International Macroeconomics Lecture III

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Current Accounts and Debt

- Countries can borrow to:
  - Purchase Consumption Goods
  - Purchase Investment Goods
  - Pay off Debt (the value of which can be effected by the exchange rate)

- Default occurs when payments are not made on time and are not rescheduled in advance

Finance

- One type of financing of consumption:
  - Debt
- Two types of financing of investment:
  - Equity
  - Debt
- Two types of debt:
  - Sovereign
  - Private

Debt

- Debt can be issued through:
  - Banks (loans)
  - Markets (Bonds)
    - Note: bonds are usually underwritten by investment banks
- Debt can be issued:
  - Abroad
    - In home currency (developed countries)
    - In foreign currency (developing countries)
  - Domestically

History of Debt Crises

- 1982 Debt Crisis
  - Borrowing of petrodollars in 1970s
    - Project lending to governments via World Bank
    - Private lending to businesses
  - High interest rates in early 1980s
    - Short-term debt: rollover
    - Floating-Rate Debt

- More recent debt crises
  - Borrowing in foreign currency (‘original sin’)
  - Devaluation or depreciation raises costs of debt

Capital Flows I

- Lucas, May 1990 AER, “Why Doesn’t Capital Flow from Rich to Poor Countries?”
  - Intertemporal model of current account says developing countries should borrow to invest now (run current account deficits now) and pay back later (run future current account surpluses)
- Reality: Africa is a net exporter of capital
  - Why?

Capital Flows II

- Usual Answer: Risk
  - Political
  - Default
  - Expropriation
  - Market Instability
- Other answers:
  - Trade in goods equates returns to capital across countries (Heckscher-Ohlin)

Evidence from Reinhart-Rogoff

- Serial Default and the “Paradox” of Rich-to-Poor Capital Flows (May, 2004, AER)
- Debt Intolerance – Reinhart, Rogoff and Savastano
- One consideration: Market failures to rollover can cause default (or large rises in future expected interest rates can cause self-fulfilling default)

Table 1.2. Emerging Market and Developing Countries: Net Capital Flows[1]

(Billions of U.S. dollars)

	1994-96	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Total											
Private capital flows, net[2]	156.4	191.7	76.2	86.0	74.3	66.2	68.2	158.2	232.0	132.9	53.8
Private direct investment, net	98.5	146.2	158.6	173.2	167.0	178.6	142.7	153.4	189.1	209.2	206.1
Private portfolio flows, net	65.0	60.8	42.6	69.5	21.0	-83.6	-87.6	-7.3	64.0	-28.6	-19.0
Other private capital flows, net	-7.0	-15.3	-125.0	-156.7	-113.7	-28.8	13.0	12.1	-21.1	-47.7	-133.3
Official flows, net	15.2	28.4	56.0	18.3	-52.1	-0.6	10.6	-61.7	-81.0	-137.1	-139.3
Change in reserves[3]	-97.3	-105.2	-34.8	-93.4	-113.2	-115.9	-185.7	-364.6	-517.4	-510.5	-506.8
Memorandum											
Current account[4]	-88.7	-82.6	-51.6	38.9	127.2	91.5	143.8	229.1	319.4	490.2	570.9
Africa											
Private capital flows, net[2]	2.0	7.9	7.9	10.1	-1.0	7.4	3.4	10.7	14.2	22.7	18.3
Private direct investment, net	2.3	7.7	6.6	9.4	8.0	22.3	14.7	14.6	13.9	19.5	17.8
Private portfolio flows, net	3.6	7.4	4.3	9.1	-1.8	-7.6	-0.9	0.1	6.3	5.5	6.3
Other private capital flows, net	-3.8	-7.3	-3.0	-8.4	-7.3	-7.2	-10.4	-4.1	-6.0	-2.2	-5.8
Official flows, net	2.8	-4.4	2.6	1.8	0.2	-1.9	1.8	2.8	--	-8.7	1.7
Change in reserves[3]	-4.7	-11.3	1.7	-2.8	-12.7	-12.4	-8.1	-19.4	-35.5	-38.6	-61.0
Central and eastern Europe											
Private capital flows, net[2]	12.3	20.2	27.3	36.7	39.0	11.8	55.8	48.1	58.0	72.3	58.6
Private direct investment, net	9.3	11.6	19.2	22.6	23.9	23.9	25.2	14.9	23.8	32.5	30.3
Private portfolio flows, net	4.0	5.4	-1.3	5.7	3.1	0.5	1.7	7.5	28.3	24.1	22.0
Other private capital flows, net	-1.0	3.2	9.4	8.4	12.0	-12.7	28.8	25.8	5.9	15.7	6.3
Official flows, net	0.4	-3.3	0.3	-2.6	1.6	5.6	-7.6	-5.4	-5.7	-5.7	-2.8
Change in reserves[3]	-14.2	-10.7	-9.5	-11.3	-2.8	7.4	-11.6	-11.7	-14.8	-17.0	-2.3
Commonwealth of Independent States[5]											
Private capital flows, net[2]	-0.8	19.9	6.4	-6.4	-12.9	-1.9	-9.5	16.5	9.4	-10.3	0.4
Private direct investment, net	3.2	5.9	5.3	4.2	2.4	4.6	4.0	5.3	13.4	8.6	8.5
Private portfolio flows, net	-7.7	17.6	7.7	-3.1	-6.1	-9.2	-8.2	-4.8	4.1	-16.2	-1.1
Other private capital flows, net	3.7	-3.6	-6.7	-7.5	-9.2	2.7	-5.3	16.0	-8.1	-2.6	-7.0
Official flows, net	9.2	8.7	10.0	0.1	-4.3	-4.5	-1.7	-5.1	-4.6	-5.2	-2.9
Change in reserves[3]	-3.2	-4.3	7.5	-2.7	-17.2	-11.3	-11.7	-33.8	-54.8	-80.7	-112.2
Emerging Asia[6]											
Private capital flows, net[2,7]	92.7	36.6	-49.9	11.8	7.5	14.7	21.0	62.0	132.9	84.6	34.1
Private direct investment, net	50.6	55.7	56.6	67.1	59.8	48.6	47.5	67.1	81.6	84.2	83.8
Private portfolio flows, net	25.3	6.8	8.7	55.8	20.1	-54.7	-60.2	4.9	25.8	-3.3	-1.4
Other private capital flows, net[7]	16.8	-26.0	-115.2	-111.1	-72.4	20.7	33.7	-10.0	25.4	3.8	-48.2
Official flows, net	-3.3	22.7	15.4	-0.3	-11.7	-11.3	5.2	-16.6	5.8	13.1	16.2
Change in reserves[3]	-48.7	-36.0	-52.9	-87.5	-52.5	-90.9	-149.9	-227.8	-342.7	-291.6	-234.9
Middle East[8]											
Private capital flows, net[2]	4.2	7.4	13.7	-4.7	1.2	7.2	-2.8	2.4	7.5	-51.7	-66.2
Private direct investment, net	4.0	7.6	9.6	4.1	3.4	7.7	7.4	15.3	9.7	18.4	18.9
Private portfolio flows, net	-1.3	-6.8	-2.3	0.7	3.3	-3.5	-5.1	-5.9	9.7	-40.3	-48.7
Other private capital flows, net	1.5	6.6	6.5	-9.4	-5.4	2.9	-5.2	-7.0	-11.9	-29.8	-36.4
Official flows, net	4.7	-0.8	10.4	13.7	-30.7	-15.5	-7.6	-44.7	-71.1	-121.5	-141.8
Change in reserves[3]	-9.6	-16.5	8.8	-1.0	-29.5	-11.6	-3.3	-34.4	-45.9	-54.5	-76.5
Western Hemisphere											
Private capital flows, net[2]	46.1	99.7	70.8	38.5	40.5	27.0	0.4	18.5	9.9	15.2	8.5
Private direct investment, net	29.2	57.6	61.3	65.8	69.4	71.3	43.9	36.1	46.6	46.1	46.7
Private portfolio flows, net	41.1	30.3	25.6	1.3	2.4	-9.1	-14.9	-9.0	-10.3	1.7	4.0
Other private capital flows, net	-24.2	11.7	-16.1	-28.6	-31.3	-35.3	-28.7	-8.5	-26.4	-32.5	-42.2
Official flows, net	1.4	5.5	17.2	5.6	-7.2	27.0	20.6	7.3	-5.4	-9.1	-9.7
Change in reserves[3]	-16.9	-26.5	9.6	11.9	1.5	2.9	-1.0	-37.5	-23.7	-28.1	-19.8
Memorandum											
Fuel exporters											
Private capital flows, net[2]	-13.6	27.4	17.2	-22.3	-36.6	-9.7	-20.1	11.9	3.9	-76.6	-91.5
Nonfuel exporters											
Private capital flows, net[2]	170.0	164.3	59.1	108.3	110.9	75.8	88.3	146.4	228.1	209.5	145.3

