International Macroeconomics - Session IV

Endogenous Frictions in International Financial Markets

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Recap: Session II and III

Recap: "International real business cycles"

- Stylised Facts and puzzles
- Properties of models with capital accumulation and international asset trade, subject to shocks
- One good model:
  1. Productivity shocks
     - Corr $(y, y*)$, $(n, n*)$, $(inv, inv*)$ negative; $c, c*$ strongly positive
     - NX and CA: sum of procyclical imports of inv goods, countercyclical imports of cons goods, $\approx$ acyclical
     - Taste shocks deliver: negative Corr $(c, c*)$, positive $(y, y*)$,$(n, n*)$,$(inv, inv*)$
  2. Bond economy similar, unless very persistent shocks without spillovers.

Recap: "International real business cycles"

- Stylised Facts and puzzles
- Properties of models with capital accumulation and international asset trade, subject to shocks
- One good model
- Two country-specific traded goods:
  1. For intermediary values of elasticity much the same for CM and bond economy
  2. Financial autarky better on comovement, worse on cons-correlation

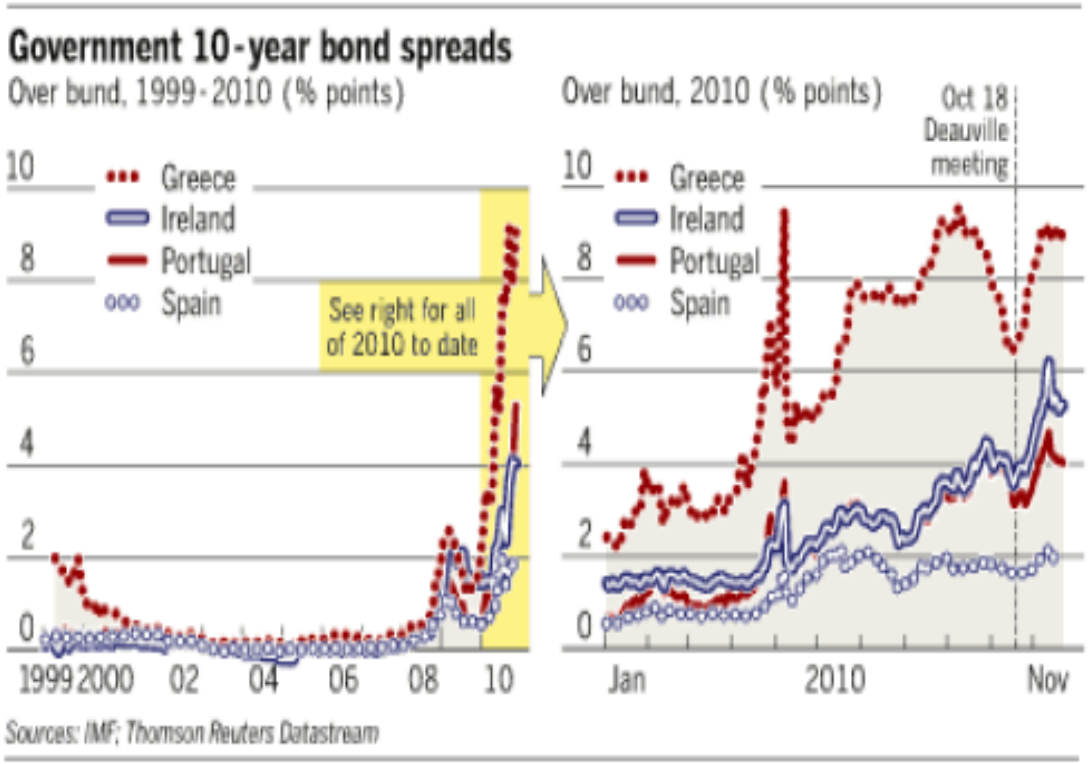
Recap: "International real business cycles"

- Stylised Facts and puzzles
- Properties of models with capital accumulation and international asset trade, subject to shocks
- One good model with productivity shocks:
- Two country-specific traded goods:
- Corsetti Dedola Leduc (2008)
  1. Non-traded goods can help to break consumption correlations puzzle
  2. Very low elasticity implies POSITIVE response of ToT to supply shock and strong positive wealth effect
  3. Very high elasticity plus sluggish output response implies excess short-run demand for domestic goods

Recap: Financial markets so far...

1. 3 exogenous scenarios: CM, bond trade (with No-Ponzi condition), financial autarky
2. Country-assets perfect substitutes
3. Bonds were riskless: no sovereign default
4. Law of one price for assets

Euro Zone Spreads



Source: FT 23 Nov 2010

But...

1. Why do governments borrow in (non-contingent) bonds?
2. What explains differences in sovereign interest rates across countries or time?
3. Why does capital not flow to poor countries?
4. Why is lending to emerging markets so volatile?

This session: "Endogenous market frictions"

- What are the frictions that can explain observed asset trade between countries?
  1. What assets are traded in equilibrium?
  2. At what prices?
- Are there market setups other than CM or bond trade that do better on puzzles?

Next session: "Global Imbalances"

- What explains persistent CA deficits / surplusses?
- What could explain the low savings in the US?
- Were global imbalances responsible for the crisis?

What this session doesn't answer...

- Why poor countries borrow in dollars.
- Why there are sudden reversals in credit availablity to poorer countries.
- How market incompleteness within and across countries interacts.

Learning points

1. Efficient risk sharing contracts require perfect information and perfect enforcement.
2. When agents are risk-neutral and state-contingency is costly, equilibrium contract is standard debt.
3. With option to misreport productivity shocks and store output, countries cannot share risk!
4. When default on bonds only implies exclusion from future credit, countries cannot borrow in the first place!

Learning points

1. Efficient risk sharing contracts require perfect information and perfect enforcement.
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4. When default on bonds only implies exclusion from future credit, countries cannot borrow in the first place!
5. Incentives to fulfill contract become crucial!
6. Incentive constraints might help explain some business cycle facts.

Roadmap for this section

1. Some facts
2. Frictions in asset markets: Asymmetric information and limited contract enforcement
3. Constrained efficient risk sharing between 2 countries: Kehoe and Perri (2001)
4. Risk premia, default and business cycles in a small open emerging economy: Arellano (2008)

