International Trade and Sovereign Debt

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- **This paper: Loss of *intratemporal* trade = *endogenous* cost of default**

This Paper's Story

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\text{Lower Probability of Default} &\implies \text{Lower Interest Rate} \\
\text{Lower Interest Rate} &\implies \text{More Debt}
\end{aligned}$$

This Paper's Contribution

- Theory:
  - Develops a simple sovereign debt model à la Eaton and Gersovitz (1981) with both inter and intratemporal trade
  - Characterizes the relationship between openness to (intratemporal) trade and interest rate and debt
- Empirics:
  - Causal evidence of impact of openness to (intratemporal) trade on interest rate and debt

Literature Review

- **Sovereign debt literature:** Eaton and Gersovitz (1981), Kaletsky (1985), Bulow and Rogoff (1989), **Rose (2005)**, Aguiar and Gopinath (2006), Arellano (2008), Reinhart and Rogoff (2009), **Mendoza and Yue (2012)**, Tirole (2015), Hebert and Schreger (2016), Arellano, Bai and Boccola (2019)
- **Intertemporal and intratemporal trade:** Portes and Rey (2005), Aviat and Coeurdacier (2007), Antràs and Caballero (2009), Reyes-Heroles (2016), Eaton, Kortum, Neiman and Romalis (2016)
- **Gains From Trade:** Frankel and Romer (1999), Rodrik, Subramanian and Trebbi (2004), Arkolakis, Costinot and Rodríguez-Clare (2012), Feyrer (2019)

Motivating Evidence

Trade decreases when Countries Default

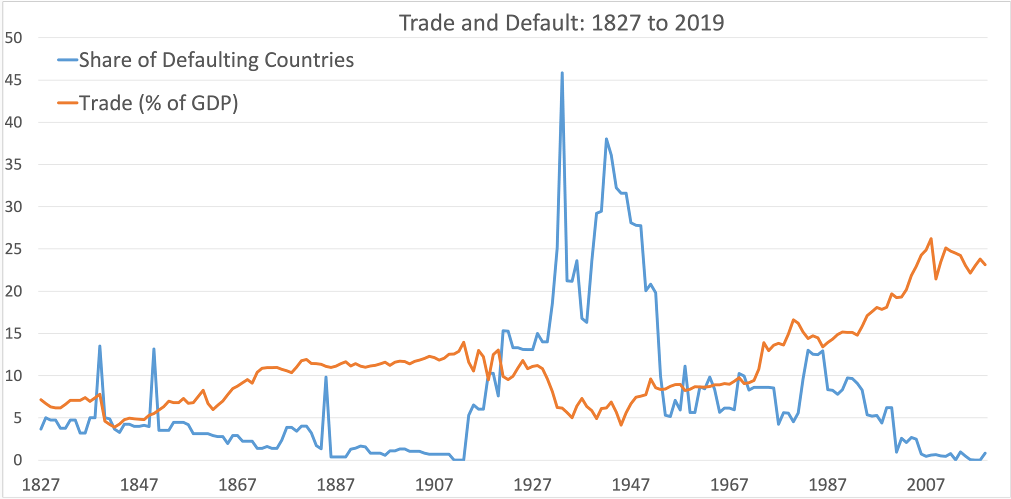


Figure 1: Sources: Reinhart and Rogoff (2009), Fouquin and Hugot (2016), Reinhart et al. (2016)

Existing Evidence on Crisis and Trade

- It has been observed that trade significantly decreases after default and crises:
  - Rose (2005), Martinez and Sandleris (2008): persistent decrease in trade up to **15 years** after default
- Why would trade cost go up?
  - Kohlscheen and O'Connell (2008): 30 to 50% reduction in **trade credit** after default
  - Amiti and Weinstein (2011): exporting firms dependent on trade credit disproportionately hurt by default
  - Gopinath and Neiman (2014): firms stopped importing inputs