[1]Net capital flows comprise net direct investment, net portfolio investment, and other long- and short-term net investment flows, including official and private borrowing. In this table, Hong Kong SAR, Israel, Korea, Singapore, and Taiwan Province of China are included.

[2]Because of data limitations, "other private capital flows, net" may include some official flows.

[3]A minus sign indicates an increase.

[4]The sum of the current account balance, net private capital flows, net official flows, and the change in reserves equals, with the opposite sign, the sum of the capital account and errors and omissions. For regional current account balances, see Table 25 of the Statistical Appendix.

[5]Historical data have been revised, reflecting cumulative data revisions for Russia and the resolution of a number of data interpretation issues.

[6]Consists of developing Asia and the newly industrialized Asian economies.

[7]Excluding the effects of the recapitalization of two large commercial banks in China with foreign reserves of the Bank of China (US$45 billion), net private capital flows to emerging Asia in 2003 were US$107.0 billion while other private capital flows net to the region amounted to US$35.0 billion.

[8]Includes Israel.

Enforcement of Debt

- Domestically: law

- Internationally:
  - "Gun boat diplomacy"
    - War
    - Trade Sanctions
  - Reputation (future exclusion from capital markets)

Bulow-Rogoff I

- Huge impact on literature: Essential message is that reputation alone can not sustain borrowing
- Earlier paper (Eaton and Gersovitz, 1981 – RESTUD) was the first to distinguish between willingness and ability to pay
- Argument: When a country receives the maximum it can borrow, it will never, on net, get more money. Therefore, any future borrowing from the bank can be achieved by the country defaulting and "lending to itself" with the defaulted-upon money.

Bulow-Rogoff II

- Country production at time t is given by:

$$Y_t = f\left(\vec{\theta}_t, \vec{I}_{t-1}\right)$$

- where θ_t is a serially independent shock to income and I_{t-1} is investment the period before period t

- Each period, income gets allocated between Investment, Consumption, and Net Exports. Total market value of the wealth if the individual is:

$$W_t\left(\vec{\theta}_t\right) = E_t \sum_{s=t}^{\infty} \frac{Y_s}{\left(1+r\right)^{s-t}}$$

Bulow-Rogoff III: Borrowing

- The discounted value of debt is the expected state-contingent repayment schedule:

$$D_t\left(\vec{\theta}_t\right) = E_t\left(\sum_{s=t}^{\infty} \frac{P_s}{(1+r)^{s-t}}\right)$$

- So, there must exist some fraction of total expected wealth, k´ such that

$$D_t\left(\vec{\theta}_t\right) \leq k', k' \in [0,1] \forall \vec{\theta}_t$$

- Denote by k the minimum of such k´

Bulow-Rogoff IV: Consumption Insurance

- Suppose the country can purchase insurance, G, with its assets, A (which must be at least zero), that gives the insurer a rate of return r:

$$E_t\left[G_{t+1}\left(\vec{\theta}_{t+1}\right)\right] = (1+r)A_t,\ \mathrm{G}_{t+1}\left(\vec{\theta}_{t+1}\right) \geq 0\ \forall \vec{\theta}_{t+1}$$