I. Facts

Facts

1. Interest rates on sovereign bonds and default
2. Consumption and income fluctuations within and across countries

Facts I: Interest rates on sovereign bonds and default

Developed economy interest rates

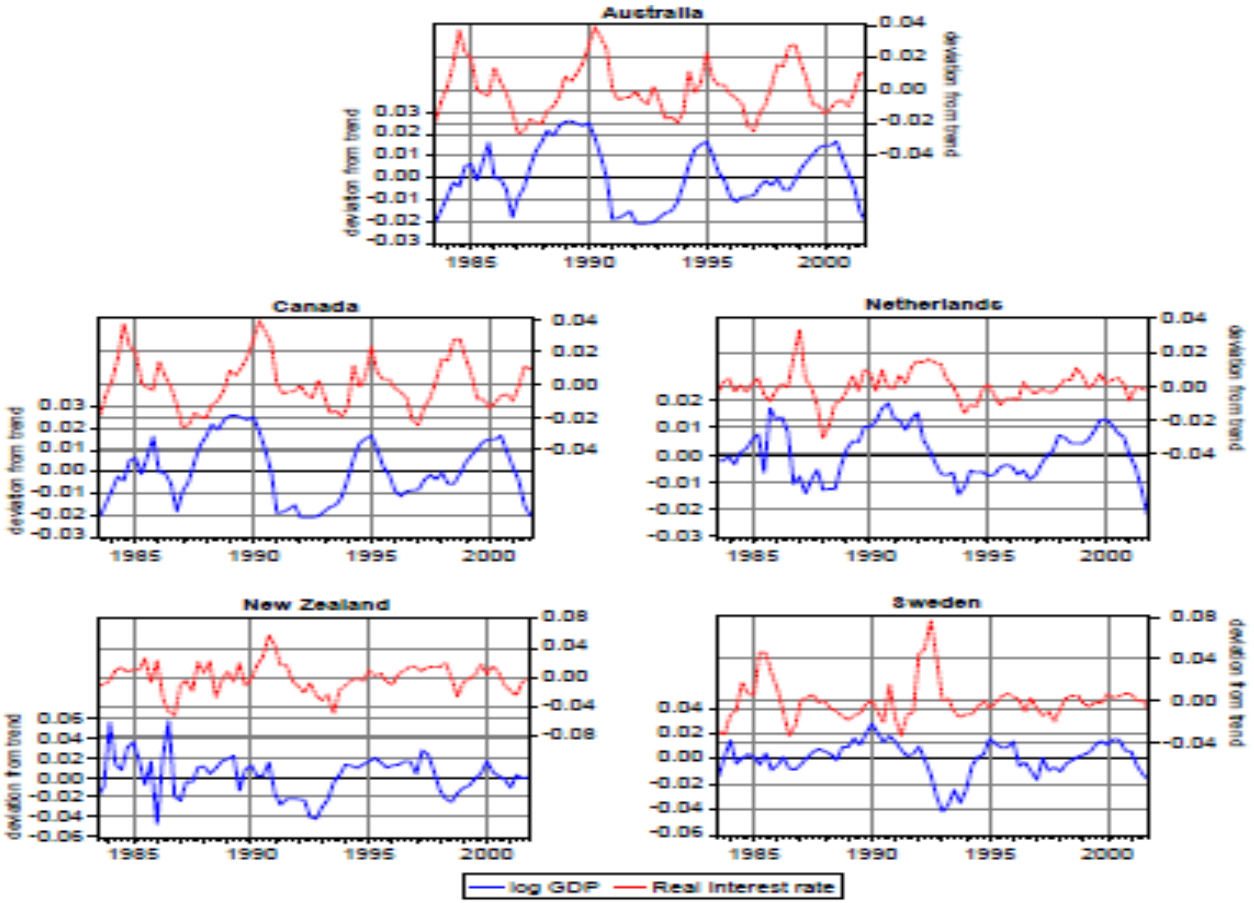
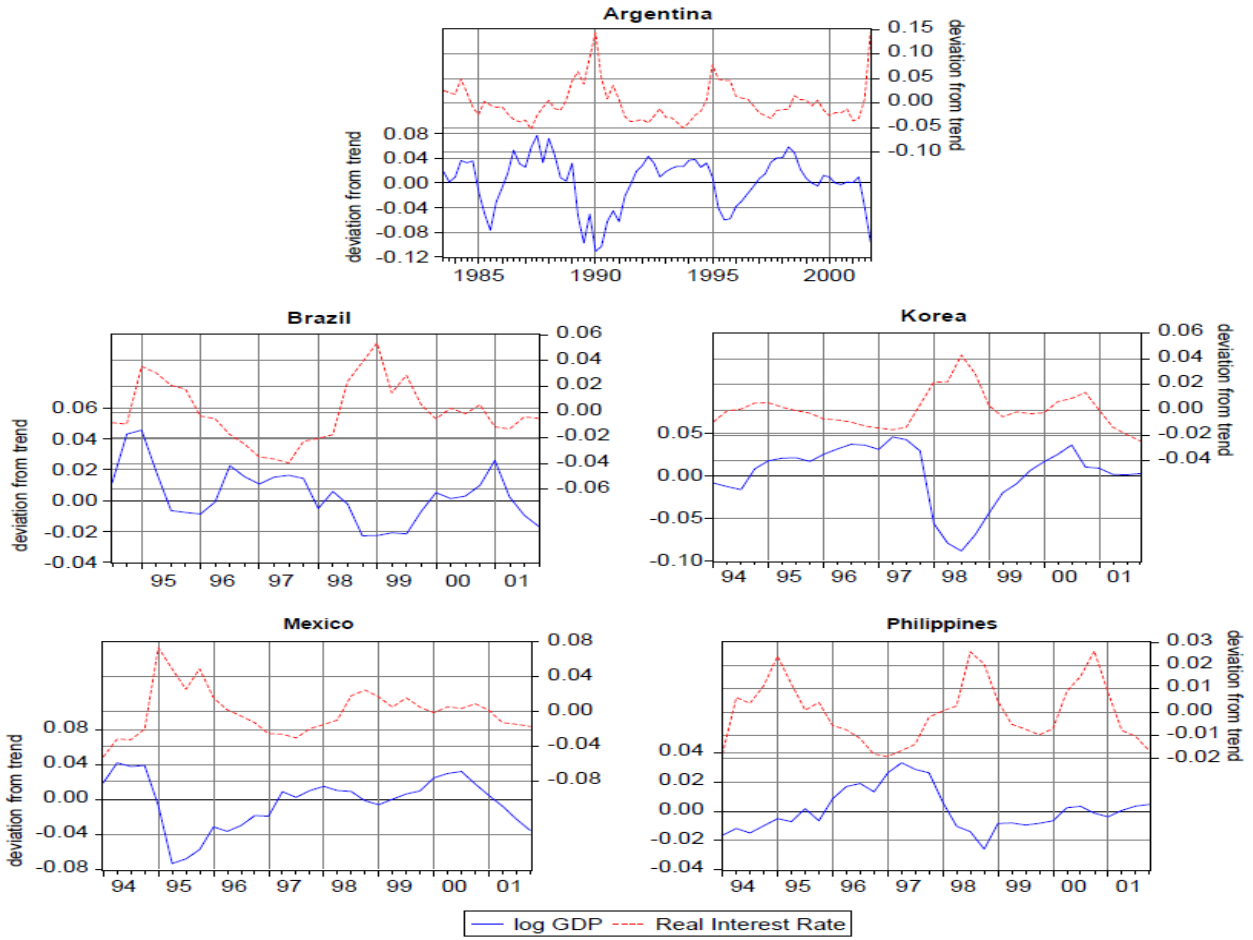


Fig. 2. Output and interest rates in developed economies.

Source: Neumeyer and Perri (2001)

Emerging Market interest rates



Source: Neumeyer and Perri (2001)

Facts I: Interest rates on sovereign bonds and default

- Developed country interest rates are pro-cyclical
- Interest rates on EM bonds are strongly countercyclical

Argentina interest rates

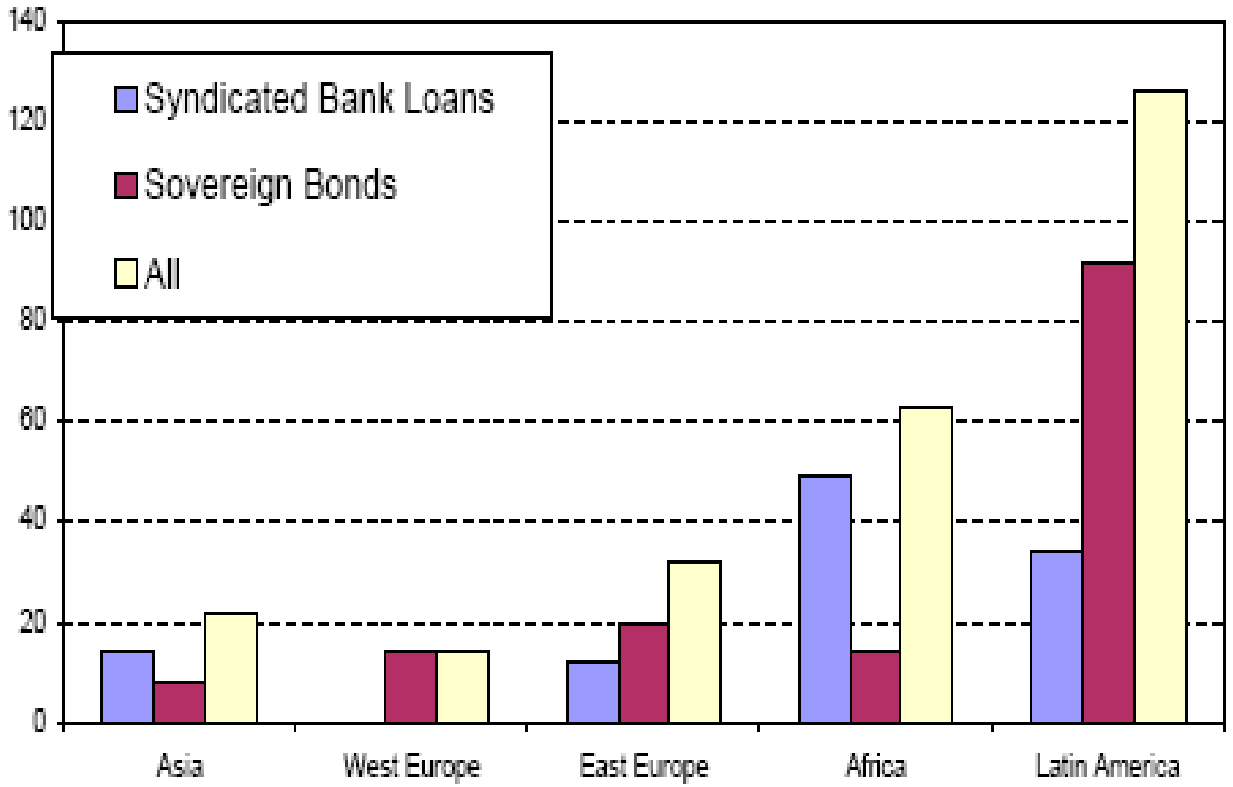
Source: Neumeyer and Perri (2005)

Facts I: Interest rates on sovereign bonds and default

- Developed country interest rates are pro-cyclical
- Interest rates on EM bonds are strongly countercyclical
- They have a world, country-specific and EM specific component

Frequency of default by regions and debt instrument

Figure 1: Number of Defaults (1824-2004)



Source: Borensztein et al (2008)

Facts I: Interest rates on sovereign bonds and default

- Developed country interest rates are pro-cyclical
- Interest rates on EM bonds are strongly countercyclical
- They have a world, country-specific and EM specific component
- Sovereign defaults are not that rare

Facts II: Consumption and income fluctuations

Evidence on consumption smoothing across countries

Backus Smith (1993) Puzzle

- Relative consumption and RER not (or negatively) correlated across countries
- Contradicts complete markets

Evidence on consumption smoothing across countries

Deaton (1992): Excess Smoothness in US consumption

- With borrowing and saving at $R = 1/\beta$, consumption should respond 1-to-1 to permanent income changes.
- Empirically, US GDP cannot be rejected to be a random walk
- But Consumption is much smoother than GDP - Deaton's Paradox

Excursion: Evidence on consumption smoothing within countries

- Complete risk sharing is rejected by the data (Zeldes 1989, Attanasio and Davis 1996)
- So is pure self-insurance through borrowing and saving
  - Excess sensitivity of consumption to transitory and predictable income movements (Hall and Mishkin 1982)
  - Excess smoothness to permanent innovations (Blundell et al 2008, Campbell and Deaton 1989)

Summary facts

- Developed country interest rates are pro-cyclical
- Interest rates on EM bonds are strongly countercyclical, have a world, country-specific and EM specific component
- Sovereign defaults are not that rare
- Both within and across countries perfect risk-sharing and the simple PIH are rejected by the data

Questions

- What frictions explain limited risk sharing and limited set of traded assets?
- What is the role of default in different market environments?
- What drives fluctuations in asset prices, especially for emerging economies?

Roadmap

1. Some facts
2. Frictions in asset markets: Asymmetric information and limited contract enforcement

Frictions in insurance markets

- Why not complete insurance contracts?
  1. Missing information / non-verifiability
  2. Asymmetric information: Moral Hazard and adverse selection problems
  3. Missing enforcement: outside option to the contract - "default"
- Why simple debt contracts as alternative?

Frictions in insurance markets

- Introduce frictions to insurance / asset trade between agents (not necessarily countries)
- 1 WT no longer holds: Analyse constrained efficient allocation or decentralised equilibrium
- But: countries are special in that...
  1. More difficult to force governments to pay than private agents
  2. More difficult for governments to put up collateral for contracts
  3. Governments ressources depend on willingness to tax domestic agents

I. Asymmetric information in financial contracts

Asymmetric information I: Costly state verification

- Gale and Hellwig (1985), Townsend (1979), Diamond (1984)
- Borrower need funds from a lender to finance risky project paying $y(s_t)$, both risk-neutral
- Contracts can be contingent on s_t, but lender can observe state s_t only at cost c
- Monitoring can not be random
- Result: Optimal contract minimises verification cost, and is a "standard debt contract"
- Problem: risk-neutrality, non-random state verification

Asymmetric information II: AI on income and hidden savings

- Allen (1985), Cole and Kocherlakota (2001)

Asymmetric information II: AI on income and hidden savings

- Risk-averse agents receive stochastic endowments $y(s_t)$ that are private knowledge
- Planner can provide insurance by allocating $c(s_t)$ subject to truth-telling constraint
- Agents can store goods at market interest rate R

Asymmetric information II: AI on income and hidden savings

- Agents can reallocate ressources across periods, so will always consume such that their Euler equation holds
- Thus they only care about NPV of transfers, not time path: always report y_t to max NPV
- NPV is thus constant across reports y_t - no risk sharing!
- Constrained optimal allocation can be decentralised using standard borrowing and saving

II. Limited enforcement of contracts

Limited enforcement of contracts

- Contract: defines state-contingent transfers (investment, effort levels) ex ante.
- Assume agents can not be forced to honour contract ex post: can decide to "default".
- No enforcement plus anonimity: no non-collateralised financial contracts.
- Without anonimity, default can be "punished" by market exclusion, direct penalties, etc. This might support certain, but not all financial contracts.

