檢視中國債務陷阱
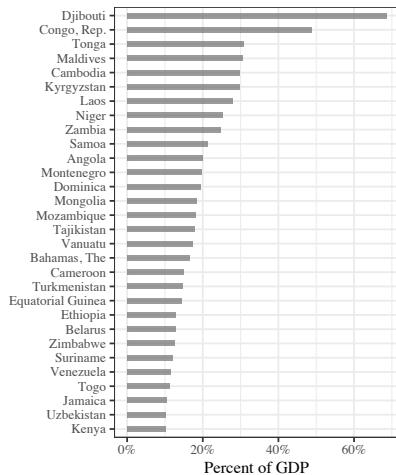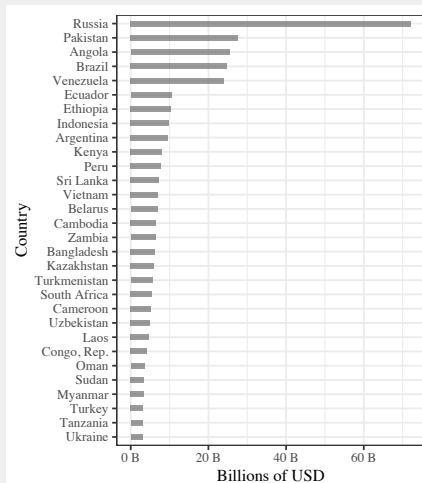# **Examining the Chinese Debt-Trap Diplomacy**

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Debt Trap

Debt-trap Diplomacy

China extends excessive loans to countries and places a debt burden upon them in exchange for political or economic concessions.

Sri Lanka Project List

Hambantota Port

- Initiated: 2007
- 2008: Phase I, $307 million from Chinese Exim Bank, 6% rate
- 2012: Phase II, $304 million
- 2017: 99-year lease, 70% sale to China Merchant Port

Mattala Rajapaksa International Airport

- 2009: $181 million from Chinese Exim Bank, 2% rate
- 2013: Open
- 2014: 21,000 passengers only
- "The world's emptiest airport'

Road Projects

- 2009: $1.14 billion Colombo-Katunayake Expressway (CKE)
- 2010&2011: 1.51%
- 2014: $1.99 on road construction and improvement

Pakistan Project List

Power Project 2016

- $2.7 billion on the Gwadar-Nawabshah LNG terminal and pipeline project;
- $1.26 billion on the Karot Hydropower Project;
- $1.28 billion on the Matiari to Lahore Transmission Line;
- $1.55 billion on the Pakistan Port Qasim Power Project; and $0.75 billion on the Qasim Datang Power Station (Horn, Reinhart and Trebesch, 2021).

Power Project 2017

- $1.35 billion for Suki Kinari Hydropower Project
- $1.5 billion on the Hubco Coal Power Plant Project

Gwadar Port

- 2015: 43-year lease to China Overseas Port Holding Company
- Develope Special Economic Zone (SEZ)

Model

- Decentralized version of Eaton-Gersovitz model
- Tradable vs Nontradable goods
- Household, Firm, Government, Foreign lender

Household

- Maximize

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

- Utility function

$$U(c_t) = \frac{c_t^{1-\sigma} - 1}{1 - \sigma} \tag{2}$$

- Aggregation function for consumption

$$c_t = A(c_t^T, c_t^N) = \left[a \left(c_t^T \right)^{1-\frac{1}{\xi}} + (1 - a) \left(c_t^N \right)^{1-\frac{1}{\xi}} \right]^{\frac{1}{1-\frac{1}{\xi}}} \tag{3}$$

- Budget constraint

$$P_t^T c_t^T + P_t^N c_t^N + P_t^T d_t = P_t^T \tilde{y}_t^T + W_t h_t + (1 - \tau_t^d) P_t^T q_t^d d_{t+1} + F_t + \Phi_t \tag{4}$$

- Working hours

$$h_t \leq \bar{h} \tag{5}$$

Notation: $p_t \equiv \frac{P_t^N}{P_t^T}$, $w_t = \frac{W_t}{P_t^T}$, $f_t = \frac{F_t}{P_t^T}$, and $\phi_t = \frac{\Phi_t}{P_t^T}$

$$p_t = \frac{A_2(c_t^T, c_t^N)}{A_1(c_t^t, c_t^N)} \tag{6a}$$

$$\lambda_t = U'(c_t) A_1(c_t^T, c_t^N) \tag{6b}$$

$$(1 - \tau_t^d) q_t^d \lambda_t = \beta E_t \lambda_{t+1} \tag{6c}$$

- Technology

$$y_t^N = F(h_t) \tag{7}$$

- Profit

$$\Phi_t(h_t) = P_t^N F(h_t) - W_t h_t \tag{8}$$

- F.O.C

$$p_t F'(h_t) = w_t \tag{9}$$

$$W_t \geq \gamma W_{t-1}, \qquad \gamma > 0 \tag{10}$$

This implies that the growth rate $\frac{W_t - W_{t-1}}{W_{t-1}} \geq \gamma - 1$

