EXCHANGE RATES: THE BASICS

PREQUEL TO CHAPTER 31

OUTLINE FOR PREQUEL

- Exchange rates:
  - Basic terminology: *definitions and examples*
  - Simple Supply-Demand analysis*: you can think of currencies as goods sold in markets*
  - Application - Argentine currency peg: *Using supply-demand analysis to analyze Argentine currency peg in the 90s, showing how excess demand was created and led to BOP crises.*
  - Singapore foreign exchange policy

EXCHANGE RATE

EXCHANGE RATES

- Definition: A nominal exchange rate is the price of one currency in terms of another currency
  - (Can also define a *real* exchange rate…Chapter 30)

- Selected exchange rates on November 19, 2008

Currency pair		Inverse representations	
U.S. $ / Japanese yen	97 yen / $	⟷	0.0103 $ / yen
U.S. $ / Argentine peso	2.89 peso / $	⟷	0.3460 $ / peso
U.S. $ / euro	0.79 euro / $	⟷	1.2658 $ / euro
U.S. $ / Chinese yuan	6.83 yuan / $	⟷	0.1464 $ / yuan
U.S. $ / Canadian $	1.24 C$ / $	⟷	0.8065 $ / C$

- Crucial: Each exchange rate can be expressed in 2 diff. directions
  - Neither way is "correct"
  - Pick a direction for the definition and stick with it!!!

EXCHANGE RATES – BASIC TERMINOLOGY

- A currency appreciates (depreciates) against another currency when it becomes stronger (weaker) compared to the other currency
  - Currency appreciation ⟷ "currency strengthening"
  - Currency depreciation ⟷ "currency weakening"

- November 19, 2007: 111 yen / U.S. $
- November 19, 2008: 97 yen / U.S. $
- Japanese yen has appreciated against the U.S. $ over the past year
- U.S. dollar has depreciated against the yen over the past year

Exchange Rates – Basic Terminology

- Definition: Foreign reserves are a central bank's holding of foreign currencies for the purpose of government international transactions (most commonly, exchange rate interventions)
  - Foreign reserves are a *stock* variable
- Definition: A country's foreign reserves change during a given time period measures by how much its foreign reserves *changed* during that time period – it is a *flow* variable

EXCHANGE RATES – BASIC TERMINOLOGY

- Definition: A nominal exchange rate is floating if it is determined solely by the forces of market supply and demand

- Definition: A nominal exchange rate is fixed (pegged) if it is determined through government intervention in exchange markets in order to fix the rate at some value.

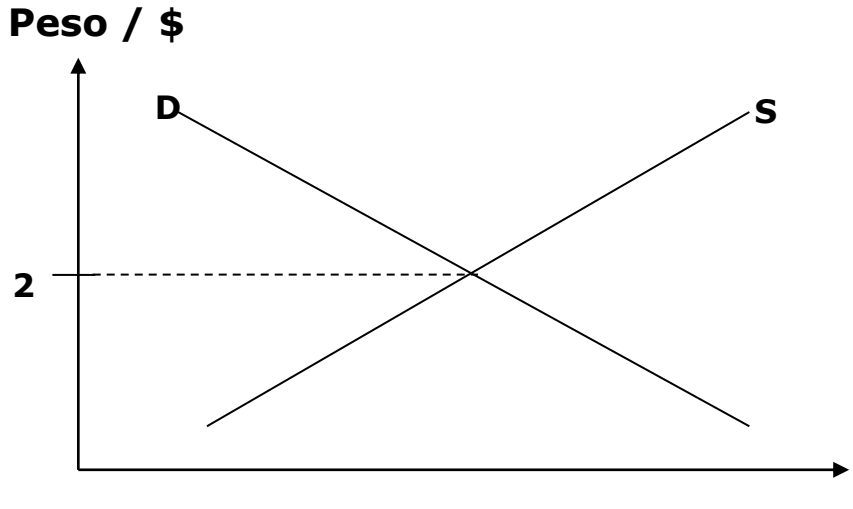
Simple Supply-Demand Analysis

- Exchange rates are *prices*
  - Floating rates determined by "usual" forces of supply & demand
  - Ex: exchange market for U.S. $ in terms of Argentine pesos

Peso / U.S. $ *must be* the "price" variable *because* we chose U.S. $ as the "quantity" variable

Floating rate

is nothing more than the equilibrium price!