Limited Enforcement I: Default punished by exclusion from borrowing

- Bulow and Rogoff (1989)

Limited Enforcement I: Default punished by exclusion from borrowing

- Agents/countries borrow and save at R, s.t. limit $b_t \geq B \ \forall t$
- Default possible, causes permanent exclusion fr borrowing, but not saving at R
- Which B prevents default?
- Assume $B < 0$ and binding. Any continuation path in consumption thereafter satisfies
  $\sum_0^\infty q(s_{t-1})[y(s_t) - c(s_t)] \geq B \ \forall s_t$
- But default and saving can implement
  $\widetilde{c(s_t)} = c(s_t) + (R(s_{t-1}) - 1)B$ since
  $\sum_0^\infty q(s_{t-1})[y(s_t) - \widetilde{c(s_t)}] \geq 0 \ \forall s_t$
- So for any binding negative B default is optimal. Thus $B = 0$!

Bulow and Rogoff: Discussion

- Bulow and Rogoff-result rests on several assumptions
  - Markets are as complete after default as before
  - Market prices are not contingent upon default
  - Creditors cannot impose direct penalties
- But:
  1. For debtor countries collateralised contracts may be difficult, as collateral may be seized by previous creditors
  2. Direct penalties may include restricted access to credit for private sector, trade sanctions, etc.

Limited Enforcement II: Default punished by exclusion from all financial trade

- Closed economy, default punished by indiv. financial autarky
- Implies participation constraint: Continuation utility from no-default must be greater than that from default
- Bond economy: Zhang (1997): No-default constraint more stringent than "natural" borrowing limit, lowers R.
- CM: Kocherlakota (1996), Alvarez et al (2000): Default restricts borrowing against high $y(s_t)$, raises asset prices.
- Krueger and Perri (2006): Saving after default in CM. Consumption responds less to rise in US income inequality 1980-2003 than in bond economy.
- Common feature: No default in equilibrium.

Limited Enforcement III: Equilibrium default

- Zame (1992): When markets are incomplete default may pareto-improve allocation

A step back: The double role of default (Perri 2008)

- With complete markets
  - default restricts transfers
  - the resulting time-varying outside option is a lower bound of expected utility
  - always inefficient
- With debt contracts, supported e.g. by external punishment
  - Default introduces contingency!
  - ... may be welfare-improving

Roadmap

1. Some facts
2. Frictions in asset markets: Asymmetric information and limited contract enforcement
    - Asymmetric information: can rule out insurance contracts
    - Limited enforcement
        - ... of debt contracts: Can rule out borrowing (Bulow and Rogoff 1989), but also improve risk-sharing (Zame 1992)
        - ... of insurance contracts: constrains risk-sharing

Roadmap

1. Some facts
2. Frictions in asset markets: Asymmetric information and limited contract enforcement
3. Limited enforcement of risk sharing contracts in a 2 country world: Kehoe and Perri (2001)
4. Risk premia, default and emerging market business cycles: Arellano (2008)

Kehoe and Perri (2001): Issue

1. Both CM and bond trade deliver counterfactual results: Cons-Corr and Comovement Puzzles
2. Can an economy where complete asset markets are constrained by countries' default into autarky improve on this?
3. Answer: Yes! (but net exports are procyclical)

KP 2001: Environment - as in BKK 1992

- 2 countries of equal size, discrete time
- Agents: representative infinitely lived agents, competitive firms for each country
- Single perishable good used for consumption and investment and government consumption
- Immobile labour but free trade in goods (and capital)

KP 2001: Environment

- Consumers have identical preferences across countries i

$$U_i = E_0 \sum_{t=0}^{\infty} \beta^t u(c_{it}, l_{it}) \tag{1}$$

- Technology is CRTS with persistent shocks

$$y_{i,t} = A_{it} k_{it}^{1-\alpha} n_{it}^{\alpha} \tag{2}$$

where $n_{it} = 1 - l_{it}$, $A_t = [A_{1t}, A_{2t}]' = RA_t + \epsilon_{t+1}$ and ϵ_{t+1} has var-cov matrix Ω

- Capital accumulates according to $k_{it+1} = (1 - \delta)k_{it} + x_{it}$

Asset trade subject to enforcement constraints

- Markets are complete, but countries can at any point default on contracts
- Default implies autarky forever, so any allocation has to satisfy participation constraint:

$$W(s^t) = \sum_{r=t}^{\infty} \sum_{s^r} \pi(s^r|s^t) U(c_i(s^r), l_i(s^r)) \geq V_i(k_i(s^{t-1}, s^t) \quad (3)$$

where s^r is the history of events until period r and

$$V_i(k_i(s^{t-1}, s^t) = max \sum_{r=t}^{\infty} \sum_{s^r} \pi(s^r|s^t) U(c_i(s^r), l_i(s^r)) \quad (4)$$

$$s.t.\ c_i(s^r) + k_i(s^t) \leq y_{i,t} + (1-\delta) k_i(s^{t-1}) \quad (5)$$

Intuition: Why default constraints might help

$$W_i(s^t) =\geq V_i(k_i(s^{t-1}, s^t) \tag{6}$$

- Productivity shocks A_i raise V_i, so planner needs to raise W_i - might break consumption correlation
- k_i raises V_i, and thus tightens participation constraint; so planner raises k_i less in response to a productivity shock: might break comovement puzzle

Constrained social planner's problem (SP)

$$max_{\{c_{it},k_{it+1},l_{it}\}} E_0[\sum_i \mu_i \sum_{t=0}^{\infty} \beta^t u(c_{it}, l_{it})]$$

subject to

$$\sum_i c_{it} + x_{it} \leq \sum_i exp(A_{it}) F(k_{it}, n_{it}) - g_{it} \tag{7}$$

$$\sum_{r=t}^{\infty} \sum_{s^r} \pi(s^r|s^t) \beta^t u(c_i(s^r), l_i(s^r)) \geq V_i(k_i(s^{t-1}, s^t) \forall s_t, \ \ i = h, f$$

$$k_{it+1} = (1-\delta)k_{it} + x_{it}$$

k_{i0} *given* (8)

Solution of the SP

- Problem: SP is not recursive: binding PC implies promised utility, promise keeping implies history dependence
- Solution: Summarise history dependence by time-varying planner weights μ_{it} (Marcet and Marimon 1999)

Lagrangian for SP

$$\mathbb{L} = E_0\{\sum_i \mu_i \sum_{t=0}^{\infty} \beta^t u(c_{it}, l_{it}) - \gamma_{it}[V_i(k_{it}) - \sum_{r=t}^{\infty} \beta^t u(c_{it}, l_{it})]$$
$$+\lambda_t[\sum_i c_{it} + k_{it+1} - \sum_i A_{it} F(k_{it}, n_{it}) - g_{it} - (1-\delta)k_{it} + x_{it}]\} \tag{9}$$

Rewrite Lagrangian for SP

$$\mathbb{L} = E_0\{\sum_i \sum_{t=0}^{\infty}[\beta^t(\mu_i + \gamma_{it})u(c_{it}, l_{it}) - \gamma_{it} V_i(k_{it})] + ...\}$$

$$= E_0\{\sum_i \sum_{t=0}^{\infty}[\beta^t(\mu_{it})u(c_{it}, l_{it}) - \gamma_{it} V_i(k_{it})] + ...\}$$

$$\mu_{it+1} = \mu_{it} + \gamma_{it}$$

$$\mu_{i1} = \mu_i \tag{10}$$

So the time-varying planner weight μ_{it} summarises history dependence. Intuition: Planner increases weight of country with binding PC to keep it happy.