Slackness condition

$$(\bar{h} - h_t)(W_t - \gamma W_{t-1}) = 0 \tag{11}$$

GOVERNMENT

Government decides to default of not for the economy

- If repay ($I = 1$): able to lend in $t + 1$, or $d_{t+1} > 0$
- If default ($I = 0$): excluded from international credit market, $d_{t+1} = 0$

Written as slackness condition

$$(1 - I_t)d_{t+1} = 0 \qquad (12)$$

Government returns tax to household via lump-sum transfer

$$f_t = \tau_t^d q_t^d d_{t+1} + (1 - I_t)d_t \qquad (13)$$

- If repay ($I = 1$): gives back $\tau_t^d q_t^d d_{t+1}$
- If default ($I = 0$): further distribute current debt d_t

- Risk neutral
- If country in good standing, offer price q_t for debt that returns 1 unit of $d_{t+1} \rightarrow$ return on debt $= \frac{1}{q_t}$
- take future default events into evaluation

$$\frac{\Pr(I_{t+1} = 1 \mid I_t = 1)}{q_t} = 1 + r^* \qquad (14)$$

- Slackness condition

$$I_t \left[q_t - \frac{E_t I_{t+1}}{1 + r^*} \right] = 0$$

Output

- Nontradable goods

$$c_t^N = y_t^N \tag{15}$$

- tradable goods

$$\ln(y_t^T) = \rho \ln(y_{t-1}^T) + \mu_t \tag{16}$$

- Endowment loss under bad standing ($I_t = 0$)

$$\tilde{y}_t^T = \begin{cases} y_t^T - L(y_t^T) & \text{if } I_t = 0 \\ y_t^T & \text{otherwise.} \end{cases} \tag{17}$$

- $L(y_t^T) = \max\{0, \delta_1 y_t^T + \delta_2 (y_t^T)^2\}$

- price demand = price supply during good standing

$$I_t(q_t^d - q_t) = 0 \qquad (18)$$

- combine above with budget constraint

$$c_t^T = y_t^T - (1 - I_t)L(y_t^T) + I_t(q_t d_{t+1} - d_t) \qquad (19)$$

- law of one price $P_t^T = P_t^{T*} \mathcal{E}_t$
- normalize foreign currency price to 1L $P_t^T = \mathcal{E}_t$
- devaluation rate

$$\epsilon_t \equiv \frac{\mathcal{E}_t}{\mathcal{E}_{t-1}} = \frac{P_t^T}{P_{t-1}^T}. \qquad (20)$$

$\left\{ c_t^T, h_t, w_t, d_{t+1}, \lambda_t, q_t, q_t^d \right\}$ satisfying:

$$c_t^T = y_t^T - (1 - I_t)L(y_t^T) + I_t(q_t d_{t+1} - d_t), \quad (21)$$

$$(1 - I_t)d_{t+1} = 0, \quad (22)$$

$$\lambda_t = U'(A(c_t^T, F(h_t)))A_1(c_t^T, c_t^N), \quad (23)$$

$$(1 - \tau_t^d)q_t^d \lambda_t = \beta E_t \lambda_{t+1}, \quad (24)$$

$$I_t(q_t^d - q_t) = 0, \quad (25)$$

$$\frac{A_2(c_t^T, F(h_t))}{A_1(c_t^t, F(h_t))} = \frac{w_t}{F'(h_t)}, \quad (26)$$

$$w_t \geq \gamma \frac{w_{t-1}}{\epsilon_t}, \quad (27)$$

$$h_t \leq \bar{h}, \quad (28)$$

$$(h_t - \bar{h})\left(w_t - \gamma \frac{w_{t-1}}{\epsilon_t}\right) = 0, \quad (29)$$

$$I_t\left[q_t - \frac{E_t I_{t+1}}{1 + r^*}\right] = 0, \quad (30)$$

given processes $\left\{ y_t^T, \epsilon_t, \tau_t^d, I_t \right\}$ and initial conditions w_{-1} and d_0.