Trade Costs and Sovereign Defaults

- Gravity-inferred Trade costs:

$$T_{i,j,t} = \frac{Y_{i,t}^{\phi_1} Y_{j,t}^{\phi_2}}{Cost_{i,j,t}}$$

- Question: Does $Cost_{i,j,t}$ increase if country i or j defaults at time t ($D_{i,t} = 1$, $D_{j,t} = 1$)?
- Consider the log-linear specification:

$$\begin{aligned}\log T_{i,j,t} &= \gamma_1 D_{i,t} + \gamma_2 D_{j,t} + \alpha_{i,j} + \alpha_{R(i),t} + \alpha_{R(j),t} \\ &+ \phi_1 \log Y_{i,t} + \phi_2 \log Y_{j,t} + \varepsilon_{i,j,t}\end{aligned}$$

  for bilateral fixed effects $\alpha_{i,j}$ and regional yearly shocks $\alpha_{R(i),t}$, $\alpha_{R(j),t}$
- Answer: Yes if $\gamma_1, \gamma_2 < 0$
  - Extends Rose (2005) from 1950-1999 to 1820-2014 + Regional controls.

Results: Trade Costs Go Up After Default

	Exports (log or hyperbolic arcsine)					
Default (origin)	-0.643^{***}	-0.438^{***}	-0.447^{***}	-0.126^{***}	-0.117^{***}	-0.027^{***}
	(0.016)	(0.017)	(0.018)	(0.009)	(0.018)	(0.009)
Default (destination)	-0.904^{***}	-0.534^{***}	-0.521^{***}	-0.149^{***}	-0.195^{***}	-0.108^{***}
	(0.014)	(0.016)	(0.016)	(0.008)	(0.017)	(0.009)
	Controls					
GDP (log)	No	Yes	Yes	Yes	Yes	Yes
Pair F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Time-Varying Pair F.E.	No	No	No	No	Yes	Yes
Data Before 1950	Yes	Yes	No	No	No	No
Null=0	Yes	Yes	Yes	No	Yes	No

Likely Culprit: Trade Credit

- Trade credit depends on financial institutions abroad and at home, especially for imports
    - A default creates constraints on local banks' ability to lend in dollars
    - Importing firms / retailers have to pay larger rate or rely more on trade partners (more adverse selection)
    - Higher lending cost $\implies$ Larger trade costs

The Model

Overview

- Standard sovereign debt model with intratemporal trade
  - Country wants to borrow debt B because it is impatient
  - Debt is priced by financial markets depending on the probability of default
  - Intratemporal trade: Armington
    - Domestic country does not produce the same good as ROW
    - Results also apply to gravity trade models
- Default entails financial and commercial autarky
- Debt and Terms of Trade effects:
  - TOT effects absent in theory/presentation

Outline

Government's Utility

- Domestic Economy / Sovereign Government's objective is to maximize flow of utility:

$$\mathbb{E}_0\Big(\sum_{t=0}^{+\infty}\beta^t u(C_t)\Big)$$

  - consumption C_t is **aggregate consumption**
- As long as the government did not default, it will **trade and borrow**
- At each period, state of the world $s \in \mathbb{S}$. The process $(s_t)_{t\geq 0}$ is a Markov process.

Intertemporal Trade: Borrowing

- **Intertemporal trade** for consumption smoothing
  - β is low $\implies$ Government wants to borrow
- Government has endowment (Markov process) $Y_t = Y(s)$ in domestic goods
  - Foreign good is the *numéraire*
  - Price p_t depends on state s_t: $p_t = p(s_t)$.
- inherits debt B_{t-1}
- Issues new debt B_t at price $q(B_t, s_t)$
  - q is the price schedule determined by financial markets
    - Government takes the function q as given
- Expenditures Z_t determined by:

$$Z_t = p_t Y_t + q(B_t, s_t) B_t - B_{t-1}$$

Intratemporal Trade: Trade

- There is **intratemporal trade**
  - Armington trade $\implies$ gains from new different varieties
- Aggregate consumption is a mix of domestic and foreign consumption:

$$C_t = M(c_t, c_t^\star)$$

  - M homothetic, typically CES
- Prices: domestic variety p_t, foreign variety 1
  - Domestic economy is a small open economy
- Iceberg trade costs τ apply to goods for imports and exports
- Budget constraint at time t: given expenditures Z_t

$$p_t c_t + \boldsymbol{\tau}^{\boldsymbol{I}} c_t^\star = Z_t$$

Terms of Trade and Current Account

Outline

Default Cost

- Default has two permanent consequences/costs:

1. **Financial/Intertemporal Autarky (Standard):**

$$Z_t = Y_t$$

2. **Commercial/Intratemporal Autarky (New):**
   2.1 Extreme assumption:

$$C_t = M(Z_t, 0)$$

   2.2 Realistic assumption:

$$\tau \to \tau^D = (1+\delta)\tau$$

- Under complete autarky, government that defaulted has expected value:

$$V^D(s_t) = \mathbb{E}_t\Big[\sum_{t'=t}^{+\infty} \beta^{t'-t} u(M(Y_{t'}, 0))\Big]$$

Robustness

Financial Markets

- Financial markets are international and competitive.
  - Domestic economy is "small", investors are risk-neutral
  - The price of bond is probability of repayment discounted by risk-free interest rate at the next period:

$$q_t(B_t, Y_t) = \frac{\mathbb{P}_t(V^D_{t+1}(Y_{t+1}) \leq V^R_{t+1}(B_{T+1}, Y_{t+1}))}{1+r}$$

    where r is the safe interest rate.

Timing of the Model

1. At time t, sovereign with debt B_{t-1}, learns s_t: Y_t, p_t
2. Decides whether to default or repay debt
   2.1 If default, financial ***and commercial*** autarky
   2.2 If repayment
      2.2.1 Financial markets determine price schedule $q_t^{\tau}(B_t, Y_t)$
      2.2.2 Government takes function $q_t^{\tau}(B_t, Y_t)$ as given and chooses new debt B_t
      2.2.3 ***Government chooses how much to trade***
3. Government plays again at $t+1$ if it chose to repay - stays a defaulter otherwise

See equilibrium definition

Outline

More Open Countries Face Lower Interest Rates

Proposition
Lower trade costs τ implies that larger debt-to-GDP ratios are sustainable. Moreover, for the same level of debt, the price of bond increases when trade costs get lower. In other words, more open economies have lower levels of risk and interest rates.

- Cost of default is larger because of larger trade
  - At the final period: default if burden of trade is more than losses from intertemporal trade
  - Extends to the period before and to infinite horizon
- The markets anticipate it in the price

More Open Countries Face Lower Interest Rates: Comment

- Proposition: for a given level of debt, more open countries will have lower interest rates
- Q: do more open governments default less, **without controlling for debt**?
- A: **Yes**
    - Default is an "inferior" position

Borrowing Decision

- At each period with inherited debt b and at state s, government solves:

$$\max_{B, c_t, c_t^\star} u((1+g(\tau))C) + \beta \mathbb{E}_s(V(b,s)) \quad \text{s.t. } C = p(s)Y + q^\tau(B,s)B - b$$

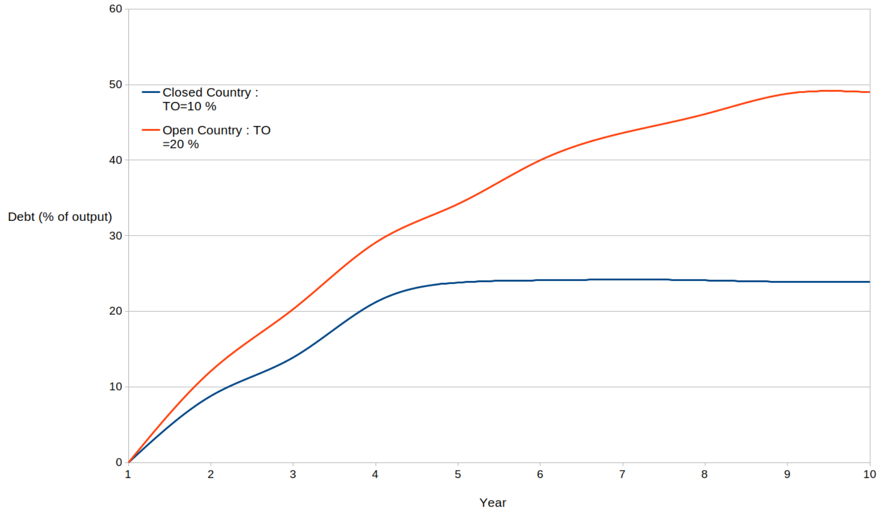
- What happens to optimal debt policy function $B_\tau^\star(s,b)$ that solves this problem?
- What is the sign of $\frac{\partial B^\star}{\partial \tau}$?

More Open Countries Borrow More

Proposition
Compare two economies with similar characteristics but different openness ratios (due to inherent trade costs). In otherwise similar conditions, the more open economy should always borrow more than the closed economy. In mathematical terms, for any s and b, $B^{\star}_{\tau}(s, b)$ is decreasing in τ.

- 2 forces at play when an economy gets more open
    1. Substitution effect: borrowing becomes cheaper $\implies B \uparrow$
    2. Income effect: country gets richer $\implies$ less willing to default $\implies B \downarrow$
        - Default is an "inferior" possibility used by poorer countries
- Substitution effect always stronger

Debt Build-Up: a Closed and an Open Economy



Quantitative Results (i)

- Incorporate other aspects (re-entry after default, debt maturity, Terms of trade effect) in a sovereign debt model calibrated on Mexico
  - Run the model for 10,000 periods 1,000 times, exclude first 500 periods.

Table 1: Simulation of "full-fledge" Debt model

Variable	"Closed"	"Open"
Mean Imports (in % of GDP)	34.3	43.0
Mean Spread	0.112	0.102
S.d. of spread	0.076	0.064
Debt to GDP ratio	0.060	0.088
Spread diff., 95th percentile	0.062	0.052
Frequency of Crises	0.038	0.031

Quantitative Results (ii)

- All propositions are true in more general framework
- When trade parameters modify average openness from 30% to 40% - as happened to Mexico from the 1970s to the 2000s
    - Debt-to-GDP increases by 46%
    - Default likelihood decreases by 22%

Summary: One Assumption and Two Predictions

1. International Trade: decreases after default
2. Interest Rates: lower for more open countries
    2.1 True when controlling for debt
    2.2 True without controlling for debt
3. Sovereign debt: higher more open countries
    3.1 Quantitatively Important in simulations

Empirics of Trade and Sovereign Debt

Outline

Data

1. International Trade:
    1.1 bilateral trade flows from CEPII (until 2014)
    1.2 Total trade flows from World Bank

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- Other Macroeconomic Indicators from IMF, World Bank and Penn World since 1950

Baseline Equation

- Let $Y_{i,t}$ be a variable: bond, CDS spreads or debt
- $T_{i,t}$ (log) trade openness of country i at time t

$$Y_{i,t} = \gamma \, \mathbf{log} \, \boldsymbol{T_{i,t}} + \beta \log X_{i,t} + \varepsilon_{i,t}$$

  - $X_{i,t}$ is a set of controls (including fixed effects and GDP)
- $\mathrm{Cov}(T_{i,t}, \varepsilon_{i,t}) \neq 0$. Example of OVB: financial system size
  - Financial system disruption might be another casualty of default
  - It is also correlated with trade through trade credit
- We need instruments: two different ones

Frankel-Romer: Geographic Instrument for Trade

- Geography determines long-run bilateral trade between i and j
  - Gravity equations
- Trade is determined by distance: $d_{i,j}$, and areas of both countries, population, common border, language etc.: $X_{i,j}$

$$\log\left(\frac{Trade_{i,j,t_0}}{GDP_{i,t_0}}\right) = a_0 \log d_{i,j} + \beta X_{i,j,t_0} + u_{i,j}$$