First order conditions

- Intratemporal I: $\frac{u_c(c_{ft},1-n_{ft})}{u_c(c_{ht},1-n_{ht})} = \frac{\mu_{ht}+\gamma_{ht}}{\mu_{ft}+\gamma_{ft}}$ - higher weight, higher consumption
- Intratemporal II: $\frac{u_n(c_{it},l_{it})}{u_c(c_{it},l_{it})} = A_{it}F_n(k_{it},n_{it})$
- Intertemporal: $u_c(c_{ft},1-n_{ft})$
  $= E[\beta\frac{\mu_{it+1}+\gamma_{it+1}}{\mu_{it+1}}u_c(c_{ft+1},1-n_{ft+1})A_{it}F_k(k_{it},n_{it}) - \frac{\gamma_{it+1}}{\mu_{it+1}}V_{it+1k}]$

Interpretation

$$u_c(c_{ft}, 1 - n_{ft}) =$$
$$E[\beta \frac{\mu_{it+1}+\gamma_{it+1}}{\mu_{it+1}} u_c(c_{ft+1}, 1 - n_{ft+1}) A_{it} F_k(k_{it}, n_{it}) - \frac{\gamma_{it+1}}{\mu_{it+1}} \frac{dV_{it+1}}{dk}]$$

1. 1st RHS term: $\gamma_{it+1}(s_{t+1}) > 0$ for some s_{t+1} implies higher benefits of consumption next period
2. But 2nd RHS term: $\gamma_{it+1}(s_{t+1}) > 0$ implies higher costs of capital, via incentives to run away
3. Cross-country investment is constrained by incentive to run away with foreign capital.
4. This is binding in HIGH productivity period!

Results

Results

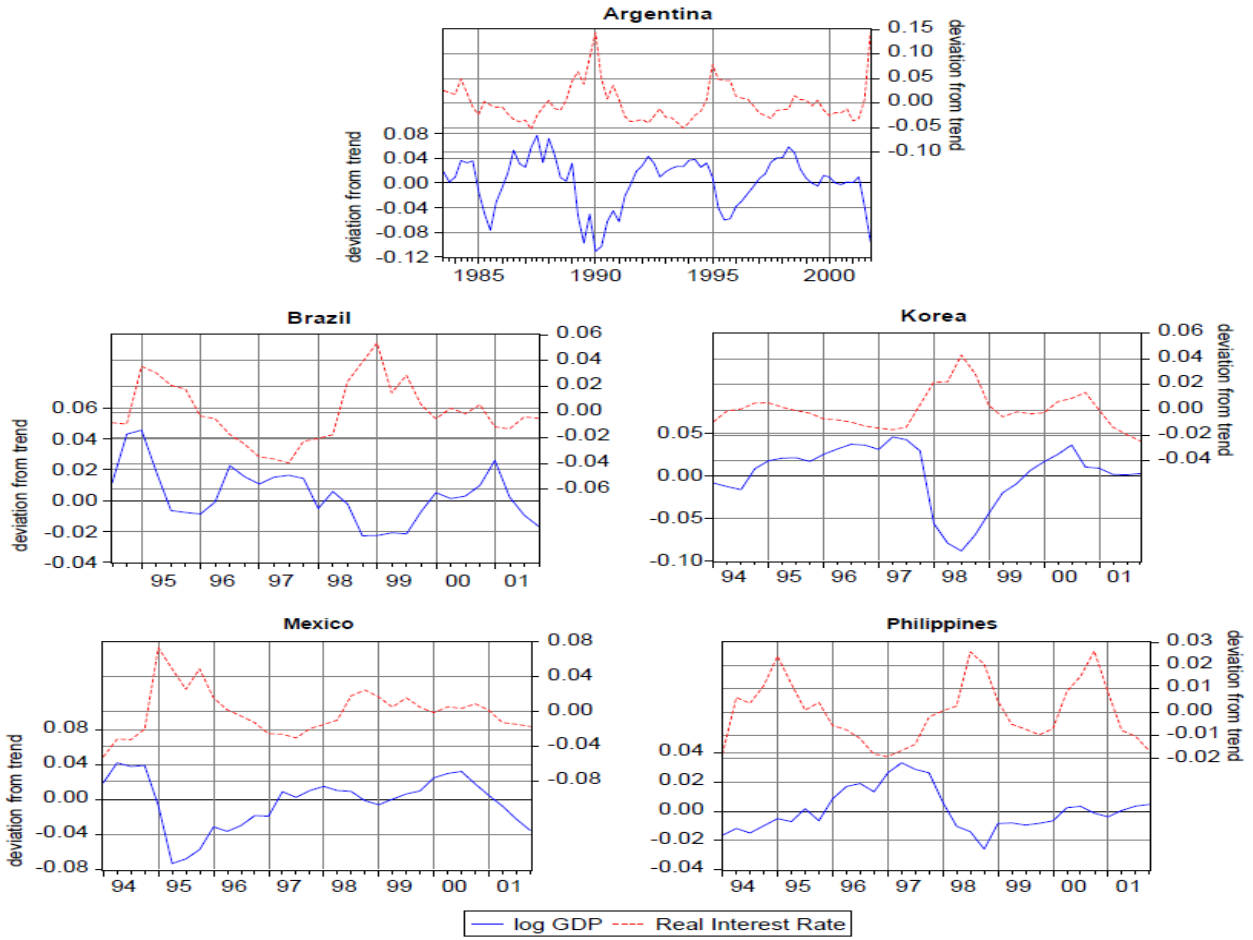
Statistic	Data	Economy with *No Adjustment Costs* Complete Markets	*No Adjustment Costs* Bond	*No Adjustment Costs* Enforcement	*Adjustment Costs* Complete Markets	*Adjustment Costs* Bond
Volatility						
% Standard deviations						
GDP	1.72 (.20)	2.01	1.94	1.33	1.37	1.34
Net Exports/GDP	0.15 (.01)	13.04	12.42	0.06	0.36	0.33
% Standard deviations relative to GDP						
Consumption	0.79 (.05)	0.19	0.21	0.28	0.27	0.29
Investment	3.24 (.17)	25.23	25.06	3.04	3.42	3.24
Employment	0.63 (.04)	0.56	0.54	0.50	0.52	0.49
Domestic Comovement						
Correlations with GDP						
Consumption	0.87 (.03)	0.90	0.93	0.93	0.90	0.94
Investment	0.93 (.02)	0.07	0.08	0.99	0.95	0.95
Employment	0.86 (.03)	0.99	0.99	0.99	0.99	0.99
Net Exports/GDP	–0.36 (.09)	0.06	0.06	0.27	–0.02	–0.05
International Correlations						
Home and Foreign GDP	0.51 (.13)	–0.46	–0.43	0.25	0.09	0.12
Home and Foreign Consumption	0.32 (.17)	0.28	0.13	0.29	0.77	0.62
Home and Foreign Investment	0.29 (.17)	–0.99	–0.99	0.33	–0.17	–0.09
Home and Foreign Employment	0.43 (.11)	–0.58	–0.53	0.23	–0.15	–0.04

Source: Kehoe and Perri (2001)

Roadmap

1. Some facts
2. Endogenously Incomplete Markets: Results from the literature on international and domestic risk-sharing
3. Constrained efficient risk sharing: Kehoe and Perri 2001
4. Risk premia, default and emerging market business cycles
   - Neumeyer and Perri (2005)
   - Arellano 2008

Emerging Market interest rates



Source: Neumeyer and Perri (2005)

Neumeyer and Perri (2005)

"Emerging economies business cycles are more volatile than in developed ones, real interest rates are countercyclical and lead the cycle, consumption is more volatile than output and net exports are strongly countercyclical" (p. 346)