$$v^c(y_t^T, d_t) = \max_{\{c_t^T, h_t, d_{t+1}\}} \left\{ U\left(A\left(c_t^T, F(h_t)\right)\right) + \beta E_t v^g\left(y_{t+1}^T, d_{t+1}\right)\right\}$$
$$\text{s.t} \quad c_t^T + d_t = y_t^T + q(y_t^T, d_{t+1})d_{t+1} \tag{31}$$
$$h_t \leq \bar{h}.$$

$$v^b(y_t^T) = \max_{\{h_t\}} \left\{ U\left(A\left(y_t^T - L(y_t^T), F(h_t)\right)\right) + \right.$$
$$\left. \beta E_t \left[\theta v^g\left(y_{t+1}^T, 0\right) + (1-\theta)v^b\left(y_{t+1}^T\right)\right] \right\} \tag{32}$$
$$\text{s.t} \quad h_t \leq \bar{h}.$$
$$v^g(y_t^T, d_t) = \max\left\{v^c(y_t^T, d_t), v^b(y_t^T)\right\}. \tag{33}$$

- Given a debt level d_t, the output under which default is optimal

$$D(d_t) = \left\{ y_t^T : v^b(y_t^T) > v^c(y_t^T, d_t) \right\}. \tag{34}$$

- Gray: Non-default set
- White: Default set
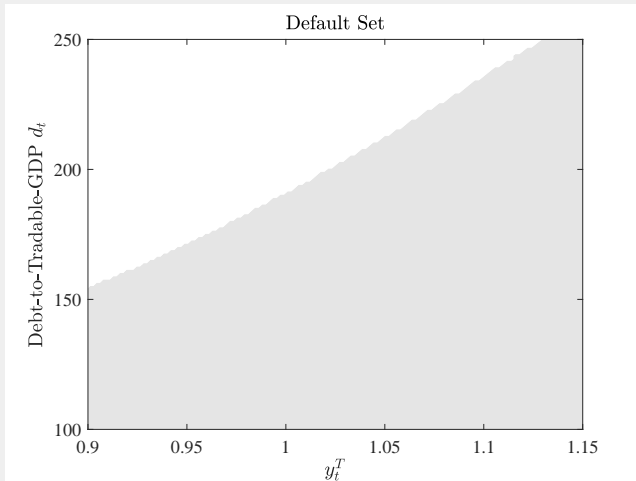
Default Set

- $\Pr(I_{t+1} = 1 \mid I_t = 1)$ is probability that next period output falls into default set

$$q(y_t^T, d_{t+1}) = \frac{1 - \Pr\left\{y_{t+1}^T \in D(d_{t+1}) \mid y_t^T\right\}}{1 + r^*} \qquad (35)$$

- Since y_t^T is AR(1), output today is enough information about tomorrow $\rightarrow$ function of y_t^T

Optimal Devaluation Rate

- Optimal labor supply: $h_t = \bar{h}$ or full employment
- To ensure full employment, wage must be

$$w_t = w^f(c_t^T) \equiv \frac{A_2(c_t^T, F(\bar{h}))}{A_1(c_t^T, F(\bar{h}))} F'(\bar{h}) \tag{36}$$

- Because downward rigidity

$$\gamma \le \frac{W_t}{W_{t-1}} = \frac{w_t}{w_{t-1}} \frac{P_t^T}{P_{t-1}^T} = \epsilon \frac{w_t}{w_{t-1}}$$

- Optimal devaluation rate is any ϵ_t such that

$$\epsilon_t \ge \gamma \frac{w_{t-1}}{w^f(c_t^T)} \tag{37}$$

Calibration

Parameters needed to be calibrated

| Param.	Description
ρ	Autocorrelation of output
σ_u	Standard deviation of output
r^*	Risk-free rate
θ	Probability of reentry
α	Labor share in nontradable goods sector
a	Share of tradable consumption
ξ	Intratemporal elasticity of substitution of consumptin
σ	1/(intertemperal elasticity of substitution of consumption)
γ	Downward wage rigidity
β	Discount factor
δ_1	Coefficient of the linear term in loss function
δ_2	Coefficient of the quadratic term in loss function