- We can now show that in any sequential equilibrium,

$$D_t\left(\vec{\theta}_t\right) \leq 0\ \forall t$$

Bulow-Rogoff V: Consumption Insurance

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- We can now show that in any sequential equilibrium,

$$D_t\left(\vec{\theta}_t\right)\leq 0\ \forall t$$

Bulow-Rogoff VI

- Suppose $D_s \geq k(W_s - y_s)$

- Then the borrower can have higher consumption in every period by setting savings slightly less than debt payments:

$$A_s\left(\vec{\theta}_s\right) = P_s\left(\vec{\theta}_s\right) + k\left(W_s - Y_s\right) - D_s$$

- And in every period afterwards:

$$A_t\left(\vec{\theta}_t\right) = G_t\left(\vec{\theta}_t\right) + P_t\left(\vec{\theta}_t\right) - ky_t$$

Bulow-Rogoff VII

- And the asset pays off:

$$G_t\left(\vec{\theta}_t\right) = kW_t\left(\vec{\theta}_t\right) - D_t\left(\vec{\theta}_t\right)$$

- We have to show two main things: (1.) That this leads to higher consumption in every period t and (2.) That this gives the expected return to investors equal to (1+r):

$$A_t\left(\vec{\theta}_t\right) = kW_t\left(\vec{\theta}_t\right) - D\left(\vec{\theta}_t\right) + P_t\left(\vec{\theta}_t\right) - ky_t = k\left[W_t\left(\vec{\theta}_t\right) - y_t\right] - D\left(\vec{\theta}_t\right) + P_t\left(\vec{\theta}_t\right)$$

- Since the first part of this is negative, the borrower consumes more than if she just paid off her debt

Bulow-Rogoff VIII

- Also note that consumption insurance payoffs are positive:

$$G_t\left(\vec{\theta}_t\right) = kW_t\left(\vec{\theta}_t\right) - D_t\left(\vec{\theta}_t\right) \geq 0$$

- Now, it remains to show that the rate of return to the provider of insurance is r

$$W_{t+1} = (1+r)\left(W_t - y_t\right)$$

$$E_t D_{t+1} = (1+r)\left(D_t - P_t\right)$$

$$A_t\left(\vec{\theta}_t\right) = k\left[W_t\left(\vec{\theta}_t\right) - y_t\right] - D\left(\vec{\theta}_t\right) + P_t\left(\vec{\theta}_t\right) = \frac{kE_t W_{t+1}}{1+r} - \frac{E_t D_{t+1}}{1+r} = \frac{E_t G_{t+1}}{1+r}$$

$$\Rightarrow (1+r)A_t\left(\vec{\theta}_t\right) = E_t G_{t+1}$$

Bulow-Rogoff IX

- So, the borrower will have to pay:

$$A_s \leq P_s, \mathrm{P_t} - ky_t \leq P_t$$

- And thus consumes more in every period as long as k>0

- Note that if the lender can borrow up to Π_t if the lender can apply sanctions every period after a default equal to:

$$\Pi_t = E_t \sum_{s=t}^{\infty} \frac{\pi_s}{(1+r)^{s-t}}$$

Bulow-Rogoff X

- Assumptions:
  - Reputation loss from default does not effect trade credit, private market borrowing or anything else potentially affecting government welfare
  - No collusion in credit and consumption insurance markets; also, no market power (Kletzer, AER 2000)
  - No value to government of paying debt inherently
  - States are non-contractible (either due to observability or enforceability)

Bulow-Rogoff XI

- Kletzer, AER 2000: Assume bilateral consumption sharing; no outside markets. Neither side can commit to providing consumption insurance to the other. Then borrowing becomes sustainable.

- Amador, 2005 (unpublished): Assume government changes power and only consumes when in power. Then, it is difficult for the government to commit to saving (whatever it leaves over will be consumed by its predecessor). Also, assume that the government is run by parties who are long-lived rather than politicians. Then there is a value to being able to borrow in the future (i.e. when they get into power again). The combination of the inability to save and the desire to be able to borrow leads to sustainability of debt.

Comments on Debt

- Debt Laffer Curve
  - Krugman, “Market Based Debt-Reduction Schemes” argues that by forgiving debt, you can raise probability of paying back and thus secondary-market value of debt.

  - Bulow and Rogoff, “Cleaning Up Sovereign Debt Without Getting Taken To the Cleaners” argues that sovereign debt buybacks are not helpful because when the sovereign buys back, it raises the lowers the probability of default, raising the value of the remaining debt stock and potentially not decreasing the total market value of outstanding debt.

Questions About Debt

- Why is sovereign default only restricted to developing countries?
- Why do developing countries default at much lower levels of debt than developed countries?
- Why do private firms default when governments do?
- Why is developed country debt sold to foreigners denominated in foreign currency?
- Why are sovereign debt ratings always above private debt ratings?
- Why is sovereign default followed by a worsening of any economic and currency crisis?

Exchange Rates

- A nominal exchange rate is the price of foreign currency.
  - US dollar exchange rate for Sweden = 7.77 (i.e. price of one Dollar in Krona)
  - Swedish exchange rate for the US is 0.13 (i.e. price of 1 Krona in Dollars)
  - Home country exchange rate is the price of one unit of foreign currency; since the price of a unit of domestic currency is one (in domestic currency), the exchange rate can be seen as the price of foreign currency divided by the price of domestic currency.

- A real exchange rate is the price of a foreign good in terms of a domestic good. For example, if a McDonalds Hamburger costs 30 krona, and a US Hamburger costs 2 dollars and the exchange rate is 7.5 Krona to the dollar, then the price of the US Hamburger in Krona is 15 so that the price of the foreign (US) hamburger to the domestic (Swedish) Hamburger is ½.