Neumeyer and Perri (2005): Model

1. Small open economy, consumers yield utlity from c, l, CD technology, Labout productivity grows with $(1+\gamma)^t$
2. Consumers invest in bonds subject to quadratic cost of deviations from long-run level $\overline{b}$, and capital subject to adjustment costs, taking as given the country interest rate $R(s_t)$
3. Shocks
   - ... to productivity A_t
   - ... interest rates $R(s_t) = R^{World}(s_t) + R^{country}(s_t)$
   - R^{World} exogenous, $R^{country}$ exogenous but possibly correlated with A_t
   - "Working Capital" amplifies changes in $R(s_t)$: firms have to borrow fraction θ of wage bill, paid before production

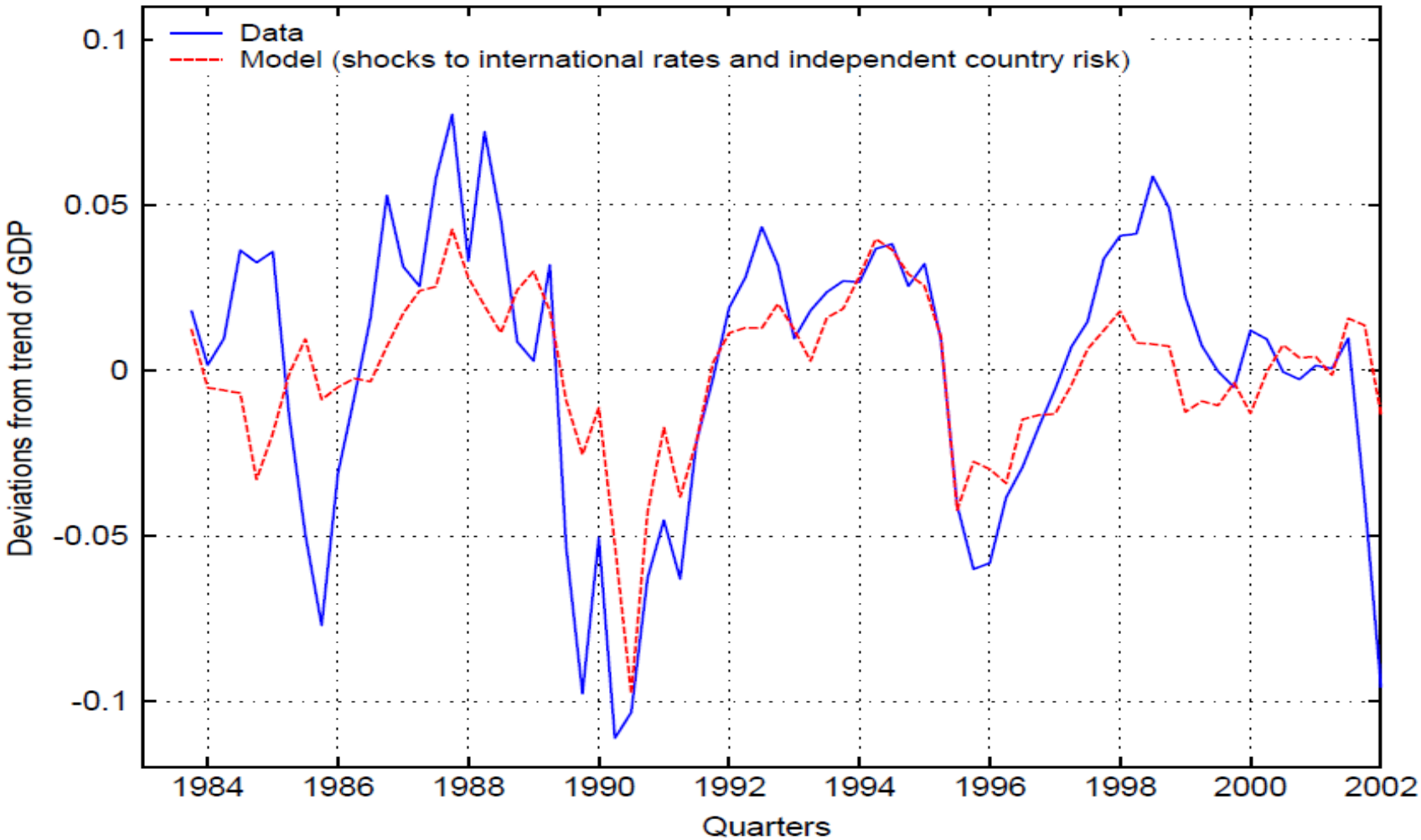
Neumeyer and Perri (2005): Calibration to Argentina

1. Preferences
   - $u(c) = \frac{[c^{\mu} l^{1-\mu}]^{1-\sigma}}{1-\sigma}, \sigma > 0, 0 < \mu < 1$
   - $u(c) = \frac{[c+\psi(1+\gamma)^t l^{\nu}]^{1-\sigma}}{1-\sigma}, \sigma > 0, 0 > \nu, \psi > 0$

     "GHH" preferences (Greenwood et al 1988)
2. ... interest rates $R(s_t) = R^{World}(s_t) + R^{country}(s_t)$
3. $\overline{b}$ chosen to have average debt of 42 percent of GDP

Results

Argentinian business cycles



Sensitivity

Table 4
Sensitivity analysis

	Preferences									
	GHH ($v = 1.2$)		GHH (*Baseline*)		GHH ($v = 4$)		CD ($\sigma = 5$)		CD ($\sigma = 50$)	
	$\frac{\sigma(y)}{\sigma(y_{DATA})}$	Corr(Y,R)	$\frac{\sigma(y)}{\sigma(y_{DATA})}$	Corr(Y,R)	$\frac{\sigma(y)}{\sigma(y_{DATA})}$	Corr(Y,R)	$\frac{\sigma(y)}{\sigma(y_{DATA})}$	Corr(Y,R)	$\frac{\sigma(y)}{\sigma(y_{DATA})}$	Corr(Y,R)
$\theta = 1$	0.89	–0.57	0.55	–0.54	0.22	–0.34	0.97	0.86	0.36	–0.18
$\theta = 1/2$	0.52	–0.44	0.34	–0.38	0.18	–0.16	1.02	0.94	0.26	0.20
$\theta = 0$	0.27	0.16	0.21	0.14	0.15	0.13	1.12	0.97	0.24	0.69

Notes: The capital adjustment cost parameter ϕ is set to 25.5 in all experiments. All remaining parameters are set to their baseline values.

Discussion

1. Successfull in terms of countercyclical real interest rates
2. But:
   - Needs working capital, GHH preferences, exogenous long-run borrowing
   - Interest rates exogenous

Cristina Arellano (2008) Default Risk and Income Fluctuations in Emerging Economies, AER 98 (3)

- Kehoe and Perri: complete markets with option to run away
  1. Implies agents want to run away in good times, when they have to make transfers to others.
  2. And default is never observed in equilibrium.
- Neumeyer and Perri: Only bond trade with exogenous interest rate shocks to mimick "default risk"
- Arellano 2008:
  1. Assume only uncontingent borrowing possible.
  2. But interest rates are endogenous due to default risk premia.
  3. And default does occur in equilibrium.