- Estimate predicted trade share and use it as an instrument for trade:

$$\widehat{Trade}_i^{FR} := \sum_{j \neq i} \frac{\widehat{Trade}_{i,j,t_0}^{FR}}{GDP_{i,t_0}} = \sum_{j \neq i} \exp(\hat{a}_0 \log d_{i,j} + \hat{\beta} X_{i,j})$$

Feyrer: Time Series and Geography

- Geography determines trade differently depending on time
  - Air transport got relatively cheaper in the last 70 years
- Predict bilateral trade with air distance vs. sea distance:

$$\log(Trade_{i,j,t}) = a_{i,j} + a_t + \beta_t^{sea} dist_{i,j}^{sea} + \beta_t^{air} dist_{i,j}^{air} + u_{i,j}$$

$$\implies \widehat{Trade}_{i,t}^{Feyrer} = \sum_{j \neq i} \exp(a_{i,j} + a_t + \beta_t^{sea} dist_{i,j}^{sea} + \beta_t^{air} dist_{i,j}^{air})$$

- Alternatively: impose the evolution of $\beta_t^{sea} : -1 \rightarrow 0$ and $\beta_t^{air} : 0 \rightarrow -1$ over time:

$$\widehat{Trade}_{i,t}^{Feyrer} = \sum_{j \neq i} Trade_{i,j,t_0} \times \exp((\beta_t^{sea} - \beta_{t_0}^{sea}) dist_{i,j}^{sea} + (\beta_t^{air} - \beta_{t_0}^{air}) dist_{i,j}^{air})$$

Two Instruments

- Frankel Romer (1999) instrument based on gravity equations
  - Issue: fixed for each country
    - We include GDP as a control
- Feyrer (2019) proposed a more robust instrument
  - Use changes in "gravity" over time
  - Can include fixed effects

Outline

CDS Spreads

- Reduced Form and first stage Equations:

$$CDS_{i,t} = \gamma \boldsymbol{Trade} + \delta \log D_{i,t} + \beta GDP_{i,t} + \alpha_t + \alpha_t^{OIL} + +\varepsilon_{i,t}$$

$$Trade_{i,t} = c.\widehat{Trade}_i^{FR} + d \log D_{i,t} + b.GDP_{i,t} + a_t + a_t^{OIL} + u_{i,t}$$

- Identification assumption:

Variations in $\hat{Trade}_i^{FR}$ are not correlated with institutional quality other than through GDP and other covariates

More Trade Implies Lower CDS

	Dependent variable:			
	CDS spreads			
Regression Type Fixed effects	IV, Year	IV, Year	IV, Year+Oil	OLS, Year+Country+Oil
Trade-to-GDP (log)	−160.417***	−217.445***	−204.930***	−232.357**
	(32.191)	(26.228)	(25.768)	(90.808)
GDP (log)		−80.296***	−79.425***	−204.122**
		(6.884)	(6.794)	(69.181)
Debt-to-GDP (log)		58.334***	65.078***	99.255**
		(12.018)	(12.428)	(34.973)
Note:				*p<0.1; **p<0.05; ***p<0.01

Interest Rate and Time Series

- Interest Rate data available over longer run:

$$R_{i,t} = \gamma \boldsymbol{Trade_{i,t}} + \alpha_{GDP} GDP_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t}$$

$$Trade_{i,t} = c \widehat{Trade}_{i,t}^{Feyrer} + a_{GDP} GDP_{i,t} + a_i + a_t + \varepsilon_{i,t}$$

- Control by GDP (nominal or real) because trade is likely to make countries richer
- Exclusion restriction:

Difference between air and sea distance does not directly affect **changes** in variables other than **trade and GDP**