Purchasing Power Parity

- Initially, economists thought that the real exchange rate should equal one. If the real exchange rate was greater than one, foreigners would buy domestic goods; if the real exchange rate was less than one, domestic consumers would buy the foreign good.

- This can be summed up as purchasing power parity:

$$P = \varepsilon P^{*} \quad \text{(i.e. } 15 = 7.5 * 2)$$

- In log terms, this reduces to:

$$p = e + p^{*}$$

- Empirically, purchasing power parity does not hold. Why not?

Covered and Uncovered Interest Parity I

- If I invest in a Kronor-denominated risk-free bond, I get a return 1+r(k) krona after one year. On the other hand, I could buy 1/e dollars with the money, invest it in a dollar denominated bond which matures in one year and buy a forward contract for delivery of Swedish Kronor equal to the amount I can buy with my matured dollar bond. The return to these two transactions must be equal. Otherwise, I could sell future krona bonds and buy dollar ones or vice versa and make an infinite profit. This relationship is called covered interest parity:

$$1+i=\frac{f}{e}\left(1+i^{*}\right) \qquad \text{Logs: } i=f-e+i^{*}$$

- Note: futures are in a market, forwards are between two individuals – the one year dollar/kronor exchange is probably not liquid enough to have a market)

Covered and Uncovered Interest Parity II

- Does covered interest parity hold?
  - For major currency pairs, yes.
  - With developing countries, not necessarily.
  - Why?

- There is an analog if you replace the future rate with the expected spot rate. This is called uncovered interest parity (your foreign transaction is not covered). This is strongly rejected by the data:

$$1+i=E_t\frac{e_{t+1}}{e_t}\left(1+i^*\right) \qquad \text{Logs}:\ i_t=E_t e_{t+1}-e_t+i_t^*$$

Siegel's Paradox

- One interesting note: $\frac{1}{X}$ is a convex function; this implies that:

$$E_t\left(\frac{1}{\varepsilon_{t+1}}\right) > \frac{1}{E_t\varepsilon_{t+1}}$$

- But if the forward rate is equal to the expected future spot rate:

$$\frac{1}{F_t} = E_t\left(\frac{1}{\varepsilon_{t+1}}\right) > \frac{1}{E_t\varepsilon_{t+1}}$$

- And if the same is true for the foreign country, then: $F_t = E_t(\varepsilon_{t+1})$

Forward Premium Bias I

- With a CARA-normal setup (constant absolute risk aversion with normally distributed shocks to the interest rate), we can derive uncovered interest parity as an equilibrium relationship:

$$i_t = E_t e_{t+1} - e_t + i_t^*$$

- Under rational expectations, beliefs about future exchange rates should on average be correct so we can run the following regression:

$$e_{t+1} - e_t = \alpha + \beta\left(i_t - i_t^*\right) + \mu_t$$

Forward Premium Bias II

- Alternatively, substituting with the forward rate from covered interest parity, we get:

$$e_{t+1} - e_t = \alpha + \beta\left(f_t - e_t\right) + \mu_t$$

- According to theory, the coefficient on beta should be 1. The forward premium (the premium of the forward over the spot) should predict the future exchange rate change. In other words, the forward should be an unbiased predictor of the future spot rate. Intuitively, if the foreign interest rate is 3% higher, then the domestic currency should be expected to appreciate by 3%. What is the evidence?
  - Surprisingly, beta is always less than 1 and usually less than 0.
  - This suggest that a country with a high interest rate is likely to experience currency appreciation!

Traditional Monetary Model of the Exchange Rate I

- Real Money Demand: demand for real money balances is increasing in income and decreasing in the opportunity cost of holding money in non-interest bearing accounts (all in logs):

$$m_t - p_t = -\eta i_t + \phi y_t$$

- We add purchasing power parity:

$$p_t = e_t + p_t^*$$

- And uncovered interest parity:

$$i_t = E_t e_{t+1} - e_t + i_t^*$$

Traditional Monetary Model of the Exchange Rate II

- Plug uncovered interest parity and purchasing power parity into money demand and rearrange:

$$m_t - \phi y_t - p_t^* + \eta i_t^* - e_t = -\eta\left(E_t e_{t+1} - e_t\right)$$

- Solving for the exchange rate:

$$m_t - \phi y_t - p_t^* + \eta i_t^* + \eta E_t e_{t+1} = e_t(1+\eta)$$

- Recursively substituting, we get:

$$\frac{1}{1+\eta}\sum_{s=t}^{\infty} \mathrm{E_t}\left[m_s - \phi y_s - p_s^* + \eta i_s^*\right]\left(\frac{\eta}{1+\eta}\right)^{s-t} + \lim_{s\to\infty}\left(\frac{\eta}{1+\eta}\right)^{s-t} E_t e_{s+1} = e_t$$

Traditional Monetary Model of the Exchange Rate III

- Ruling out speculative bubbles (transversality), we get that the exchange rate is like an asset depending upon the net present discounted value of future ‘fundamentals’:

$$\frac{1}{1+\eta}\sum_{s=t}^{\infty}\mathrm{E}_{\mathrm{t}}\left[m_s - \phi y_s - p_s^{\ *} + \eta i_s^*\right]\left(\frac{\eta}{1+\eta}\right)^{s-t} = e_t$$

- Now, for simplicity, assume that output, the foreign price level and the foreign interest rate are all equal to zero:

$$\frac{1}{1+\eta}\sum_{s=t}^{\infty}\mathrm{E}_{\mathrm{t}} m_s\left(\frac{\eta}{1+\eta}\right)^{s-t} = e_t$$

- And suppose that money follows a process which is integrated of order one: $m_{t+1} - m_t = \rho(m_t - m_{t-1}) + \mu_t$