General procedure

- ρ, σ_u: Per capita tradable GDP $\rightarrow$ HP-filter $\rightarrow$ cyclical component $\rightarrow$ AR(1) estimation $\rightarrow$ $\hat{\rho}, \hat{\sigma}_u$
  - Since model period is quarter, data period is year
  - $\rho = 1 - \frac{1-\hat{\rho}}{4}$, $\sigma_u = \frac{\hat{\sigma}_u}{\sqrt{4}}$
- r^*: US 3-month T-bill $\approx 4\%$ per year
- θ: 1 / average years till reentry
- α: Follow calibration of literature
- a: mean of tradable-to-GDP ratio over 1980 to 2021
- σ, ξ: Follow literature, set as (2, 0.5)
- $\beta, \delta_1, \delta_2$: match three equilibrium moment
  - Quarterly unsecured debt-to-tradable-GDP ratio
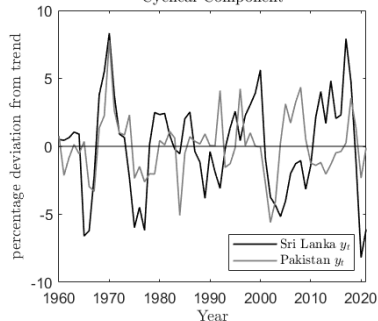 - Default frequency per century
  - Average output loss in bad standings

- HP-filter with $\lambda = 100$ since annual data
- Also tried log-quadratic detrend
- Tradable = agriculture + forestry + fishing + industry

HP Detrending on Log Per Capita Tradable Output
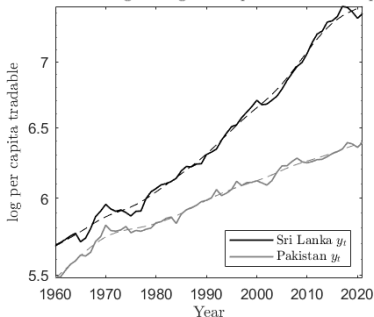
Cyclical Component

Output process II

Sri Lanka

Filtering	ρ	σ	Unconditional std
HP	0.9114	0.0180	4.37%
Log-Q	0.9325	0.0266	7.38%

Pakistan

Filtering	ρ	σ	Unconditional std
HP	0.8518	0.0116	2.21%
Log-Q	0.9239	0.0174	4.55%

- Time span: Before 2008, China started to provide large loans
- Reenty to international credit market: Since no default in the past, follow literature and choose 0.0385
- Debt-to-tradable-GDP ratio
  - Data: 118% average annual
  - Haircut: use average sovereign haircut = 37% according to Cruces and Trebesch (2013)
  - times four to make it quarter
  - $118\% \times 0.37 \times 4 = 175\%$
- Default frequency per century: There is ambiguity in counting default events. Therefore, set as 2.6 following literature
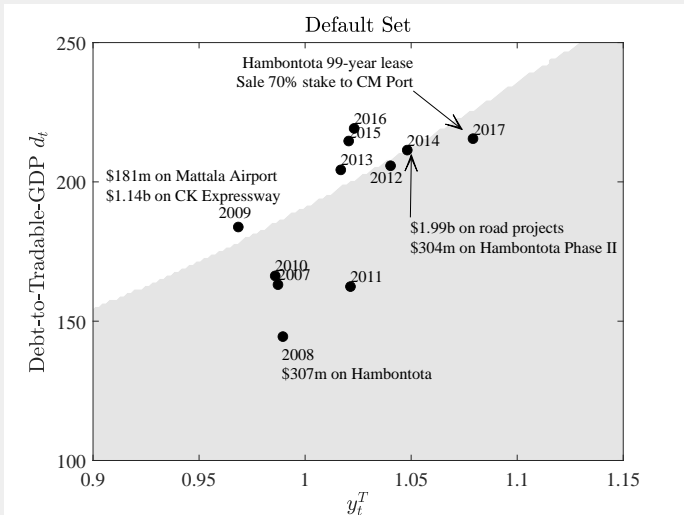- Output loss: Set as 7% following literature

Parameter	Value	Source
ρ	0.9114	Estimation of AR(1) on GDP
σ_u	0.0180	Estimation of AR(1) on GDP
r^*	0.01	U.S. 3-month treasury bill rate
θ	0.0385	Chatterjee and Eyigungor (2012)
α	0.65	Jegajeevan (2016)
a	0.35	Share of tradable goods in GPD
ξ	0.5	Na et al. (2018)
σ	2	$1/\xi$
γ	1.109	Matschke and Nie (2022)
β	0.6919	Estimated
δ_1	-0.4391	Estimated
δ_2	0.5530	Estimated
$\bar{h}$	1	Normalized to 1

Pakistan

- Time span: Before 2013, China started to provide large loans
- reentry to international credit market: 1999 default $\rightarrow$ 2004 gain possitive flow $\rightarrow$ 6 years, or 24 quarters
- Debt-to-tradable-GDP ratio
    - Data: 69% average annnual
    - Haircut: use average sovereign haircut $= 37\%$ according to Cruces and Trebesch (2013)
    - times four to make it quarter
    - $69\% \times 0.37 \times 4 = 102\%$
    - (Typo in the thesis)
- Default frequency per century: There is ambiguity in counting default events. Therefore, set as 2.6 following literature
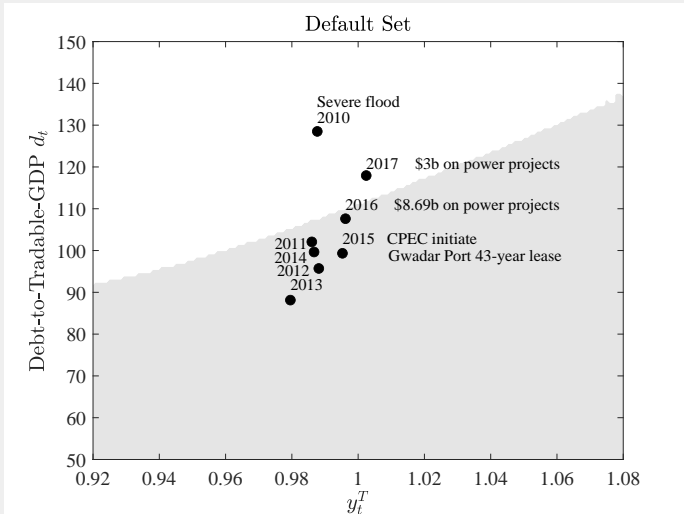- Output loss: Set as 7% following literature

Parameter	Value	Source
ρ	0.8518	Estimation of AR(1) on GDP
σ_u	0.0116	Estimation of AR(1) on GDP
r^*	0.01	3 month treasury bill rate
θ	0.0417	Trebesch (2011)
α	0.4	Rehman et al. (2020)
a	0.33	Share of tradable goods in GDP
ξ	0.5	Na et al. (2018)
σ	2	$1/\xi$
γ	1.048	Matschke and Nie (2022)
β	0.6252	Estimated
δ_1	-0.5148	Estimated
δ_2	0.5789	Estimated
$\bar{h}$	1	Normalized to 1

Result

Default Set

y_t^T

Debt-to-Tradable-GDP d_t

Hambontota 99-year lease
Sale 70% stake to CM Port

$181m on Mattala Airport
$1.14b on CK Expressway

$1.99b on road projects
$304m on Hambontota Phase II

$307m on Hambontota

Sri Lanka

Sri Lanka

pakistan

pakistan
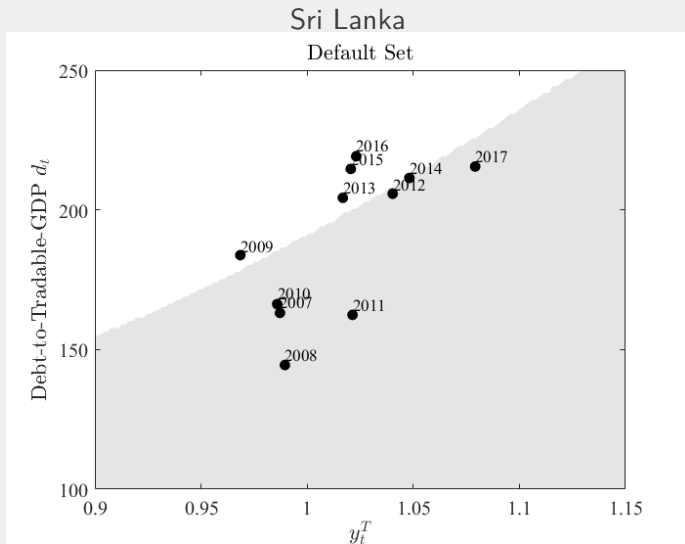
Problems with Removing China's Debt

- Debt is endogenous in the model — Might borrow from other countries
  - ▶ Hambantota Port is originally the former President's idea
  - ▶ Pakistan is under severe power shortage, might borrow money for infrastructure constructions
- GDP might be lower — BRI investment might have cause the counties' GDP to grow
  - ▶ BRI investment may increase labor demand on industrial sectors
- Counterfactual analysis must account for the two factor.

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