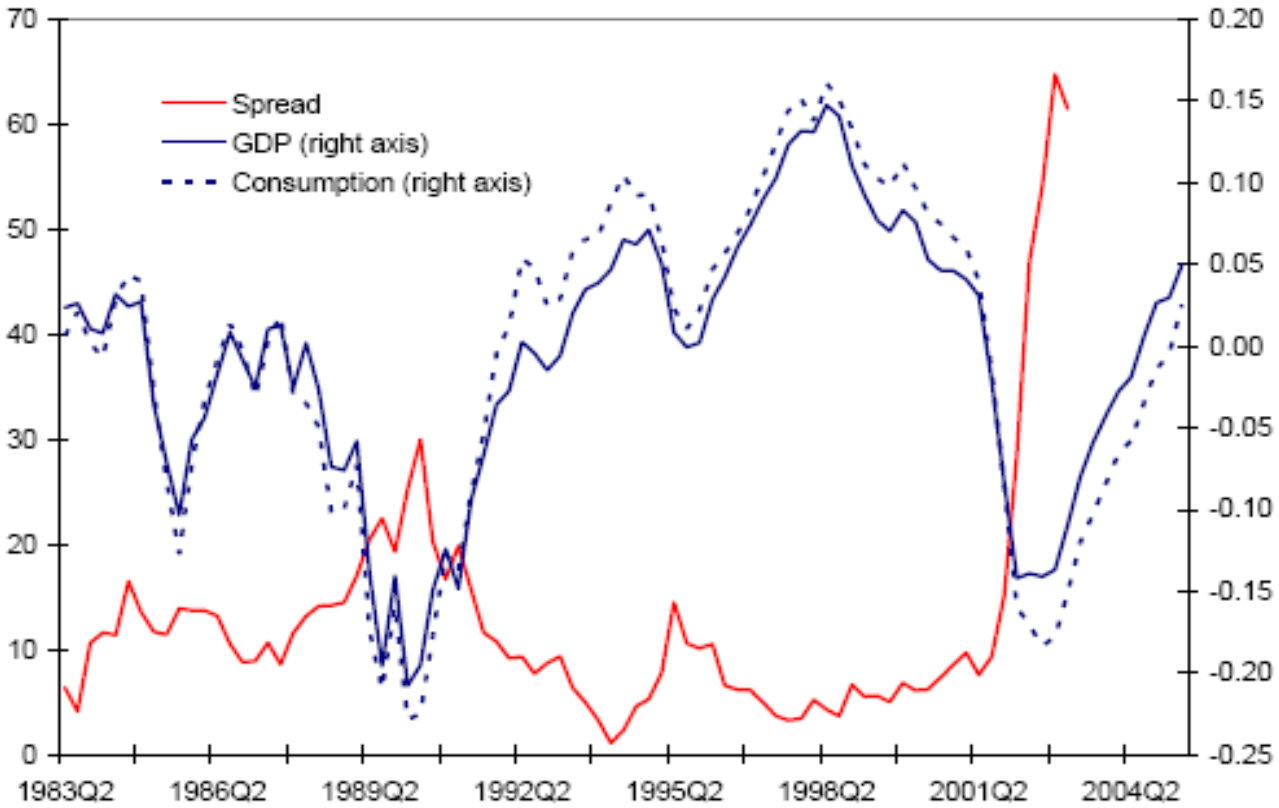
Arellano 2008: Issue

- Emerging Market Sovereign Spreads are volatile, countercyclical, and show spikes in default periods
- Also EM borrowing is procyclical
- Default premia can account for this: incentives to default on non-contingent bonds are high in periods of low output

Contribution and Main results

- Paper accounts for dynamic relationship of output, current account, and sovereign spreads in EEs via time-varying default premia
- "Predicts" Argentinian default in 2002
- Default incentives properly modelled, including equilibrium default
- (Some) Analytical results for special case

Argentina: Interest rate spreads and the business cycle



Argentina: Interest rate spreads and the business cycle

Table 1. Business Cycle Statistics for Argentina

	Default episode			
	x: Q1–2002	$std(x)$	$corr(x,y)$	$corr(x,r^c)$
Interest rates spread	28.60	5.58	-0.88	
Trade balance	9.90	1.75	-0.64	0.70
Consumption	-16.01	8.59	0.98	-0.89
Output	-14.21	7.78		-0.88

Model

- Small open endowment economy, discrete time, single consumption good
- Infinitely lived agents:
  1. Benevolent government
  2. Representative consumer
  3. Risk-neutral foreign lenders
- Uncertainty: country-specific endowment y_t of perishable good follows Markov process described by $f(y', y)$

Consumers

- Do not trade in assets, just consume endowment plus government transfers, yielding utility $\sum_t^\infty \beta^t u(c_t)$

Government

- maximises expected household utility every period through 2 decisions
  1. wether to default
  2. if no default, the amount of Borrowing B' at price $q(B', y)$
- Budget constraints

  No default: $c = y + B - q(B', y)B'$

  Default: $c = y^{def} = h(y)$, $h() \leq y$
- 2 costs of government default
  1. direct output cost of default if $h(y) < y$
  2. exclusion from financial markets: only allowed to reenter with probability θ

Foreign lenders

- risk-neutral
- maximise expected profits from lending with opportunity cost r and probability of default δ

  $\phi = qB' - \frac{1-\delta}{1+r}B'$

Government problem

- Recursive, with 3 value functions
  1. before default decision $v^0(B, y)$
  2. under default $v^d(y)$, and
  3. with a continued contract $v^c(B, y)$
- Optimal decisions $\{c, d, B'\}$ satisfy
  1. $v^0(B, y) = max_{c,d}\{v^c(B, y), v^d(y)\}$
  2. $v^d(y) = u(y^{def}) + \beta \int_{y'} [\theta v^0(0, y) + (1 - \theta) v^d(y)] f(y', y) dy'$
  3. $v^c(B, y) =$
     $max_{B'}\{u(y + B - q(B', y)B') + \beta \int_{y'} v^0(B', y) f(y', y) dy'\}$

Government problem: Default sets

- Define sets of endowments for which, given B, default and repayment is optimal as

$$D(B) = \{y \in Y : v^d(B, y) > v^c(B, y)\}$$

$$A(B) = D^c(B) = \{y \in Y : v^c(B, y) > v^d(B, y)\}$$

Recursive equilibrium

Given a state (B,y) a RE consists of

- a policy function for consumers
- a bond price function $q(B', y)$
- a policy function for the government
- a set of default ($D(B)$) and repayment states ($A(B)$)

  such that

- consumers consume their available resources
- $q(B', y)$ reflects zero expected profits and default probabilities $q(B', y) = \frac{1-\delta(B',y)}{1+r}$
- B'(B,y), A(B), and D(B) solve the government's problem

Characterisation of equilibrium

Special case: iid shocks, $h = y$, $\theta = 0$

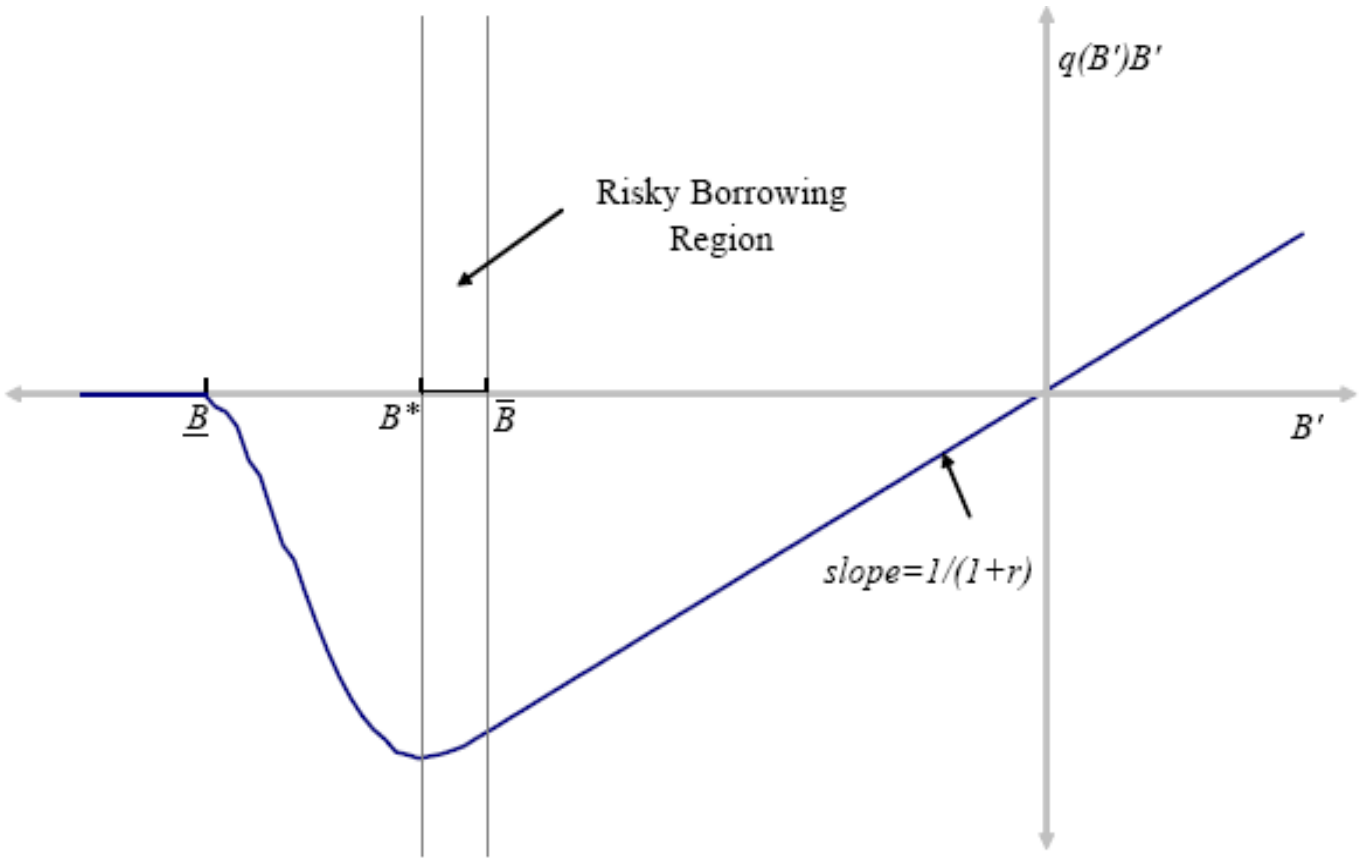
Proposition III: Default incentives decrease with income

- Default incentives are decreasing in y.
  I.e. for $y_1 < y_2$ if $y_2 \in D(B)$ then $y_1 \in D(B)$.
- Intuition: Continuation value is independent of y. Marginal utility is decreasing and the contract requires (weakly) positive net payments. So the loss in current utility from honouring the contract rather than defaulting is higher for lower y.

Proposition III: Implications

- Default incentives are decreasing in y, so:
  - Default sets are closed intervals, where only the upper bound depends on B: $D(B) = [\underline{y}, y^\star(B)))$
  - $y^\star(B)$ defined by indifference condition $v^d(y^\star(B)) = v^c(B, y^\star(B))$
  - Bond prices given by $q(B') = \frac{1-F(y^\star(B'))}{1+r}$, independent of y
  - Laffer curve of the value of bond issuance $q(B')B' = \frac{1-F(y^\star(B')}{1+r}B'$ with maximum at $B^\star$ (Borrowing limit)

Laffer curve of the value of bond issuance



iid case: Evaluation

- Delivers observed negative correlation between interest rates and output.
- But
  - $cor(q, y) > 0$ only via $cor(B', y) < 0$, no direct effect of shocks.
  - Effect not strong enough to get pro-cyclical imports: with iid shocks recessions are strongly transitory, so come with net imports / current account deficits
  - Partly because of "small" region of risky borrowing: cost of default is volatility of consumption, which has low associated utility costs (Lucas 1987). So exclusion threat alone does not sustain high level of borrowing.

General case

- Persistent shocks: y follows AR (1) process with high persistence to limit borrowing in recessions
- Output loss from default:
  $h(y) = y$ for $y < \widehat{y}$
  $h(y) = \widehat{y}$ for $y > \widehat{y}$
- Non-permanent exclusion from borrowing: $\theta > 0$

General case: Calibration

Chosen to match features of Argentinian business cycle and default probability

Table 3. Parameters

Risk free interest rate	$r = 1.7\%$	U.S. 5 year bond quarterly yield
Risk aversion	$\sigma = 2$	
Stochastic structure	$\rho = 0.945$, $\eta = 0.025$	Argentina's GDP
Calibration		
	Values	Target Statistics
Discount factor	$\beta = 0.953$	3% default probability
Probability of re-entry	$\theta = 0.282$	Trade balance volatility 1.75
Output costs	$\widehat{y} = 0.969E(y)$	5.53% debt service to GDP

Argentina: Interest rate spreads and the business cycle

Table 1. Business Cycle Statistics for Argentina

	Default episode			
	x: Q1–2002	$std(x)$	$corr(x,y)$	$corr(x,r^c)$
Interest rates spread	28.60	5.58	-0.88	
Trade balance	9.90	1.75	-0.64	0.70
Consumption	-16.01	8.59	0.98	-0.89
Output	-14.21	7.78		-0.88

Simulation Results

Table 4.

Business Cycle Statistics in the Benchmark Model

	Default Episodes	$std(x)$	$corr(x, y)$	$corr(x, r^c)$
Interest rates spread	24.32	6.36	-0.29	
Trade balance	-0.01	1.50	-0.25	0.43
Consumption	-9.47	6.38	0.97	-0.36
Output	-9.60	5.81		-0.29
Other Statistics				
Mean Debt (% output)	5.95	Mean Spread		3.58
Default Probability	3.00	Output Deviation in Default		-8.13

- Model matches countercyclical interest rate spreads and current account, also higher volatility of consumption
- But: doesn't match mean debt or mean spread

Discussion

- Model of default in emerging economies that matches Argentinian experience, including its default
- Driven entirely by domestic real shocks
- Investors are passive, no external shocks, no money, no exchange rate

Summary

- CM require perfect information and perfect enforcement.
- Cole and Kocherlakota (2001): With asymmetric information about productivity and storage, countries cannot share risk!
- Bulow and Rogoff (1989): With option to default and save, countries cannot borrow!
- So borrowing relies on exogenous penalties or inferior contract terms after default - default becomes optimal decision.
- Kehoe and Perri (2001): Outside option of default into autarky dampens cross-country investments, helps comovement puzzle.
- Neumeyer et al (2005): R shocks can reproduce EM cycles.
- Arellano (2008): Since low output makes default more likely with uncontingent debt, can explain procyclical interest rates.

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