Traditional Monetary Model of the Exchange Rate IV

- We can now subtract the recursive equation at date t from the date t expected recursive equation at date t+1 to get:

$$E_t e_{t+1} - e_t = \frac{1}{1+\eta} \sum_{s=t}^{\infty} \left(\frac{\eta}{1+\eta} \right)^{s-t} E_t \left[m_{s+1} - m_s \right]$$

- Substituting in with the monetary dynamics equation:

$$E_t e_{t+1} - e_t = \frac{1}{1+\eta} \sum_{s=t}^{\infty} \left(\frac{\eta\rho}{1+\eta} \right)^{s-t} \rho \left[m_t - m_{t-1} \right]$$

- Reexpressing the geometric sequence, we get that:

$$E_t e_{t+1} - e_t = \frac{\rho}{1+\eta-\eta\rho} \left[m_t - m_{t-1} \right]$$

Traditional Monetary Model of the Exchange Rate V

- Now, going back to our original money demand equation (augmented with uncovered interest parity and purchasing power parity):

$$m_t - e_t = -\eta\left(E_t e_{t+1} - e_t\right) \Rightarrow e_t = m_t + \eta\left(E_t e_{t+1} - e_t\right)$$

- Thus, we finally get:

$$e_t = m_t + \frac{\rho}{1+\eta-\eta\rho}\left[m_t - m_{t-1}\right]$$

- This says that the exchange rate (the price of foreign currency) goes up (or depreciates) if money growth is large; in other words that inflation should cause the exchange rate to depreciate. Is this true empirically?

Mundell-Fleming I: Setup

- In ISLM, we had:

$$E = C(Y - T) + I(i - \pi^e) + G - T$$

- To this, we now add net exports, which is a function of the exchange rate:

$$E = C(Y - T) + I(i - \pi^e) + G - T + NX(\frac{\varepsilon P^*}{P})$$

- Where NX is assumed (Marshall Lerner condition) increasing in the real exchange rate:

$$\frac{\varepsilon P^*}{P}$$

Mundell-Fleming II: Setup

- Note that P is the domestic price level, $P*$ the foreign price level, and ε the nominal exchange rate (i.e. the price of foreign currency expressed in domestic currency).

- Now we look at the nominal side of the economy:

$$\frac{M}{P}^{D} = L(i, Y)$$

- We also assume static expectations and perfect capital mobility which in this context means that: $i = i^{*}$

Mundell-Fleming III: Floating Exchange Rate

- Static expectations means that future expectations equal the current state.

- So, with a floating exchange rate, we end up with two equations:

$$Y = E(Y, i^{*} - \pi^{e}, G, T, \frac{\varepsilon P^{*}}{P})$$

$$\frac{M}{P} = L\left(i^{*}, Y\right)$$

- Notice that the LM* curve is vertical and the IS* (both graphed in exchange rate versus output space) curve is upward sloping.

Mundell-Fleming IV: Floating Exchange Rate

- Monetary expansion with a flexible exchange rate:
  - Money supply increases
  - Temporary fall in domestic interest rate
  - Capital outflow
  - Fall in demand for domestic currency
  - Depreciation
  - Output expansion

- Fiscal expansion with a flexible exchange rate:
  - Government expenditures increase
  - Temporary rise in domestic interest rate
  - Capital inflow
  - Increase in demand for domestic currency
  - Appreciation
  - Greater domestic demand but lower net exports offset each other

Mundell Fleming V: Floating Exchange Rate

- Why is the fiscal expansion exactly offset by appreciation and decline in net exports?
  - Suppose not… then for a given M and P, Y would be higher
  - Then in order for money demand to equal money supply, the domestic interest rate would have to be higher which goes against the assumption of perfect capital mobility.

Mundell Fleming VI: Fixed Exchange Rates

- Two changes need to be made for the model of fixed exchange rates:

- (1.) $\varepsilon = \bar{\varepsilon}$

- (2.) M is now endogenous in order to make sure that the exchange remains fixed (it is bought and sold by the central bank to retain the exchange rate target).

Mundell-Fleming VII: Fixed Exchange Rate

- So, with a fixed exchange rate, we end up with three equations:

$$Y = E(Y, i^* - \pi^e, G, T, \frac{\varepsilon P*}{P})$$

$$\frac{M}{P} = L(i^*, Y)$$

$$\varepsilon = \overline{\varepsilon}$$

- Now the LM* curve is replaced by a horizontal exchange rate curve and the IS* (both graphed in exchange rate versus output space) curve is upward sloping.

Mundell-Fleming VIII: Fixed Exchange Rate

- Monetary expansion with a fixed exchange rate:
  - Money supply increases
  - Temporary fall in domestic interest rate
  - Capital outflow
  - Fall in demand for domestic currency
  - Incipient Depreciation
  - Central bank buys back money to restore the exchange rate

- Fiscal expansion with a flexible exchange rate:
  - Government expenditures increase
  - Temporary rise in domestic interest rate
  - Capital inflow
  - Increase in demand for domestic currency
  - Appreciation
  - Monetary authority prints money, restoring exchange rate
  - Two sources of demand increase: fiscal and monetary

Dornbusch I: Setup

- Return on a domestic bond: $1+i_t$
- Exchange rate = price of foreign currency: i.e. if US is the home country and Sweden the foreign country, then the exchange rate would be that it cost 1/7 of a dollar divided by one dollar or just 1/7.
- Return on a foreign bond: $\left[1+i_t^*\right]\frac{\varepsilon_{t+1}}{\varepsilon_t}$
- Taking logs: $\log\left[1+i_t^*\right]\frac{\varepsilon_{t+1}}{\varepsilon_t} \approx i_t^* + e_{t+1} - e_t$

Dornbusch II: Setup

- So, we get uncovered interest parity:

$$i_t = i_t^* + e_{t+1} - e_t$$

- Under what assumptions will this hold?

- Covered interest parity: replace the future spot rate with the current future rate. Essentially, this MUST hold. If it doesn't, why not?

- Second equation: money demand

$$m_t - p_t = -\eta i_{t+1} + \phi y_t$$

Dornbusch III: Setup

- Definition of real exchange rate:

$$q = e + p^* - p$$

- In theory, the real exchange rate should have a price of 1 for tradable goods. Why?
  - Empirically, we don't see this.

- Demand is determined by the real exchange rate relative to the full employment REX:

$$y_t^d = \bar{y} + \delta\left[e_t + p^* - p_t - \bar{q}\right] = \bar{y} + \delta\left[q_t - \bar{q}\right]$$

Dornbusch IV: Setup

- Interpretation of real exchange rate: the real price of foreign to domestic goods (i.e. the price of foreign TV expressed in domestic currency to price of domestic TV).

- Real exchange rate of 1 is called PPP (Purchasing Power Parity).

- Dornbusch model allows for deviations from PPP.

Dornbusch V: Setup

- Motivation for assumption that demand for a country's output is a decreasing function of the real exchange rate
  - (1.) Monopoly power by home firm in own markets (so price adjustment doesn't lead to infinite or zero demand)
  - (2.) Home-produced tradables goods are more important to the home country
  - (3.) Domestic demand switches from foreign tradables to domestic non-tradables.

Dornbusch VI: Setup

- Dornbusch model is fully dynamic; shows period by period price adjustment.

- Assumption: price adjustment happens according to an expectations-adjusted philips curve:

$$p_{t+1} - p_t = \psi\left[y_t^d - \overline{y}\right] + \left(\tilde{p}_{t+1} - \tilde{p}_t\right)$$

- Where $\tilde{p}_t$ is the price level that would occur if the price level cleared:

$$\tilde{p}_t = e_t + p_t * - \overline{q}_t$$

Dornbusch VII: Setup

- First differencing the definition of $\tilde{p}_t$, we get:

$$\tilde{p}_{t+1} - \tilde{p}_t = \left(e_{t+1} + p_{t+1}* - \bar{q}_{t+1}\right) - \left(e_t + p_t* - \bar{q}_t\right)$$

- Plugging this into the price adjustment philips curve, we get:

$$p_{t+1} - p_t = \psi\left[y_t^d - \bar{y}\right] + e_{t+1} - e_t$$

- Now that we have specified the model, we will review the main equations: notice that this model can much better look at the time path of exchange rate dynamics in comparison with the Mundell-Fleming model which can only be used to analyze changes from one long-term equilibrium to another.

Dornbusch VIII: Setup

- Thus, we have four unknowns (e_t, p_t, y_t, i_t) and the following equations:
  - Uncovered Interest Parity: $i_t = i_t^* + e_{t+1} - e_t$
  - Money Demand: $m_t - p_t = -\eta i_{t+1} + \phi y_t$
  - Domestic Tradables Demand: $y_t^d = \overline{y} + \delta\left[q_t - \overline{q}\right]$
  - Price Adjustment: $p_{t+1} - p_t = \psi\left[y_t^d - \overline{y}\right] + e_{t+1} - e_t$

Dornbusch IX: Graphical Solution

- First, from the definition of the real exchange rate, we get

$$q_{t+1} - q_t = e_{t+1} + p_{t+1}* - p_{t+1} - [e_t + p_t* - p_t]$$

$$\Rightarrow q_{t+1} - q_t = e_{t+1} - p_{t+1} - [e_t - p_t]$$

- Then, combining the money demand equation with the price adjustment equation, we get:

$$q_{t+1} - q_t = -\psi\left[y_t^d - \overline{y}\right] = -\psi\delta\left(q_t - \overline{q}\right)$$

- This is one of two equations whose dynamics we will need… the other is the nominal exchange rate.

Dornbusch X: Graphical Solution

- First, we normalize the parameters to zero:

$$p^* = \bar{y} = i^* = 0$$

- Then, using uncovered interest parity, we get:

$$e_{t+1} - e_t = i_t$$

- From money demand, we can solve for the interest rate:

$$i_t = \frac{p_t + \phi y_t - m_t}{\eta}$$

Dornbusch XI: Graphical Solution

- Now we need to get rid of all endogenous variables besides nominal and real exchange rates (i.e. price and output). We can replace output using the demand equation (and normalizing):

$$y_t = \overline{y} + \delta\left(q_t - \overline{q}\right) = \delta\left(q_t - \overline{q}\right)$$

- Similarly, we can get price from the definition of the real exchange rate (normalized):

$$q_t = p_t * + e_t - p_t = e_t - p_t$$

Dornbusch XII: Graphical Solution

- Replacing the expressions for price and output into the interest rate equation, we get:

$$i_t = \frac{e_t - q_t + \phi\delta\left(q_t - \bar{q}\right) - m_t}{\eta} = \frac{e_t - \left[1 - \phi\delta\right]q_t - \left(\phi\delta\bar{q} + m_t\right)}{\eta}$$

- Replacing the interest rate expression from uncovered interest parity, we get:

$$e_{t+1} - e_t = \frac{e_t - \left[1 - \phi\delta\right]q_t - \left(\phi\delta\bar{q} + m_t\right)}{\eta}$$

Dornbusch XIII: Graphical Solution

- So, we have two equations of motion, each of which are functions of two dynamic variables:

- The equation of motion for the real exchange rate:

$$q_{t+1} - q_t = -\psi\delta\left(q_t - \overline{q}\right)$$

- And the equation of motion for the nominal exchange rate:

$$e_{t+1} - e_t = \frac{e_t - [1 - \phi\delta]q_t - \left(\phi\delta\overline{q} + m_t\right)}{\eta}$$

Dornbusch XIV: Graphical Solution

- First, we start with solving for the long-run equilibrium:

$$q_{t+1} - q_t = 0 \Rightarrow q_t = \bar{q}$$

$$e_{t+1} - e_t = 0 \Rightarrow e_t = [1 - \phi\delta] q_t + (\phi\delta\bar{q} + m_t)$$

- But since in equilibrium, we have $q_t = \bar{q}$, we get:

$$\bar{e} = m + \bar{q}$$

- So the q schedule is a vertical line at $q_t = \bar{q}$ and the e schedule is a straight line with slope $1 - \phi\delta$ and intercept $\phi\delta q + m$

Dornbusch XV: Graphical Solution

- Now we draw the phase diagram and look at stability properties of the equilibrium.

$$q > \bar{q} \Rightarrow \Delta q < 0 \qquad q < \bar{q} \Rightarrow \Delta q > 0$$

and

$$e_t > [1 - \phi\delta]q_t + \left(\phi\delta\bar{q} + m_t\right) \Rightarrow \Delta e > 0$$

$$e_t < [1 - \phi\delta]q_t + \left(\phi\delta\bar{q} + m_t\right) \Rightarrow \Delta e < 0$$

- These patterns imply something called saddle-path stability: convergence to the long-run equilibrium is only along a unique saddle path. Elsewhere in the space, we get divergence. Moreovere, this is no real economic reason to expect the economy to be on the saddle path.

Dornbusch XVI: Graphical Solution

- Now consider a one-time permanent increase in the money supply… a monetary shock.

- In the long run, since $q = e + p^* - p = e - p$ and also $e = m + q$ then we have , $p = m$. As a result, in the long run, an increase in the money supply from m to $\hat{m}$ will lead to an increase in the price level to $\hat{m}$ and given that the long-run real exchange rate must remain constant, an increase in the long-run exchange rate by the amount $\hat{m} - m$

Dornbusch XVII: Graphical Solution

- What about in the short run? In the short run, since prices are sticky, so $p_0 = m$ which means that the real exchange rate, nominal exchange rate combination are on the line given by:

$$q_0 = e_0 - m$$

- The initial new nominal and real exchange rate combination are given by the intersection of the above line and the new saddle path (which intersects the new long run equilibrium and has a slope of less than the exchange rate curve which itself has a slope less than 1).

Dornbusch XVIII: Graphical Solution

- Thus, as long as the exchange rate curve is positively sloped ($1-\phi\delta > 0$), there will be overshooting of the nominal exchange rate.

- What is the intuition for this? An increase in the money stock leads to an increase in real money balances because prices are fixed. If the $1-\phi\delta$ exchange jumped to its new equilibrium with p fixed, that would cause a real depreciation of the currency and thus output would increase by $\phi\delta$. If the above condition is satisfied, then real money supply will be greater than real money demand and the domestic interest rate will have to fall.

Dornbusch XIX: Graphical Solution

- If the domestic interest rate falls, then there should be an accompanying expected appreciation of the nominal exchange rate… in other words, the exchange has to depreciate more than implied by the expansion of the money supply and then it must appreciate slowly afterwards as prices increase.

Dornbusch Model XX: Analytical Solution

- We start with the real-side difference equation which is just an equation with real endogenous variables:

$$q_{t+1} - q_t = -\psi\delta\left(q_t - \overline{q}\right)$$

$$\Rightarrow q_{t+1} - \overline{q} = [1 - \psi\delta]\left(q_t - \overline{q}\right)$$

$$\Rightarrow q_{t+2} - \overline{q} = [1 - \psi\delta]\left(q_{t+1} - \overline{q}\right) = [1 - \psi\delta]^2\left(q_t - \overline{q}\right)$$

$$\Rightarrow q_{t+N} - \overline{q} = [1 - \psi\delta]^{N-t}\left(q_t - \overline{q}\right)$$

Dornbusch Model XXI: Analytical Solution

- Now taking the equation for the nominal side of the economy, which does depend upon the real side, we get:

$$e_{t+1} - e_t = \frac{e_t - [1 - \phi\delta]q_t - \left(\phi\delta\bar{q} + m_t\right)}{\eta}$$

$$\Rightarrow \frac{1+\eta}{\eta} e_t = e_{t+1} + \frac{[1 - \phi\delta]q_t + \left(\phi\delta\bar{q} + m_t\right)}{\eta}$$

$$\Rightarrow e_t = \frac{\eta}{1+\eta} e_{t+1} + \frac{[1 - \phi\delta]q_t + \left(\phi\delta\bar{q} + m_t\right)}{1+\eta}$$

$$\Rightarrow e_t - \bar{q} = \frac{\eta}{1+\eta}\left(e_{t+1} - \bar{q}\right) + \frac{[1 - \phi\delta]\left(q_t - \bar{q}\right) + m_t}{1+\eta}$$

Dornbusch Model XXII: Analytical Solution

- Iterating forward, we get:

$$\Rightarrow e_t - \bar{q} = \lim_{j\to\infty}\left(\frac{\eta}{1+\eta}\right)^{j-t} e_j + \frac{[1-\phi\delta]\sum_{j=t}^{\infty}\left[\frac{\eta}{1+\eta}\right]^{j-t}(q_j - \bar{q}) + \sum_{j=t}^{\infty}\left[\frac{\eta}{1+\eta}\right]^{j-t} m_j}{1+\eta}$$

- Imposing the no bubbles condition (which rules out paths except the saddle path):

$$\lim_{j\to\infty}\left(\frac{\eta}{1+\eta}\right)^{j-t} e_j = 0$$

Dornbusch Model XXIII: Analytical Solution

- Rewriting:

$$\Rightarrow e_t - \bar{q} = \frac{[1-\phi\delta]\sum_{j=t}^{\infty}\left[\frac{\eta}{1+\eta}\right]^{j-t}\left(q_j - \bar{q}\right) + \sum_{j=t}^{\infty}\left[\frac{\eta}{1+\eta}\right]^{j-t} m_j}{1+\eta}$$

- Now, assuming a constant money supply, we first note that:

$$\sum_{j=t}^{\infty}\left[\frac{\eta}{1+\eta}\right]^{j-t} = \frac{1}{1-\frac{\eta}{1+\eta}} = 1+\eta$$