Picking U.S. $ as the "quantity" variable…could do things the other way…

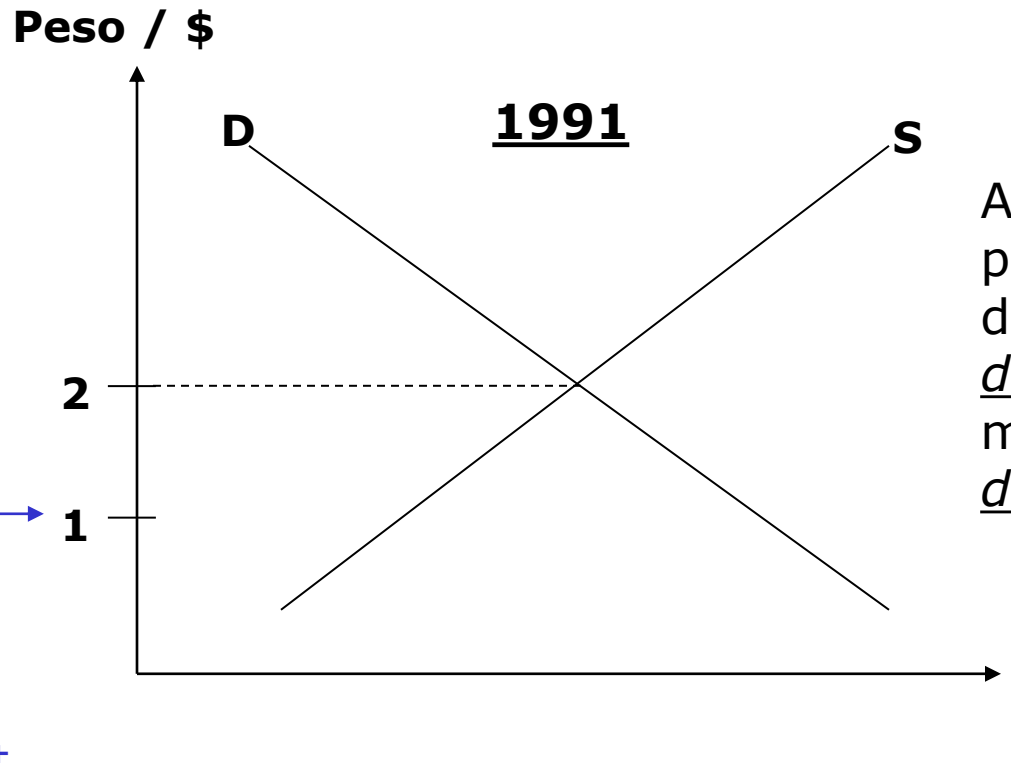
Private Forex Market for U.S. $ in terms of pesos

Back to sequel's outline

APPLICATION: THE ARGENTINE CURRENCY PEG

- 1991: Argentine government adopts a fixed ("pegged") exchange rate
  - At 1 peso/$ (note: a fixed exch. rate need not be at one-for-one…)
  - Reason: to control hyperinflation of late 1980's (discuss further in Chapter 16)

APPLICATION: THE ARGENTINE CURRENCY PEG



Floating rate →

Fixed rate →

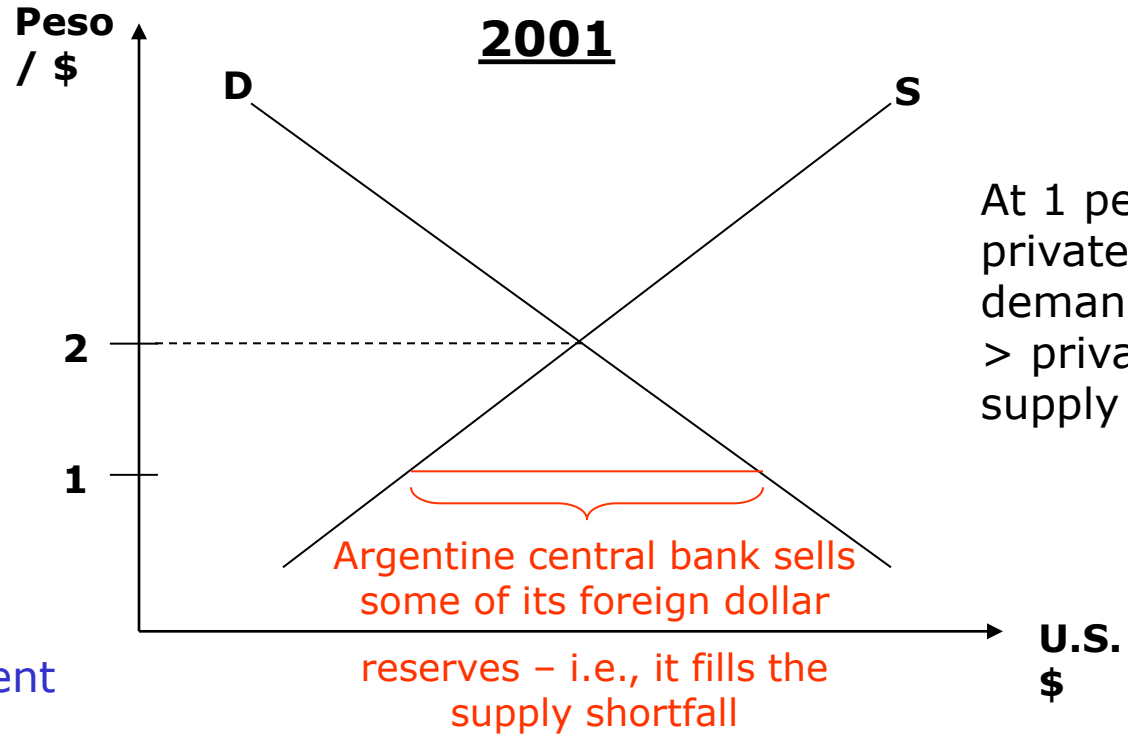
NOT an equilibrium price…Argentine government must intervene to implement this price…

At 1 peso/$, private-market demand *for dollars* > private-market supply *of dollars*

Private Forex Market for U.S. $ in terms of pesos

APPLICATION: THE ARGENTINE CURRENCY PEG

- **1991, 1992, 1993…, 2001**: Argentine central bank runs a BOP deficit (decreases its for. reserves)



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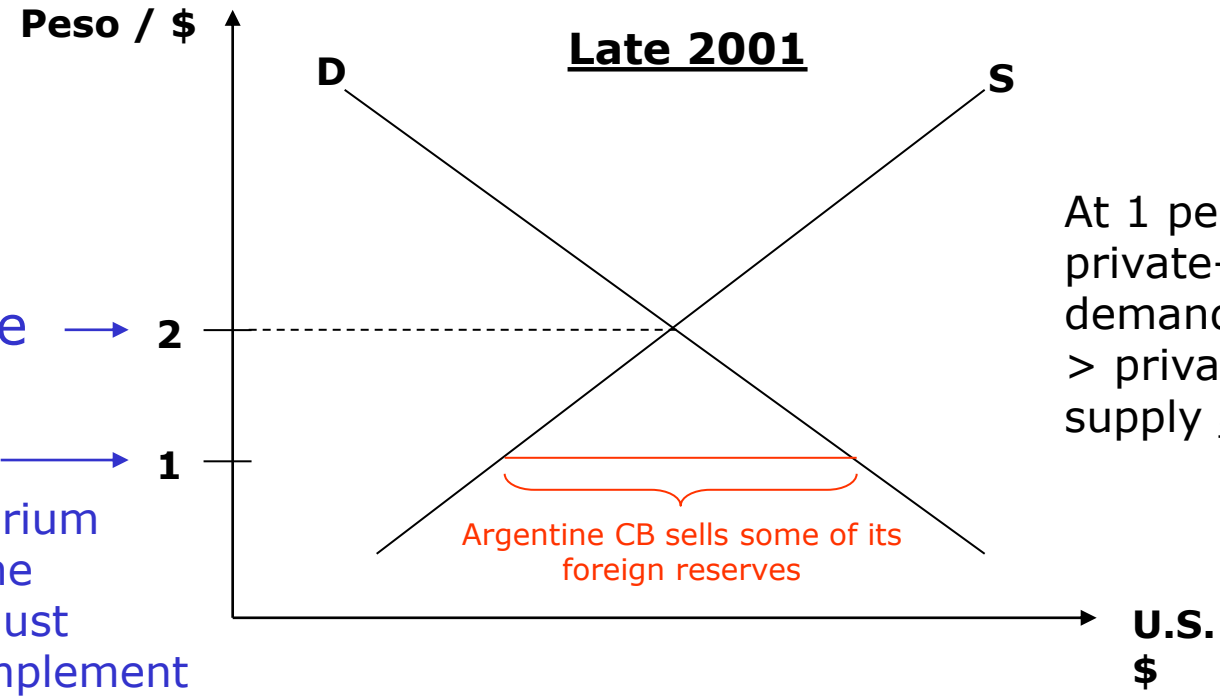
Private Forex Market for U.S. $ in terms of pesos

APPLICATION: THE ARGENTINE CURRENCY PEG

- Late 2001: Argentine central bank very low on foreign reserves
- Peg cannot last much longer, so depreciation (devaluation) to the floating rate is imminent…



Floating rate →

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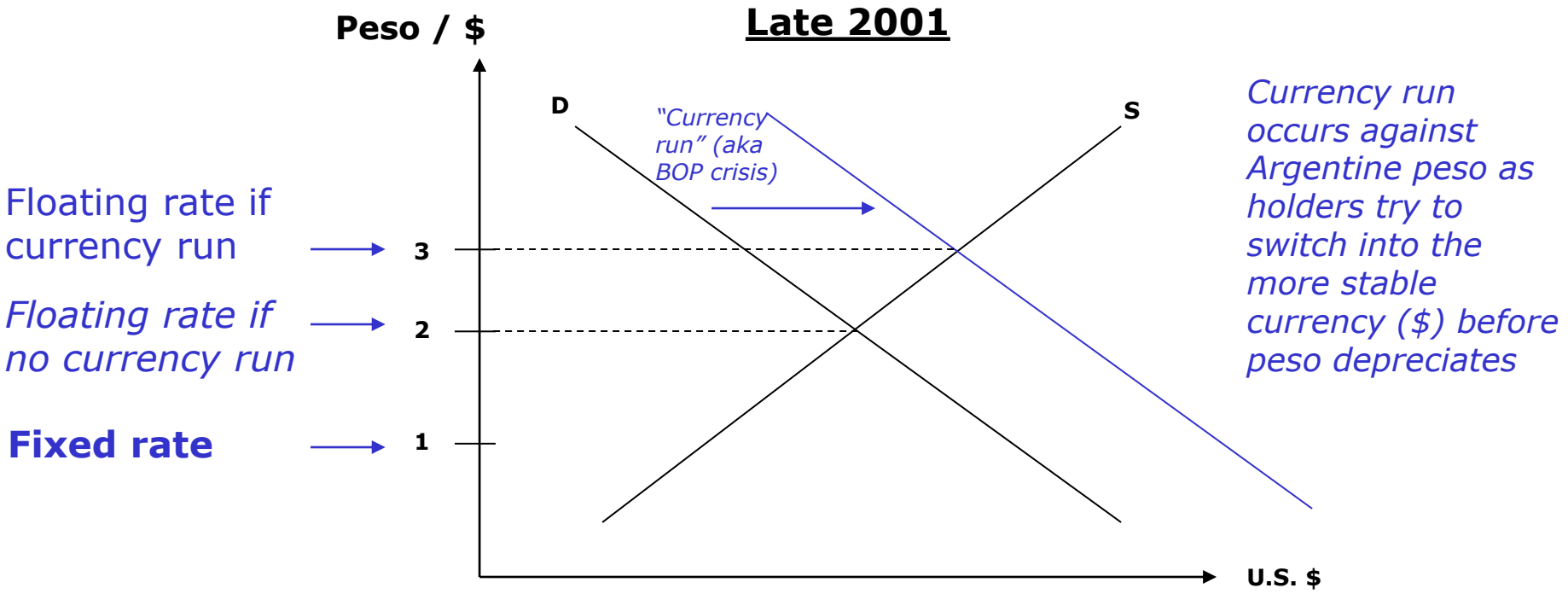
NOT an equilibrium price…Argentine government must intervene to implement this price…

At 1 peso/$, private-market demand *for dollars* > private-market supply *of dollars*

Private Forex Market for U.S. $ in terms of pesos

The Argentine Currency Peg

- …but "currency run" means devaluation likely to be even bigger than "expected"



Private Forex Market for U.S. $ in terms of pesos

BOP CRISES

- Fixed exchange rate systems inherently are dynamic phenomena
  - Argentine fixed exchange rate system took 10 *years* to collapse
  - An explicitly-dynamic macroeconomic analysis reveals more details than simplistic supply & demand story-telling
- A fixed exchange rate system is a stance of monetary policy
  - The central bank is the institution charged with actually implementing a fixed exchange rate system (via its foreign reserves)

BOP CRISES

- Fixed exchange rate systems inherently require certain combinations of monetary policy and fiscal policy to be sustainable over the long run
  - Conditions not met in the case of Argentina…
- Monetary-fiscal interactions

Singapore foreign exchange policy

- In 1980, Singapore started to adopt exchange rate-centered monetary policy.
  - Singapore exchange rate is **trade weighted**: Singapore dollar is managed against a basket of currencies of its **major trading partners** *and competitors.* The weights capture different degrees of importance of the various currencies which is determined by the extent of Singapore's trade dependence on the respective economies.
  - Foreign reserves, thus, are very important. Government of Singapore Investment Corporation (now GIC private ltd) manages the reserves.

Fiscal Theory of Exchange Rates

Chapter 31

OUTLINE FOR CHAPTER 31

- Outline of Framework: *this framework is extended/built on the consolidated government budget constraint*
  - Building block 1: Money demand function
  - Real exchange rate: *definition & concept (we need this for building block 2)*
  - Building block 2: Purchasing Power Parity
  - Domestic & Foreign Assets: *definition and concept (we need this for building block 3)*
  - Building block 3: Interest rate parity condition
  - Building block 4: Government Budget Constraint (GBC)
- Fiscal theory framework: combining four building blocks
  - Case 1: fixed exchange rate and citizens expect it to remain
  - Case 2: Unanticipated one-time devaluation of domestic currency
- Fiscal theory of exchange rates: BOP crisis (Argentina)
  - Case 3: fixed exchange rate but with fiscal deficit every period - *showing how the two combined will deplete the foreign reserves, leading to Balance of Payment (BOP) crisis.*

OUTLINE OF FRAMEWORK

OUTLINE OF FRAMEWORK

- Fiscal Theory of Exchange Rates
  - An international macroeconomic application of the fiscal theory of the price level (FTPL)
- Major ideas underlying Fiscal Theory of Exchange Rates

1. Interactions between monetary policy and fiscal policy matter for exchange rate systems

OUTLINE OF FRAMEWORK

- …

1. …
2. Expectations about future policy matter for exchange rate systems
   - Self-fulfilling prophecies can arise ("currency run" of simple supply-demand analysis)
   - Especially when future events are uncertain
3. Framework most applicable to developing-country exchange rate systems

OUTLINE OF FRAMEWORK

- Four Building Blocks of the Fiscal Theory of Exchange Rates

1. Money Demand Function
   - Derived from our MIU model of Chapter 14

2. Purchasing Power Parity (PPP)
   - A statement about how real exchange rates behave over time

OUTLINE OF FRAMEWORK

- …
  1. …
  2. …
  3. