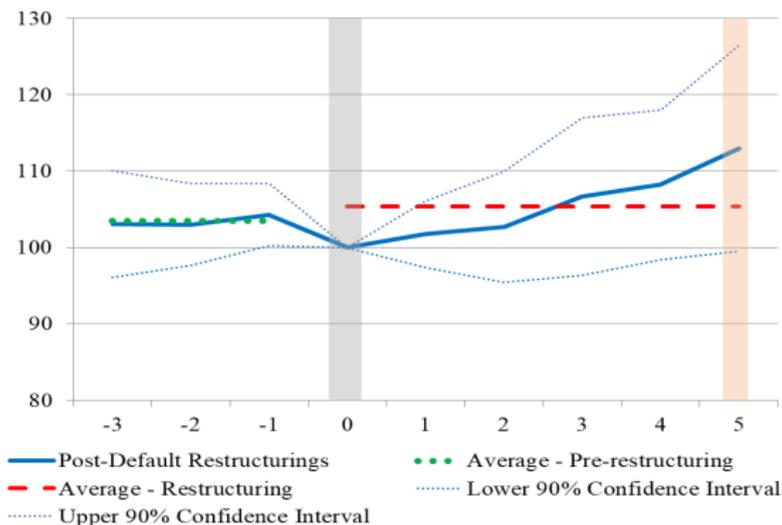
(b) Around Start of Non-debt Crisis Recessions



STYLIZED FACTS ON RESTRUCTURINGS (CONT.)

- **Stylized Fact 3:** Public consumption and transfers experience a short-lived decline and a quick recovery

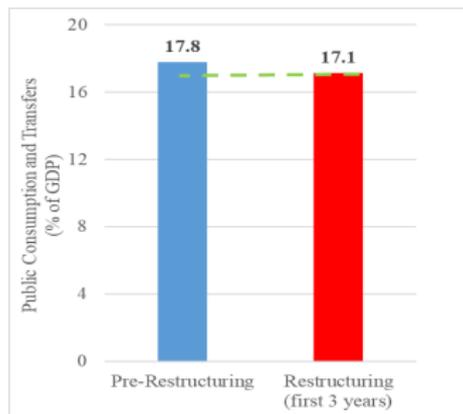
(a) Around Start of Restructurings



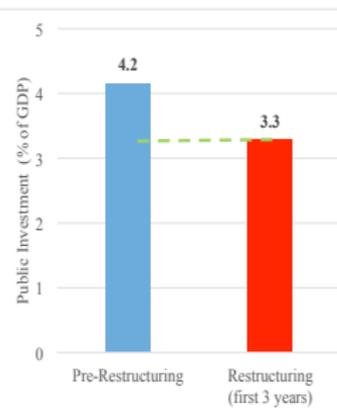
STYLIZED FACTS ON RESTRUCTURINGS (CONT.)

- **Stylized Fact 4:** Public expenditure skews heavily towards consumption and transfers during debt crises

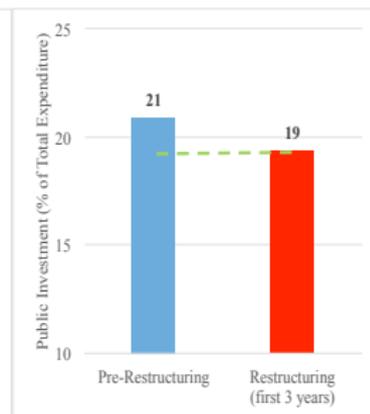
(a) Public Consumptions & transfers
(percent of GDP)



(b) Public Investment
(percent of GDP)



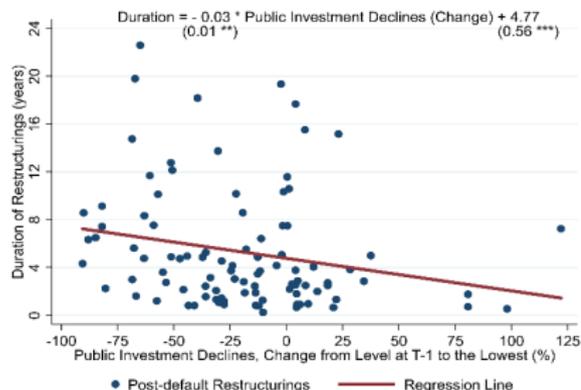
(c) Public Investment
(percent of public expenditure)



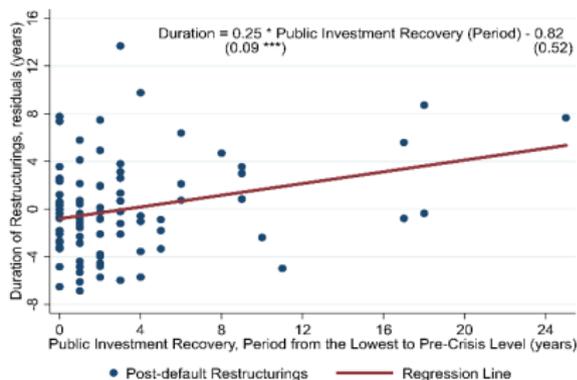
STYLIZED FACTS ON RESTRUCTURINGS (CONT.)

- **Stylized Fact 5:** The sharp declines and slow recoveries in public investment are associated with delays in restructurings

(a) Declines in Public Investment



(b) Recoveries in Public Investment



STYLIZED FACTS ON RESTRUCTURINGS (CONT.)

- **Stylized Fact 1:** Public investment experiences a severe decline and a slow recovery around restructurings
- **Stylized Fact 2:** The dynamics around restructurings differ from those around non-debt crisis recessions
- **Stylized Fact 3:** Public consumption and transfers experience a short-lived decline and a quick recovery
- **Stylized Fact 4:** Public expenditure skews heavily towards consumption and transfers during debt crises
- **Stylized Fact 5:** Sharp declines and slow recoveries in public investment are associated with long restructuring delays

- **Main questions**

- Why public investment experiences a severe decline and a slow recovery during debt crises, but public consumption and transfers do not?
- What is the role of public capital and debt overhang on the sovereign debt crises and resolution, given that both directly interact with fiscal constraint?

IMPLICATIONS OF THE PAPER

- New dataset on public expenditure composition and new stylized facts:
 - Public investment vs consumption and transfers
 - Debt restructurings vs non-debt recessions
 - Link between public investment dynamics and delays
- New theoretical explanations on sovereign debt crises and resolution:
 - Two different phases of sovereign debt overhang
 - “Capital accumulation delays” and “fiscal delays”
 - The role of public capital in sovereign debt crises and resolution
- Quantitative analysis of model rationalizes the five stylized facts

INTUITION: KEY MECHANISM

- **Prior to default:** Low productivity, high debt payments, and consumption-smoothing motive (Aguiar et al. 2009)
 - On the one hand, sovereigns opt to smooth both private and public consumption (through transfers and public consumption)
 - On the other hand, sovereigns reduce public investment
- **During restructurings:** Slow productivity recovery, no external borrowing and consumption-smoothing motive
 - Public capital accumulation is slow because of (i) consumption-smoothing motive and (ii) limited resources—due to no external borrowing and tight fiscal constraint
 - Renegotiations are delayed because of (i) the high MPK of public capital (“capital accumulation delays”) and (ii) tight fiscal constraint (“fiscal delay”)

LITERATURE REVIEW

- Sovereign debt overhang
 - Krugman (1989), Sach (1989), Aguiar et al. (2009), Ostry et al. (2014), Reinhart et al. (2012)
 - Ours: Sovereign debt overhang in the “restructuring phase”
- Sovereign debt and fiscal policy
 - Kaminsky et al. (2005), Arellano and Bai (2017), Cuadra et al. (2010), Hatchondo et al. (2017), Bianchi et al. (2017), Mendoza et al. (2014)
 - Ours: Public capital accumulation and investment choice
- Sovereign defaults and renegotiations (multi-round)
 - Benjamin and Wright (2013), Kovrijnykh and Szentes (2007), Bai and Zhang (2012), Bi (2008), Asonuma and Joo (forthcoming)
 - Ours: “Capital accumulation delays” and “fiscal delays”
- Sovereign debt and “private” capital
 - Gordon and Guerron-Quantina (2018), Park (2017)
 - Ours: “Renegotiation” channel of capital

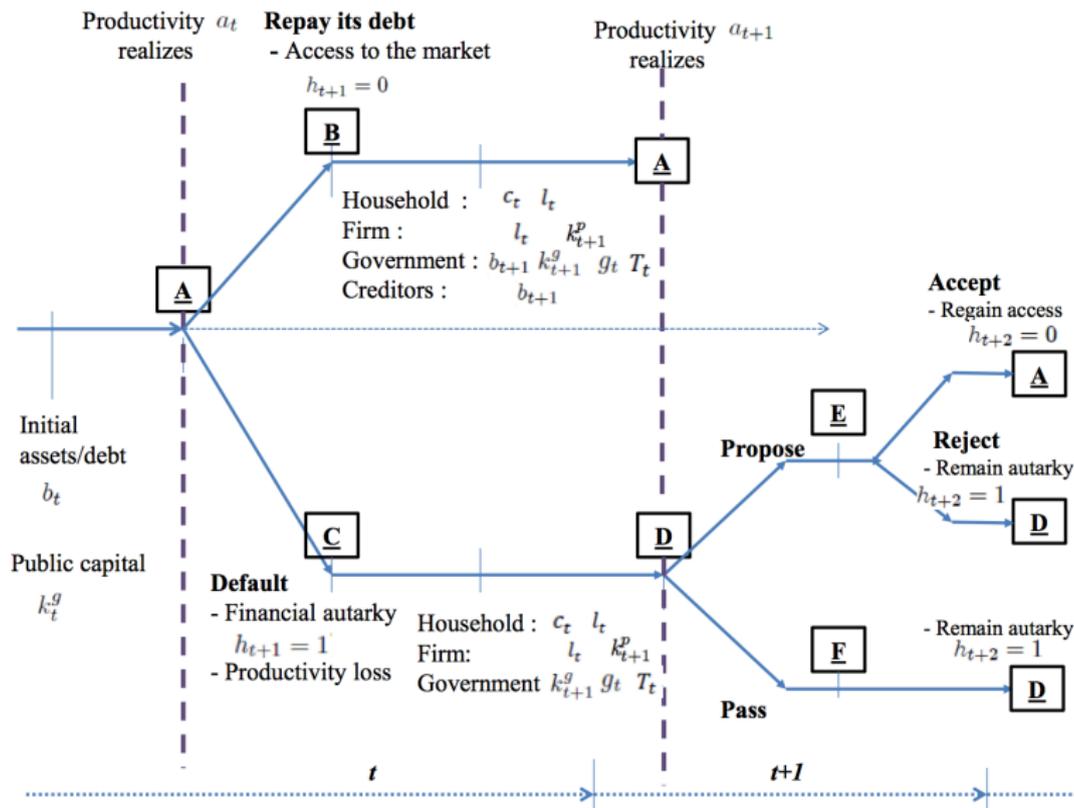
MODEL: GENERAL FEATURES

- Sovereign debt in a dynamic small open economy model:
 - Endogenous choice of default and repayment
 - Endogenous choice of settlement and delays conditional on default
 - Endogenous choice of public expenditure—public consumption, investment, transfers and debt repayments
 - Endogenous production with labor, and private and public capital

MODEL: GENERAL FEATURES (CONT.)

- A risk averse sovereign debtor, a household, a private firm and risk-neutral foreign creditors
- A stochastic TFP shock a_t
- Public expenditure choice: consumption, investment, transfers and debt repayments
- Distortionary consumption tax and **no lump-sum tax**
- Public and private 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

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

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

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

- Optimality condition of household

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

MODEL: FIRM'S PROBLEM

- Production function

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

- Private firm's profit maximization problem:

$$\max_{l_t} \pi_t^F = a_t (l_t)^{\alpha_l} (k_t^g)^{\alpha_k} (k_t^p)^{1-\alpha_l-\alpha_k} - w_t l_t - \{k_{t+1}^p - (1-\delta^k)k_t^p + \frac{\Omega}{2} \left(\frac{k_{t+1}^p - k_t^p}{k_t^p} \right)^2 k_t^p\} \quad (5)$$

$$s.t. \quad k_t^p = f(k_t^g)$$

(internalizing the sovereign's choice of public investment)

- Optimality condition of the private firm

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

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:

$$\begin{aligned}\theta_i &= \{1 \text{ (propose)}\} \quad \& \quad \theta_j = \{1 \text{ (accept)}\} \\ \theta_i &= \{0 \text{ (pass)}\} \quad \& \quad \theta_j = \{0 \text{ (reject)}\}\end{aligned}$$

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

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

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

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

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

$$(1 + \tau)c_t + k_{t+1}^p = \tilde{y}_t + T_t + (1 - \delta^k)k_t^p - \frac{\Omega}{2} \left(\frac{k_{t+1}^p - k_t^p}{k_t^p} \right)^2 k_t^p \quad (11a)$$

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

MODEL: RENEGOTIATION PROBLEM (CONT.)

- If B passes,

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

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

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

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

$$(1 + \tau)c_t + k_{t+1}^p = \tilde{y}_t + T_t + (1 - \delta^k)k_t^p - \frac{\Omega}{2} \left(\frac{k_{t+1}^p - k_t^p}{k_t^p} \right)^2 k_t^p \quad (11a)$$

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

MODEL: RENEGOTIATION PROBLEM (CONT.)

- Equilibrium

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

- If both parties reach an agreement,

$$\Gamma^B(b_t, k_t^g, a_t) = V^{PRO}(b_t, k_t^g, a_t) \quad (23)$$

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

- Otherwise,

$$\Gamma^B(b_t, k_t^g, a_t) = V^{PASS}(b_t, k_t^g, a_t) \quad (23a)$$

$$\Gamma^{B*}(b_t, k_t^g, a_t) = V^{*REJ}(b_t, k_t^g, a_t) \quad (24a)$$

THEOREM 1

Given an equilibrium debt recovery schedule $\bar{\delta}^*(b, k^g, a)$, productivity $a \in A$ and debt $b \in B$, for $k_1^g \geq k_2^g$, if settlement is optimal for k_2^g , then settlement is also optimal for k_1^g . This is $R^i(b, k_2^g) \subseteq R^i(b, k_1^g)$ for $i = B, L$.

- The likelihood of debt settlement increases with the level of public capital.

QUANTITATIVE ANALYSIS - PARAMETERS

- TFP process -AR(1) process:

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

- Household utility function - GHH, CRRA:

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

- Private capital

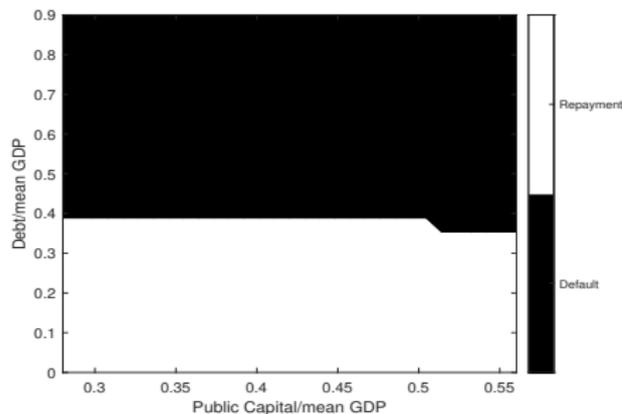
$$k_t^P = (k_t^g)^\alpha, \quad (42)$$

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 (2018)
Public capital income share	$\alpha^k = 0.058$	Argentine public and private capital (1993–2005)
Private and public capital depreciation rate	$\delta^k = 0.04$	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
Private capital elasticity w.r.t. public capital	$\alpha = 0.62$	Computed Argentine private/public capital
Direct productivity loss	$\lambda_d = 0.02$	Computed
Weight on public consumption	$\lambda = 0.8$	Computed
Public capital adjustment costs	$\Omega = 10$	Computed
Discount rate	$\beta = 0.90$	Computed
Bargaining power	$\phi = 0.9$	Computed

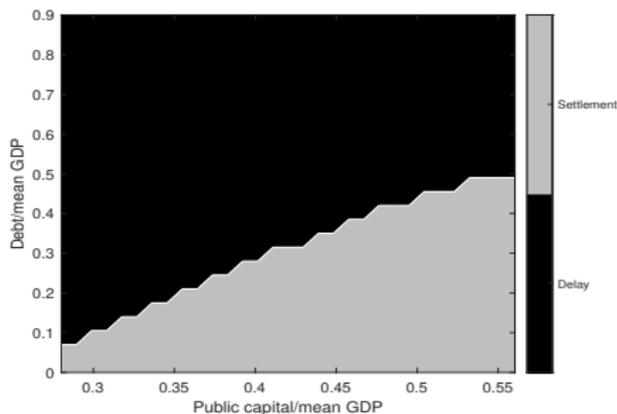
QUANTITATIVE ANALYSIS - ERGODIC DIST.

- Debtor's choice between repayment and default, and between settlement and delay - Mean TFP
 - A. "Smoothing channel"
 - B. "Autarky channel"
 - C. "Renegotiation channel"

(a) Good Credit Record

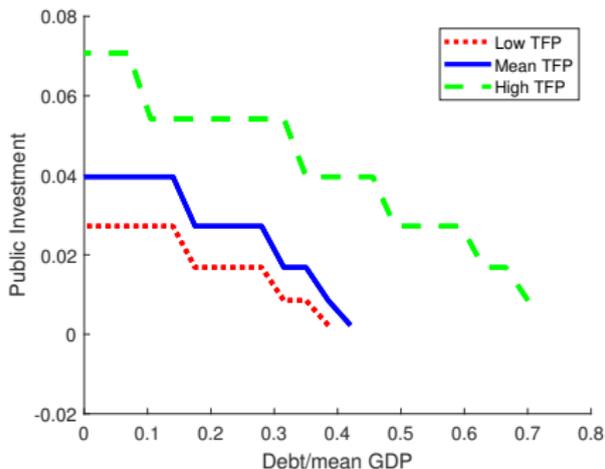


(b) Bad Credit Record



- Debtor's public investment choice - Mean public capital

(a) "Repayment" Region
- the "pre-default phase"



(b) "Delay" Region
- the "restructuring phase"

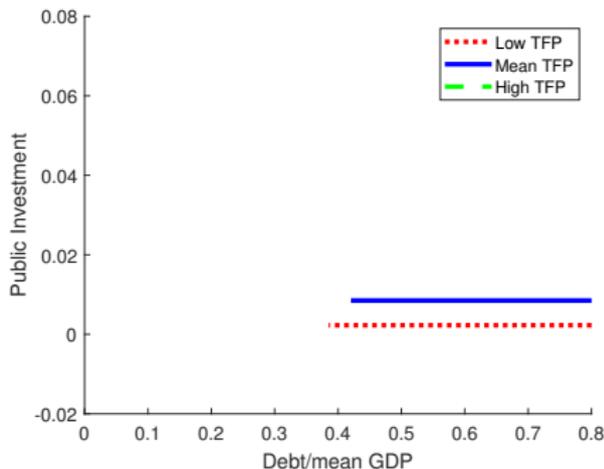
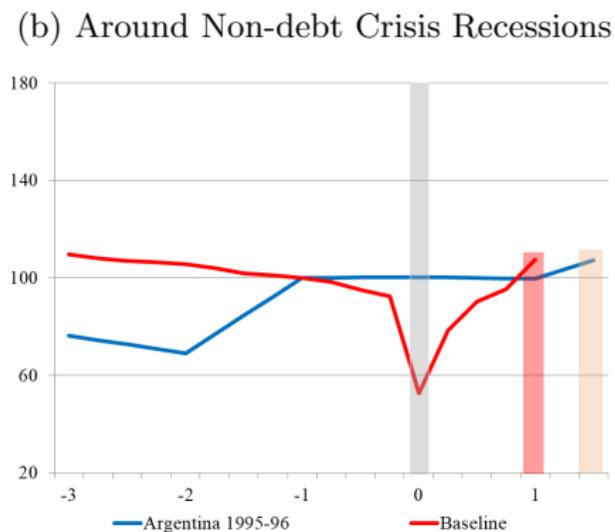
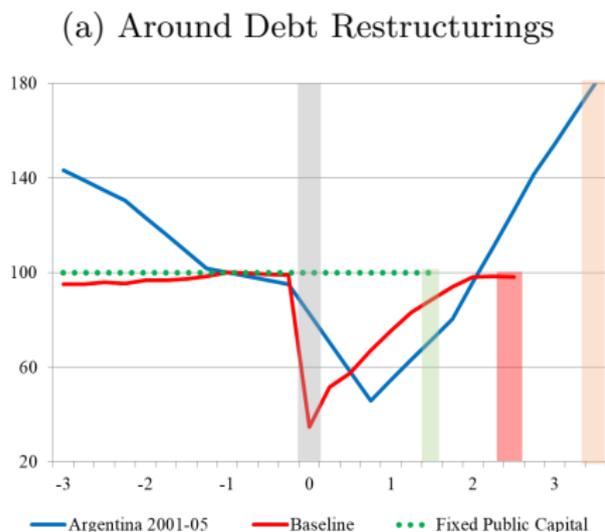


TABLE: Non-business Cycle Statistics

	Data	Model	Model with Fixed Public Capital	Model without Separation of Public/Private Sectors	Model with Fixed Capital and No Separation of Public/Private Sectors
Target statistics					
Default probability (%)	3.26	3.51	3.65	3.62	3.02
Average recovery rate (%)	25.0	25.2	30.5	36.1	31.4
Average debtor output deviation during debt renegotiation (%)	-4.45	-5.1	-7.1	-6.9	-9.0
Pre-default periods					
Average debt/GDP ratio (%)	45.4	41.7	23.0	41.0	40.0
Bond spreads: average (%)	9.4	1.70	2.20	1.60	1.50
Bond spreads: std dev. (%)	7.6	2.30	3.03	1.39	1.60
Corr.(spreads, output)	-0.88	-0.10	-0.36	-0.26	-0.48
Corr.(debt/GDP, spreads)	0.92	0.27	0.34	0.32	0.35
Corr.(debt/GDP, output)	-0.97	-0.41	-0.40	-0.10	-0.33
Renegotiation periods					
Average debt/GDP ratio (%)	130.5	49.9	29.5	51.4	51.3
Corr.(debt/GDP, output)	-0.95	-0.99	-0.99	-0.99	-0.99
Duration of renegotiation/ exclusion (quarters)	14.0	9.1	6.2	5.6	4.7
Corr.(decline in public investment, duration)	-0.25	-0.10	-	-	-
Corr.(recovery in public investment, duration)	0.22	0.16	-	-	-
Public capital (percent change from the trough to the end)	2.31	2.01	-	-	-

QUANTITATIVE ANALYSIS - SIMULATION (CONT.)

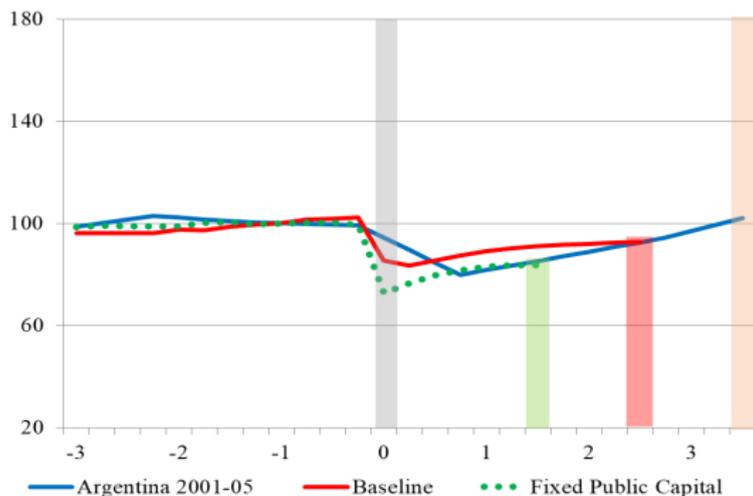
- Public investment around debt restructurings



QUANTITATIVE ANALYSIS - SIMULATION (CONT.)

- Public consumption and transfers around debt restructurings

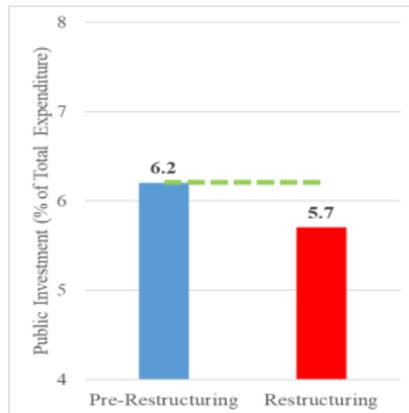
(a) Around Debt Restructurings



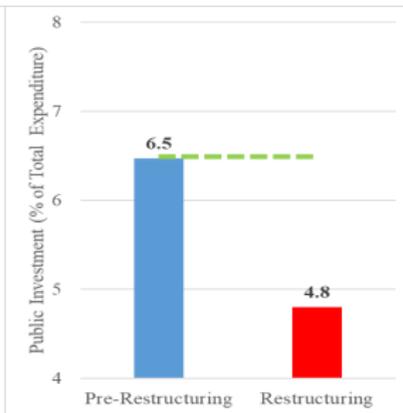
QUANTITATIVE ANALYSIS - SIMULATION (CONT.)

- Public expenditure composition

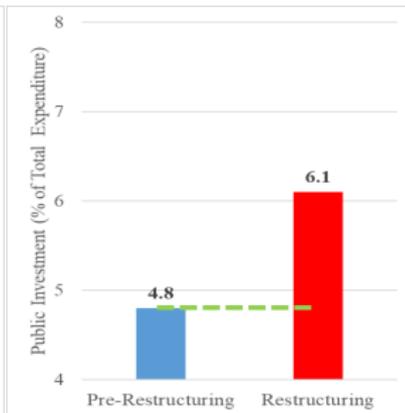
(a) Argentina 2001–05



(b) Baseline



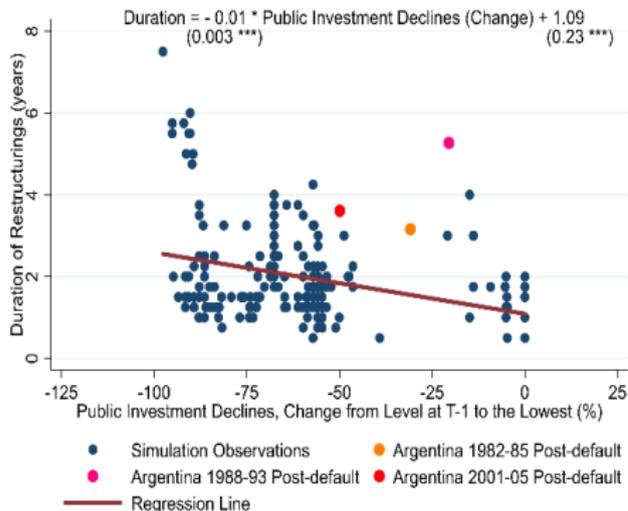
(c) Fixed Public Capital



QUANTITATIVE ANALYSIS - SIMULATION (CONT.)

- Declines and recoveries of public investment and restructuring duration

(a) Declines in Public Investment



(b) Recoveries in Public Investment

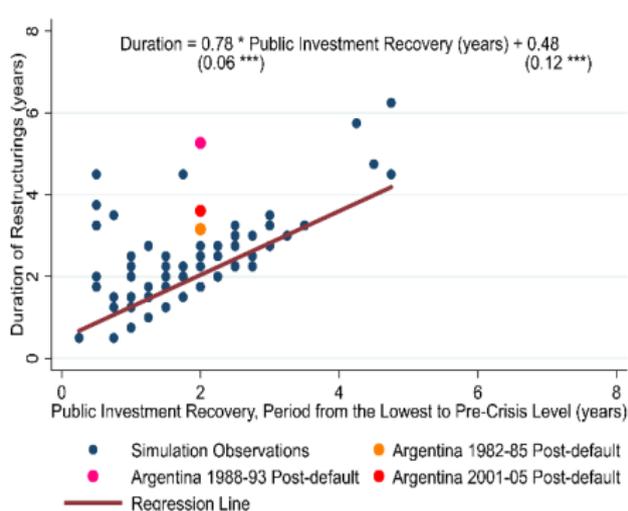


TABLE: Logit Regression Results on Debt Settlement

	Debt settlement (binary, current)			
	(1)	(1')	(2)	(2')
	coef/ se	dy/dx / Delta-method se	coef/ se	dy/dx / Delta-method se
Public investment (lagged, percent of mean TFP)	0.137*** (0.022)	0.022*** (0.003)	-	-
Public capital growth, annualized (lagged, percent)	-	-	0.157*** (0.039)	0.027*** (1.273)
External debt (lagged, percent of GDP)	-0.201*** (0.025)	-0.032*** (0.004)	-0.210*** (0.026)	-0.035*** (0.0004)
Constant	7.894*** (1.216)	-	9.347*** (1.273)	-
Episode-specific Fixed effect		No		No
Number of episodes		87		87
Number of observations		722		722
Wald χ^2		84.36		68.36
Prob.> χ^2		0.000		0.000

TESTING THE MODEL PREDICTION-RESTRUCTURING SAMPLE

TABLE: Public Investment and Capital, and Debt Settlements

	Debt Settlement (binary, current)			
	(1)	(1')	(2)	(2')
	coef/ se	dy/dx / Delta-method se	coef/ se	dy/dx / Delta-method se
Public investment, deviation from the trend (lagged, percent) ^{2/}	0.347* (0.195)	0.086* (0.048)	-	-
Public capital, cumulative growth rate (lagged, percent) ^{1/}	-	-	0.005* (0.003)	0.001* (0.0007)
PPG external debt (lagged, percent of GDP) ^{3/}	-0.003** (0.002)	-0.001** (0.0004)	-0.003* (0.002)	-0.0007*** (0.0004)
GDP, deviation from the trend (current, percent) ^{2/}	-0.017 (0.951)	-0.004 (0.236)	0.561 (0.864)	0.139 (0.215)
GDP, trend growth rate (current, percent) ^{2/}	-0.045 (0.042)	-0.011 (0.010)	-0.073 (0.045)	-0.018 (0.011)
LIBOR, 12-month average (current, percent)	-0.061*** (0.023)	-0.051*** (0.006)	-0.058** (0.024)	-0.014** (0.006)
World GDP, growth rate (current, percent)	0.207*** (0.069)	0.051*** (0.017)	0.206*** (0.069)	0.051*** (0.017)
Constant	-0.705* (0.369)	-	-0.722* (0.372)	-
Episode-specific Fixed effect		No		No
Number of episodes		90		89
Number of observations		496		492
Wald χ^2		21.01		20.74
Prob.> χ^2		0.002		0.002

CONCLUSION

- New dataset on public expenditure composition and new stylized facts:
 - Public investment vs consumption and transfers
 - Debt restructurings vs non-debt recessions
 - Link between public investment dynamics and delays
- New theoretical explanations on sovereign debt crises and resolution:
 - Two different phases of sovereign debt overhang
 - “Capital accumulation delays” and “fiscal delays”
 - The role of public capital in sovereign debt crises and resolution
- Quantitative analysis of model rationalizes the five stylized facts

STYLIZED FACTS ON RESTRUCTURINGS (CONT.)

TABLE: Public Investment, Capital, Consumption, and Transfers around Restructurings

	Debt restructuring				Non-debt crisis recession	
	Investment	Capital	Consumption	Transfers	Investment	Capital
	deviation from trend, current ^{3/}	percentage change, current ^{4/}	deviation from trend, current ^{3/}	deviation from trend, current ^{3/}	deviation from trend, current ^{3/}	deviation from trend, current ^{4/}
	(1)	(2)	(3)	(4)	(5)	(6)
	coef/se	coef/se	coef/se	coef/se	coef/se	coef/se
Restructuring period (current, dummy) ^{1/}	-0.14*** (0.03)	-1.26*** (0.23)	0.007 (0.011)	-0.02 (0.03)	-	-
Post-restructuring period (current, dummy) ^{2/}	-0.07** (0.03)	-0.87*** (0.24)	0.003 (0.012)	-0.04 (0.03)	-	-
Non-debt crisis recession period (current, dummy) ^{1/}	-	-	-	-	0.02 (0.03)	0.10 (0.24)
Post-non debt crisis recession period (current, dummy) ^{2/}	-	-	-	-	-0.01 (0.03)	0.28 (0.24)
PPG external debt (lagged, percent of GDP)	-0.0007*** (0.003)	-0.01*** (0.002)	0.00003 (0.0001)	0.000005 (0.0002)	-0.001*** (0.0004)	-0.01*** (0.003)
GDP deviation from trend (current, percent) ^{3/}	0.03*** (0.003)	0.07*** (0.03)	0.01*** (0.001)	0.01*** (0.003)	0.03*** (0.004)	0.05** (0.03)
Constant	0.10*** (0.03)	4.18*** (0.21)	-0.008 (0.01)	0.01 (0.03)	0.06* (0.03)	4.74*** (0.25)
Episode-specific fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of restructuring episodes	97	96	92	81	171	169
Number of observations	1,043	996	949	747	1488	1469
F-statistics	37.94	21.39	19.59	4.02	19.32	6.07
R ²	0.139	0.087	0.084	0.024	0.058	0.013

STYLIZED FACTS ON RESTRUCTURINGS (CONT.)

TABLE: Public Expenditure Composition around Restructurings

	Public Investment	Public Consumption	Public Transfers	Public Investment
	percent of GDP, current	percent of GDP, current	percent of GDP, current	percent of expenditure, current
	(1)	(2)	(3)	(4)
	coef/se	coef/se	coef/se	coef/se
Restructuring period (current, dummy) ^{1/}	-0.85*** (0.18)	-0.79* (0.44)	0.38** (0.18)	-2.23*** (0.80)
Restructuring period*PPG external debt (lagged, percent of GDP) ^{2/}	-0.003** (0.001)	-0.005 (0.003)	-0.009 (0.001)	-0.004 (0.005)
Post-restructuring period (current, dummy) ^{3/}	-0.47* (0.27)	-1.04 (0.65)	0.38 (0.26)	-0.58 (1.19)
Post-restructuring period*PPG external debt (lagged, percent of GDP) ^{4/}	-0.006* (0.003)	-0.015** (0.007)	-0.0006 (0.003)	-0.008 (0.013)
GDP, deviation from trend (current, percent) ^{5/}	0.03** (0.02)	0.02 (0.04)	0.03* (0.02)	0.08 (0.08)
Constant	4.23*** (0.12)	13.08*** (0.31)	2.99*** (0.12)	22.58*** (0.56)
Episode-specific fixed effects	Yes	Yes	Yes	Yes
Number of restructuring episodes	95	93	93	91
Number of observations	1,028	882	882	863
F-statistics	13.47	7.46	1.89	3.79
R ²	0.068	0.045	0.012	0.024

STYLIZED FACTS ON DEBT RESTRUCTURINGS (CONT.)

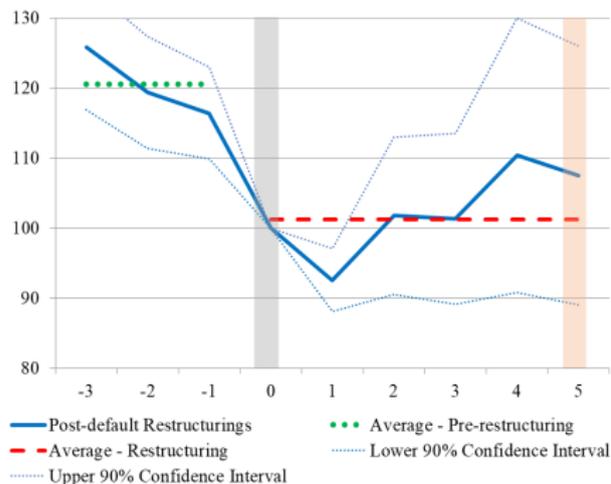
TABLE: Public Investment Declines and Recovery, and Duration of Restructurings

	Duration of restructurings (years)		
	Decline		Recovery
	(1)	(2)	(3)
	coef/se	coef/se	coef/se
Decline in public investment, percentage change from t-1 to the lowest (%) ^{1/}	-0.03** (0.02)	-	-
Decline in public investment/GDP, percentage change from t-1 to the lowest (%) ^{2/}	-	-0.74*** (0.24)	-
Recovery in public investment periods from the lowest to the pre-crisis average (years) ^{3/}	-	-	0.27*** (0.09)
Public capital (pre-restructuring, % of GDP) ^{4/}	0.005 (0.006)	-0.008 (0.007)	0.004 (0.006)
GDP deviation from trend (end, %) ^{5/6/}	0.11* (0.06)	0.09* (0.06)	0.09 (0.06)
External debt (end, % of GDP) ^{6/}	0.02* (0.01)	0.02* (0.01)	0.02** (0.01)
Export-to-debt service ratio (end) ^{6/}	0.13 (0.09)	0.13 (0.09)	0.14 (0.09)
LIBOR 12-month (end, %) ^{6/}	-0.62*** (0.16)	-0.66*** (0.15)	-0.62*** (0.16)
IMF-supported program (end, dummy) ^{6/7/}	-2.52** (0.95)	-2.75*** (0.94)	-2.89*** (0.96)
Bond restructurings (dummy) ^{8/}	-4.08* (1.64)	-3.99** (1.59)	-4.17** (1.61)
Constant	8.97*** (1.93)	10.18*** (1.84)	8.23*** (1.96)
Number of observations	87	86	85
Adjusted-R ²	0.37	0.40	0.39
Root MSE	4.02	3.93	3.96

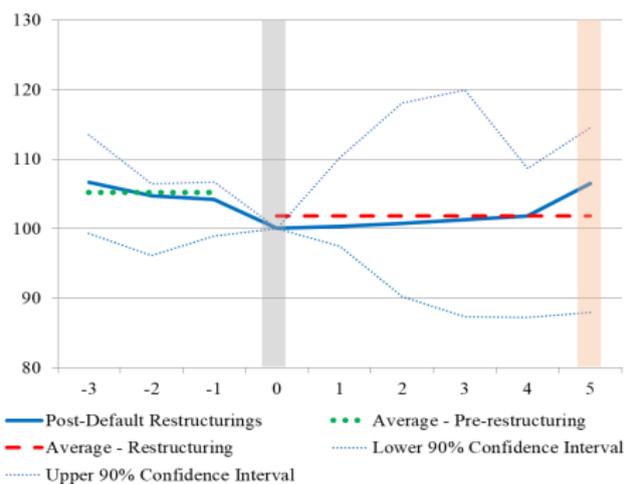
STYLIZED FACTS ON RESTRUCTURINGS (CONT.)

- Similar dynamics of public investment, and consumption and transfers in terms of GDP with those in levels

(a) Public Investment
(percent of GDP)



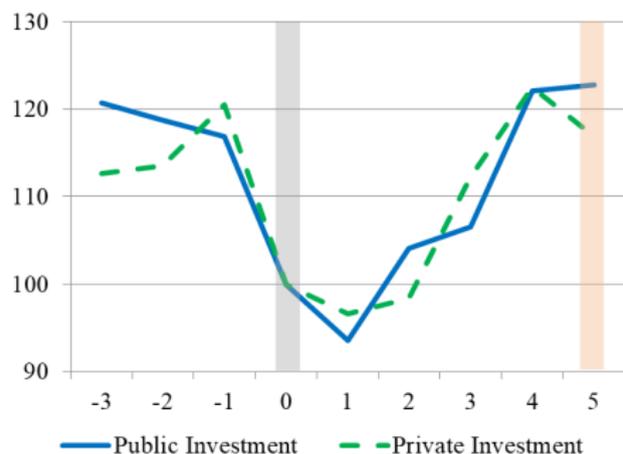
(b) Public Consumption and Transfers
(percent of GDP)



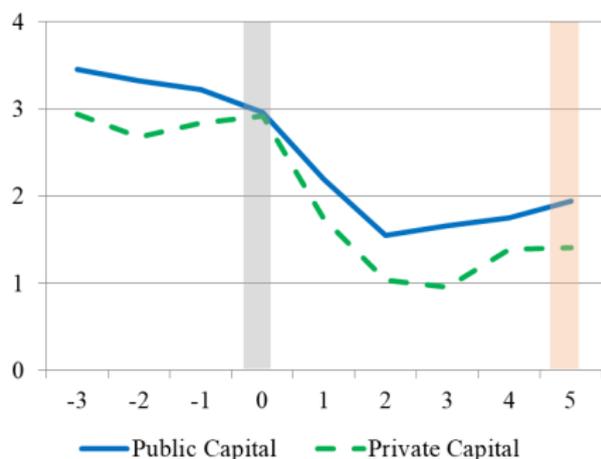
STYLIZED FACTS ON RESTRUCTURINGS (CONT.)

- Similar dynamics of private investment (capital accumulation) with those of public investment

(a) Public and private investment
(level, start=100)



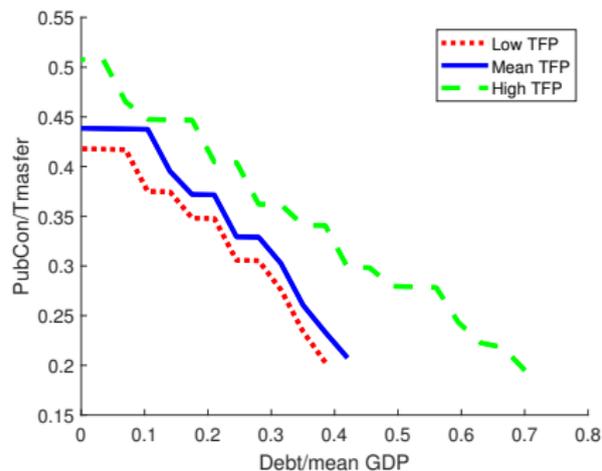
(b) Growth Rates of Public and Private Capital



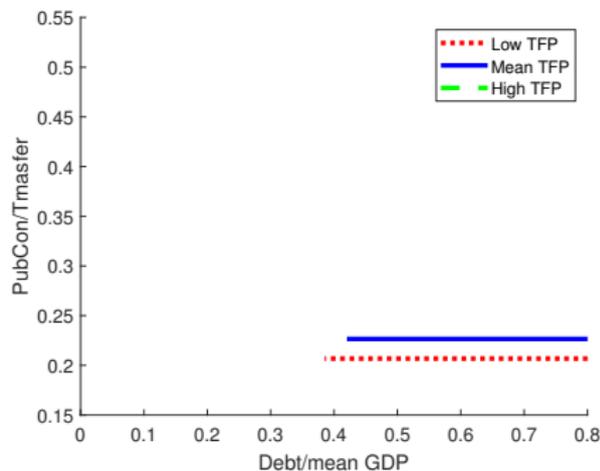
STYLIZED FACTS ON RESTRUCTURINGS (CONT.)

- Public consumption and transfers – Mean public capital

(a) ‘Repayment’ Region



(b) ‘Delay’ Region



MODEL: SOVEREIGN'S PROBLEM

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

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

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

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

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

$$(1 + \tau)c_t + k_{t+1}^p = y_t + T_t + (1 - \delta^k)k_t^p - \frac{\Omega}{2} \left(\frac{k_{t+1}^p - k_t^p}{k_t^p} \right)^2 k_t^p \quad (11)$$

MODEL: SOVEREIGN'S PROBLEM (CONT.)

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

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

- Sovereign's value of repayment

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

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

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

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

$$(1 + \tau)c_t + k_{t+1}^p = y_t + T_t + (1 - \delta^k)k_t^p - \frac{\Omega}{2} \left(\frac{k_{t+1}^p - k_t^p}{k_t^p} \right)^2 k_t^p \quad (11)$$

MODEL: SOVEREIGN'S PROBLEM (CONT.)

- Sovereign's value of defaulting (restructuring)

$$V^D(b_t, k_t^g, 0, a_t) = \max_{g_t, k_{t+1}^g, T_t} (1 - \lambda)u(c_t, l_t) + \lambda v(g_t) \\ + \beta \int_A V((1 + r^*)b_t, k_{t+1}^g, 1, a_{t+1})d\mu(a_{t+1}|a_t) \quad (13)$$

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

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

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

$$(1 + \tau)c_t + k_{t+1}^p = \tilde{y}_t + T_t + (1 - \delta^k)k_t^p - \frac{\Omega}{2} \left(\frac{k_{t+1}^p - k_t^p}{k_t^p} \right)^2 k_t^p \quad (11a)$$

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

$$V(b_t, k_t^g, 1, a_t) = \Gamma(b_t, k_t^g, a_t) \quad (15)$$

EQUILIBRIUM

DEFINITION

A recursive equilibrium is defined as a set of functions for (a) the sovereign's value function, public consumption, transfers, capital, assets/debt, default set, (b) the household's consumption and labor supply, (c) the firm's labor and private capital, (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 and private capital satisfy 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 - SIMULATION (CONT.)

TABLE: Business Cycle Statistics

	Data	Model	Model with Fixed Public Capital	Model without Separation of Public/Private Sectors
Target statistics				
Pre-default periods				
Average public consumption & transfers/GDP ratio (%)	20.0	22.2	22.7	-
Public investment (std dev.)/output (std dev.) (%)	5.1	5.9	-	-
Non-target statistics				
Pre-default periods				
Private sector				
Private consumption (std dev.)/output (std dev.)	1.11	1.06	1.07	1.06
Trade balance/output: std dev. (%)	1.28	1.90	1.17	2.51
Corr.(trade balance, output)	-0.87	-0.19	-0.37	-0.30
Public sector				
Public consumption & transfers (std dev.)/output (std dev.)	1.26	1.41	1.61	-
Corr.(public consumption & transfers, output)	0.52	0.79	0.90	-
Average public investment/GDP ratio	1.31	1.46	1.12	1.58
Average public investment/public expenditure ratio	6.20	6.5	4.68	-
Corr.(public investment, output)	0.51	0.60	-	-
Renegotiation periods				
Private sector				
Private consumption (std dev.)/output (std dev.)	1.17	1.08	1.05	1.09
Trade balance/output: std dev. (%)	0.45	0.00	0.00	0.00
Corr.(trade balance, output)	-0.97	0.00	0.00	0.00
Debtor output deviation (diff. btw start and end, %) ^{6/}	12.6	18.4	20.5	16.9
Public sector				
Public consumption & transfers (std dev.)/output (std dev.)	0.99	2.45	1.89	-
Corr.(public consumption & transfers, Output)	0.99	0.83	0.80	-
Average public consumption & transfers/GDP ratio (%)	20.23	23.9	22.3	-
Average public investment/GDP ratio	1.19	1.10	1.43	-
Average public investment/GDP ratio (downward trend) ^{3/}	0.73	0.61	-	-
Average public investment/GDP ratio (upward trend) ^{3/}	1.64	1.49	-	-
Average public investment/public expenditure ratio	5.7	4.80	6.1	-
Corr.(public investment, output)	0.99	0.65	-	-

QUANTITATIVE ANALYSIS - SIMULATION (CONT.)

TABLE: Non-business Cycle Statistics

	Data	Baseline Model	Model with fixed public capital			Model with no public capital		
			Multi-round renegotiations ^{1/}	One-round negotiation ^{2/}	Exogenous re-entry and zero recovery rates ^{3/}	Multi-round renegotiations ^{1/}	One-round negotiation ^{2/}	Exogenous re-entry and zero recovery rates ^{3/}
Target statistics								
Default probability (%)	3.26	3.10	2.71	4.80	3.40	2.10	3.98	2.93
Average recovery rate (%)	25.0	27.1	22.4	62.3	-	20.5	63.1	-
Average debtor output deviation during debt renegotiation (%)	-4.45	-3.73	-4.50	-	-	-4.35	-	-
Pre-default periods								
Average debt/GDP ratio (%)	45.4	43.9	45.6	3.99	4.01	66.1	3.50	5.3
Bond spreads: average (%)	9.4	0.20	0.20	2.71	1.10	0.20	4.50	1.68
Bond spreads: std dev. (%)	7.6	0.30	0.34	4.56	2.45	0.20	6.30	2.41
Corr.(spreads, output)	-0.88	-0.10	-0.31	-0.49	-0.36	-0.02	-0.63	-0.41
Corr.(debt/GDP, spreads)	0.92	0.21	0.37	0.44	0.37	0.12	0.53	0.36
Corr.(debt/GDP, output)	-0.97	-0.69	-0.70	-0.76	-0.62	-0.78	-0.77	-0.29
Renegotiation periods								
Average debt/GDP ratio (%)	130.5	50.6	53.7	4.10	-	77.1	3.70	-
Duration of renegotiation/ exclusion (quarters)	14.0	11.1	8.3	2.00	-	9.3	2.00	-
Corr.(debt/GDP, output)	-0.95	-0.99	-0.99	-	-	-	-	-
Corr.(cumulative change in public investment to GDP, duration)	-0.12	-0.08	-	-	-	-	-	-
Corr.(cumulative percent change in public investment, duration)	-0.16	-0.10	-	-	-	-	-	-
Debtor output deviation (diff. btw start and end, %)	12.6	21.2	22.7	-	-	19.5	-	-
Public capital (percent change from the trough to the end)	2.31	1.70	-	-	-	-	-	-

Sources: Datastream, IMF WEO, MECON.

Notes: ^{1/} Model with fixed/no public capital and multi-round renegotiations corresponds to our model (with the same parameter values) with fixed/no public capital and multi-round debt renegotiations as in Benjamin and Wright (2013) and Bi (2008).

^{2/} Model with fixed/no public capital and one-round negotiation (Nash bargaining) corresponds to our model (with the same parameter values) with fixed/no public capital and one-round debt negotiation as in Arellano and Bai (2017) and Yue (2010).

^{3/} Model with fixed/no public capital, and exogenous re-entry and zero recovery rates corresponds to our model (with the same parameter values) with fixed/no public capital and without debt renegotiations (e.g., exogenous re-entry) as in Cuadra et al. (2010), Hatchondo et al. (2017) and Arellano (2008)

TABLE: Robustness Check

	Adjustment costs			Depreciation rate			Weight on public cons			Risk aversion			Discount rate		
	5	10	15	0.025	0.04	0.075	0.7	0.8	0.9	2	3	4	0.85	0.90	0.93
Default probability (%)	4.22	3.1	1.9	5.2	3.1	4.9	3.7	3.1	5.2	5.7	3.1	4.9	3.3	3.1	3.9
Average recovery rate (%)	31.9	27.1	25.9	29.7	27.1	25.8	26.9	27.1	45.4	49.1	27.1	33.5	28.5	27.1	31.4
Public investment (std dev.)/output (std dev.) (%)	7.9	6.0	3.8	8.47	6.0	2.7	11.7	6.0	5.2	4.5	6.0	7.6	12.6	6.0	5.8
Non-target statistics															
Pre-default periods															
Public consumption & transfers (std dev.)/output (std dev.)	1.30	1.23	1.18	1.42	1.23	1.50	1.35	1.23	1.5	1.80	1.23	1.10	1.46	1.23	1.23
Corr.(public consumption & transfers, output)	0.83	0.89	0.92	0.78	0.89	0.84	0.87	0.89	0.81	0.78	0.89	0.87	0.85	0.89	0.84
Average public investment/GDP ratio	1.6	1.6	1.6	1.18	1.60	2.58	1.39	1.6	1.91	1.87	1.60	1.40	1.35	1.60	1.92
Corr.(public investment, output)	0.62	0.63	0.69	0.61	0.63	0.42	0.44	0.63	0.76	0.62	0.63	0.52	0.35	0.63	0.61
Average debt/GDP ratio (%)	40.2	43.9	43.6	40.2	43.9	44.9	42.4	43.9	25.0	25.9	43.9	23.4	42.7	43.9	36.4
Renegotiation periods															
Public consumption & transfers (std dev.)/output (std dev.)	2.28	2.23	2.30	2.30	2.23	2.20	2.0	2.23	3.54	3.85	2.23	1.30	2.10	2.23	2.14
Corr.(public consumption & transfers, output)	0.77	0.76	0.53	0.87	0.76	0.86	0.80	0.76	0.88	0.88	0.76	0.86	0.72	0.76	0.80
Average public investment/GDP ratio	1.58	1.47	1.46	0.85	1.47	2.95	1.58	1.47	1.39	1.60	1.47	1.51	1.61	1.47	1.73
Corr.(public investment, output)	0.80	0.84	0.78	0.8	0.84	0.81	0.83	0.84	0.9	0.85	0.84	0.67	0.73	0.84	0.80
Duration of restructurings & exclusion (quarters)	11.5	11.1	10.6	11.7	11.1	13.2	12.7	11.1	9.5	9.40	11.1	17.6	13.2	11.1	10.5
Public capital (percent change from the trough to the end, %)	5.0	1.7	0.4	0.56	1.7	7.49	6.4	1.7	0.11	4.21	1.7	7.9	7.1	1.7	0.8

- Probability of settling the deal

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

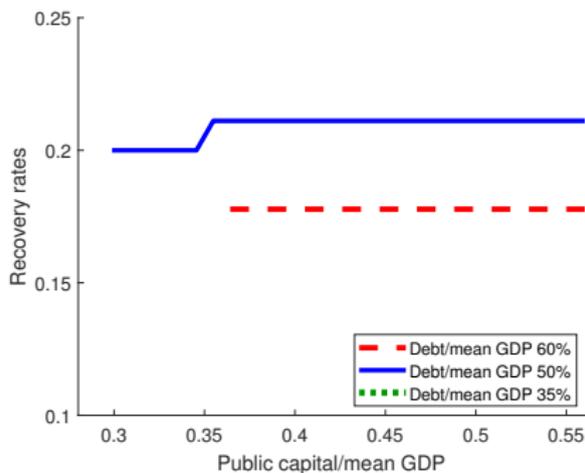
- Sovereign bond spreads

$$s(b_{t+1}, k_{t+1}^g, 0, a_t) = \frac{1}{q(b_{t+1}, k_{t+1}^g, 0, a_t)} - (1 + r^*) \quad (39)$$

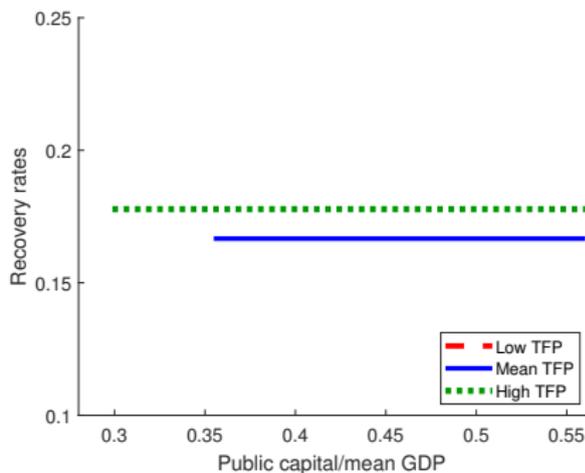
QUANTITATIVE ANALYSIS - ERGODIC DIST. (CONT.)

- Agreed recovery rates

(a) Mean TFP

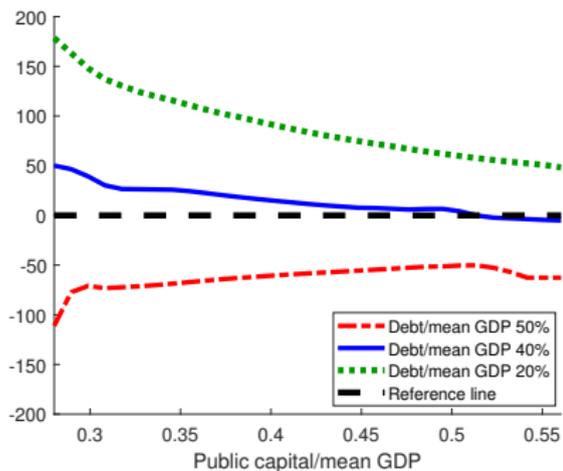


(b) Debt/Mean GDP at 50%

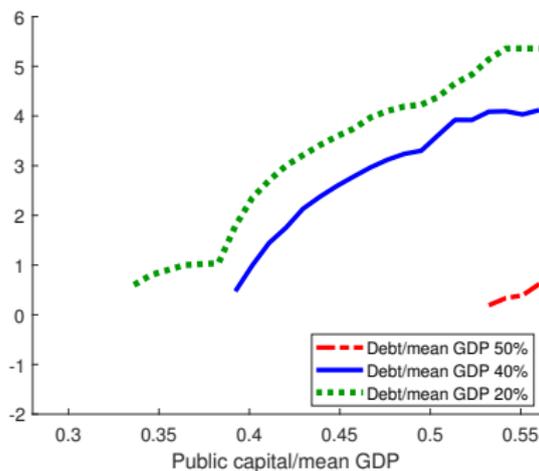


• The Role of Public Capital

(a) Difference between two value functions
 $V^R - V^D$



(b) Difference between two value functions
 $V^{PRO} - V^{PASS}$



MODEL: CREDITOR'S PROBLEM

- Expected profit

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

- Equilibrium bond price

$$q(b_{t+1}, k_{t+1}^g, 0, a_t) = \begin{cases} \frac{1}{1+r^*} & \text{if } b_{t+1} \geq 0 \\ \left[\frac{1-p^D(b_{t+1}, k_{t+1}^g, 0, a_t)}{1+r^*} + \frac{p^D(b_{t+1}, k_{t+1}^g, 0, a_t) \int_A \gamma(b_{t+1}, k_{t+1}^g, 1, a_t) d\mu(a_{t+1}|a_t)}{1+r^*} \right] & \text{otherwise} \end{cases} \quad (35)$$

- Default probability

$$p^D(b_{t+1}, k_{t+1}^g, 0, a_t) = \int_{D(b_{t+1}, k_{t+1}^g)} d\mu(a_{t+1}|a_t), \quad (36)$$

- Expected recovery rates

$$\begin{aligned} \gamma(b_{t+1}, k_{t+1}^g, 1, a_t) &= \int_A \gamma(b_{t+1}, k_{t+1}^g, 1, a_{t+1}) d\mu(a_{t+1}|a_t) \\ &= \int_A \left[\begin{array}{l} \phi 1_{a_{t+1} \in R^B(b_{t+1}, k_{t+1}^g)} \delta_t^{B*}(b_{t+1}, k_{t+1}^g, a_{t+1}) \\ + (1 - \phi) 1_{a_{t+1} \in R^L(b_{t+1}, k_{t+1}^g)} \delta_t^{L*}(b_{t+1}, k_{t+1}^g, a_{t+1}) \\ + \left(\begin{array}{l} \phi 1_{a_{t+1} \notin R^B(b_{t+1}, k_{t+1}^g)} \\ + (1 - \phi) 1_{a_{t+1} \notin R^L(b_{t+1}, k_{t+1}^g)} \end{array} \right) \gamma(b_{t+2}, k_{t+2}^g, 1, a_{t+1}) \end{array} \right] d\mu(a_{t+1}|a_t) \end{aligned} \quad (38)$$

TABLE: Comparison with Models of Multi-round Negotiations

	Data	Baseline Model	Model with	Model with	Model with fixed	
			fixed public capital (case i) ^{1/}	endogenous public capital (case ii) ^{2/}	public capital and No separation of public/private sectors (case iii) ^{3/}	
			With distortionary tax (case i-a)	No separation of public/private sectors (case ii-a)	With distortionary tax and lump-sum tax on income (case ii-b)	
Target statistics						
Default probability (%)	3.26	3.51	3.65	3.62	3.68	3.02
Average recovery rate (%)	25.0	25.2	30.5	36.1	46.1	31.4
Average debtor output deviation during debt renegotiation (%)	-4.45	-5.1	-7.1	-6.9	-6.1	-9.0
Pre-default periods						
Average debt/GDP ratio (%)	45.4	41.7	23.0	41.0	30.5	40.0
Bond spreads: average (%)	9.4	1.7	2.20	1.60	3.00	1.50
Bond spreads: std dev. (%)	7.6	2.30	3.03	1.39	3.50	1.60
Corr.(spreads, output)	-0.88	-0.10	-0.36	-0.26	-0.20	-0.48
Corr.(debt/GDP, spreads)	0.92	0.27	0.34	0.32	0.17	0.35
Corr.(debt/GDP, output)	-0.97	-0.41	-0.40	-0.10	-0.15	-0.33
Renegotiation periods						
Average debt/GDP ratio (%)	130.5	49.9	29.5	51.4	38.0	51.3
Corr.(debt/GDP, output)	-0.95	-0.99	-0.99	-0.99	-0.99	-0.99
Duration of renegotiation/ exclusion (quarters)	14.0	9.1	6.2	5.6	6.3	4.7
Debtor output deviation (diff. btw start and end, %) ^{4/}	12.6	18.4	20.5	16.9	14.5	18.8
Public capital (percent change from the trough to the end)	2.31	2.01	-	-	-	-
Corr.(decline in public investment, duration)	-0.25	-0.10	-	-	-	-
Corr.(recovery in public investment, duration)	0.22	0.16	-	-	-	-