Trade and Interest Rates

	Bonds		
Trade (Instrumented)	-1.393^{***}	-2.373^{***}	-2.266^{***}
	(0.264)	(0.778)	(0.737)
F-test (First stage)	59.49	12.83	11.42
GDP (log)	Yes	No	Yes
Country F.E.	No	Yes	Yes
Year F.E.	Yes	Yes	Yes

Note: *p<0.1; **p<0.05; ***p<0.01

Outline

Debt and Time Series

- Long-run debt data available for 100 countries:

$$Debt_{i,t} = \gamma \boldsymbol{Trade_{i,t}} + \alpha_{GDP} GDP_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t}$$

$$Trade_{i,t} = c \widehat{Trade}_{i,t}^{Feyrer} + a_{GDP} GDP_{i,t} + a_i + a_t + \varepsilon_{i,t}$$

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Debt and Trade

	Debt-to-GDP ratio		
Trade-to-GDP	0.319***	0.326***	0.315***
log (Instrumented)	(0.059)	(0.054)	(0.057)
GDP (log)	No	Yes	Yes
Year + Country	Yes	Yes	Yes
Oil	No	No	Yes
Observations	2,918	2,847	2,847
Note:	*p<0.1; **p<0.05; ***p<0.01		

How Large Is the Impact of (Intratemporal) Trade?

According to estimates:

- A 10% increase in trade should lead to:
  - a 20 b.p. decrease in CDS premia
  - A 20 b.p. decrease in the interest rate
  - a 3% increase in Debt-to-GDP ratio.
- E.g. if Argentina traded as much as Italy in 2014, it would have had **200 b.p.** less, a **2% lower yield**, and **30% larger debt-to-GDP ratio**
- In line with the model's estimates

Conclusion

Results

- Theoretical contribution
  - Sovereign debt model with gains from trade
  - More trade openness implies less sovereign risk and more debt
- Empirical Evidence of a relation between trade and sovereign debt.
  - CDS and yields: lower borrowing risks for more open countries
  - Debt: more debt for more open countries

The End

La Fin

Equilibrium (i)

Definition

Let $T \in \mathbb{N} \cup \{+\infty\}$ be the number of periods, $(Y_t)_{t\in[0,N]}$ be a Markov process, τ be a value for trade costs. A competitive equilibrium associated is given by a sequence of value functions $(V_t(B, Y, p_t), V_t^R(B, Y, p), V_t^D(Y))_{t\in[0,N]}$, policy function for borrowing $(b_t(B, Y))_{t\in[0,T]}$, policy function for default $(D_t(B, Y))_{t\in[0,T]}$, and lending functions $(q_t(B, Y))_{t\in[0,T]}$ such that, for every $t \leq T$, B, Y:

$$V_t^R(B, Y, p) = \max_{B', c_t, c_t^\star} u(M(c_t, c_t^\star)) + \beta \mathbb{E}_t(V_{t+1}(B', Y_{t+1})) \quad \text{s.t. } pc_t^\star + c_t + B = Y + q_t(B', Y, p)B'$$

$$V_t^D(Y) = u(M(Y, 0)) + \beta \mathbb{E}_t(V_{t+1}^D(Y_{t+1}))$$

$$V_t(B, Y, p) = \max\{V_t^R(B, Y, p), V_t^D(Y)\}$$

Equilibrium (ii)

- Policy functions solve the government's optimization problem::

$$
\begin{aligned}
D_t(B, Y, p) &= \mathbb{I}\{V_t^R(B, Y, p) < V_t^D(Y)\} \\
b_t(B, Y) &\in \arg\max_{B', c_t, c_t^\star} u(M(c_t, c_t^\star)) + \beta \mathbb{E}_t(V_{t+1}(B', Y_{t+1})) \\
&\text{ s.t. } \tau p c_t^\star + c_t + B = Y + q_t(B', Y)B'
\end{aligned}
$$

- Financial markets are competitive:

$$
q_t(B', Y) = \frac{\mathbb{P}(D_t(B', Y_{t+1}) = 0 | Y)}{1 + r}
$$

with the convention that $V_{N+1} \equiv V_{N+1}^R \equiv V_{N+1}^D \equiv 0$. In the model where $T = +\infty$, the definition is the same except that none of the value, policy and lending functions depend on time.

Back

More general Assumption

- Let τ be the trade costs in domestic country.
- Trade costs increase to $\tau^D := (1+\delta)\tau$ for some $\delta > 0$
- If CES $\sigma > 1$:
  - All the results still hold
- Results reverse in terms of τ if $\sigma < 1$
  - But more open countries (more imports) still lose more from default
- When $\sigma = 1$, neither cost of default nor openness vary in τ
  - Modifying τ will no have no effect on trade openness or gains from trade
  - But countries that are more open will suffer more from default

Back

The Trade Cost of Default: Sufficient Statistics

- Under general trade models, ACR (2012) holds and static cost of default is:

$$d \ln(\hat{W}_{\tau,\tau^D}) = \frac{1}{\sigma - 1}\big(\ln(1 - IM^\star(f^D(\tau))) - \ln(1 - IM^\star(\tau))\big)$$

- If $IM^\star(f^D(\tau)) = (1-d)IM^\star(\tau)$ for $d \in (0,1)$

$$\ln(\hat{W}_{\tau,\tau^D}) = \frac{1}{\sigma - 1}\big(\ln(\frac{1}{1 - IM^\star(\tau)} - 1 + d)\big)$$

  As long as $\sigma > 1$, default costs larger for more more open countries.

- A proportional decrease in trade is a sufficient condition

Back

Length of Default

- Default Permanent in proofs
- More realistic assumption: probability λ to come back to normal at each period
- $$V^D(s_t) = u(c_t^D) + (1-\lambda)\mathbb{E}_{s_t} V^D(s_{t+1}) + \lambda \mathbb{E}_{s_t} V^D(s_{t+1})$$
- The larger λ, the harsher punishment is
- $\lambda = 0$ makes the proofs tractable
- $\lambda > 0$ in calibration: does not affect the qualitative results
  - However, it mechanically affects the size of the effect

Back

Borrowing and Terms of Trade

- Price of the good p_t should depend on:
    - Domestic production $Y_t = Y(s_t)$
    - Foreign demand for the domestic good $Y_t^\star = Y^\star(s_t)$
    - Current account:

$$B_{t-1} - q(B_t, s_t)B_t,$$

      Trade deficit rises total demand for domestic good
- Model:
    - theory results proved for the case when p_t exogenously depends on s_t
    - Calibration: allows this effect, confirms theoretical results to more general case

Price of the Domestic Good when TOT effects exist

- It is determined by at each period t by:
    - Endowment Y_t, Foreign Demand $Y_t^\star$
        - Trade balance TB_t, Trade costs τ^E (exports) and τ^I (exports)
    - For CES functions with elasticity σ, price $p(Y_t, Y_t^\star, TB_t, \tau)$ solves:

$$(pY_t - TB_t)\frac{p^{-\sigma}}{(p^{1-\sigma} + \tau^{I\,1-\sigma})} + Y_t^\star \tau^{E\,-\sigma} p^{-\sigma} = Y_t$$

    - Assumption needed for the results:

$$\frac{p(Y_t, Y_t^\star, TB_t, \tau)}{p(Y_t, Y_t^\star, 0, \tau^D(\tau))} \downarrow \tau,$$

which holds well quantitatively.

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Optimal Tariff $\tau^\star$

- No market power/TOT effects $\implies \tau^\star = 1$, 0 tax
- Market power $\implies$ Optimal import tariff is

$$\tau^\star = \frac{\sigma}{\sigma - 1}$$

- Applying unilaterally the optimal tariff rises gains from trade:
  - higher tariff can rise willingness to pay back debt
  - Too high/low tariff reduces willingness to pay
- However, trade "wars: other countries apply optimal tariff
  - Trade treaty improves willingness to pay

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