Dornbusch Model XXIV: Analytical Solution

- Continuing to solve:

$$\Rightarrow e_t = \bar{q} + m + \frac{[1-\phi\delta]\sum_{j=t}^{\infty}\left[\frac{\eta}{1+\eta}\right]^{j-t}\left(q_j - \bar{q}\right)}{1+\eta}$$

- Replacing for the real exchange rate:

$$\Rightarrow e_t = \bar{q} + m + \frac{[1-\phi\delta]\left(q_t - \bar{q}\right)\sum_{j=t}^{\infty}\left[\frac{\eta}{1+\eta}\right]^{j-t}[1-\psi\delta]^{j-t}}{1+\eta}$$

$$\sum_{j=t}^{\infty}\left[\frac{\eta}{1+\eta}\right]^{j-t}[1-\psi\delta]^{j-t} = \frac{1}{1-(1-\psi\delta)\frac{\eta}{1-\eta}} = \frac{1+\eta}{1+\eta\psi\delta}$$

Dornbusch Model XXV: Analytical Solution

- Finally, we arrive at the equation for the saddle path:

$$\Rightarrow e_t = \bar{q} + m + \frac{[1-\phi\delta](q_t - \bar{q})}{1+\psi\delta\eta}$$

- Now we look at shocks:

- Suppose that at date zero, the money supply unexpectedly increases from m to m'

Dornbusch Model XXVI: Analytical Solution

- From before, we know that prices are stuck in the short run so that:

$$q_0 = e_0 - p_0 = e_0 - m$$

- We also have derived the equation for the saddle path:

$$\Rightarrow e_0 = \bar{q} + m' + \frac{[1 - \phi\delta](q_0 - \bar{q})}{1 + \psi\delta\eta}$$

- We have two equations and two unknowns so that we can solve for the initial q and e.

Dornbusch Model XXVII: Analytical Solution

- Plugging the initial condition equation into the saddle path equation, we get:

$$\Rightarrow q_0 + m = \bar{q} + m' + \frac{[1-\phi\delta](q_0 - \bar{q})}{1+\psi\delta\eta}$$

- Solving for the initial real exchange rate, we get:

$$q_0 = \bar{q} + \frac{1+\psi\delta\eta}{\phi\delta+\psi\delta\eta}(m'-m)$$

- We can also solve for the initial nominal exchange rate:

$$e_0 = \bar{q} + m + \frac{1+\psi\delta\eta}{\phi\delta+\psi\delta\eta}(m'-m)$$

Dornbusch Model XXVIII: Analytical Solution

- Since, by assumption, $1 > \phi\delta$, we find that

  $$e_0 > \bar{q} + m' = \bar{e}$$

- In other words we get overshooting of the nominal exchange rate!

- Note that we can continue to solve for other period values by iterating forward on the real exchange rate equation and then plugging the real exchange rate into the equation for the nominal exchange rate.

Meese-Rogoff I

- Estimates parameters of models using time period March, 1973 to June, 1981. Forecasts start beginning with November 1976. Forecasts are made at the one month, three months, six months, and one year horizons.
- 3 Monetary models, a VAR, a univariate autoregression, the forward rate, and a random walk model area all compared using root mean square forecast errors with respect to the true data for the forecasting period.
- Data
  - Dollar/Pound, Dollar/Yen, Dollar/Mark
  - Monthly
  - Exchange Rates (Spot and Future), Long-term interest rates, treasury bill rates or interbank lending rates: draws from one day per month (same day every month)
  - Money: M1-B, M2, M3

Meese-Rogoff II

- Estimated Models

$$s = \alpha_0 + \alpha_1 (m - m^*) + \alpha_2 (y - y^*) + \alpha_3 (r_s - r_s^*) + \alpha_4 (\pi^e - \pi^{e*}) + \alpha_5 TB + \alpha_6 TB^* + \varepsilon$$

where s is the exchange rate, m the money supply, log income, r the short term interest rate, pi(e) expected inflation, and TB cumulted trade balance

- Expected inflation is calculated using future CPI or WPI or current long term interest rates

Meese-Rogoff III

- Meese-Rogoff Estimating Equation:

$$s = \alpha_0 + \alpha_1 (m - m*) + \alpha_2 (y - y*) + \alpha_3 (r_s - r_s *) + \alpha_4 (\pi^e - \pi^e *) + \alpha_5 TB + \alpha_6 TB* + \varepsilon$$

- All models restrict a(1)=1
- The Frenkel-Bilson model assumes PPP, and requires a(4)=a(5)=a(6)
- The Dornbusch Frankel model allows for slow price adjustment and allows a(4) not to equal zero
- The Hooper-Morton Model allows the trade balance also to effect the exchange rate and does not impose any restrictions on a(4), a(5), and a(6)

Meese-Rogoff IV

- Note that there can be problems with inference in autoregressions when a variable follows a unit root (likely with exchange rates). A random variable follows a unit root when it is non-stationary. One specific example is when the expectation of a random variable at any time in the future is the current value. This is called a martingale. One particular type of martingale is the random walk (which goes up with probability ½ and down with probability ½ every period).

- Something which has a unit root is not necessarily a martingale. Example (martingale would be alpha equal to zero):

$$s_{t+1} - s_t = \alpha\left(s_t - s_{t-1}\right) + \varepsilon_{t+1} - \varepsilon_t$$

Meese-Rogoff V

- For example: income is non-stationary. It may be integrated of order one (i.e. the sequence of first differences of income is stationary). The process below is stationary in first differences (because alpha is a constant):

$$s_{t+1} - s_t = \alpha(s_t - s_{t-1}) + \varepsilon_{t+1} - \varepsilon_t$$

- It could be the case that income is not even integrated of order one (no steady-state growth in income). It could still be stationary of order 2 or higher (second-differences).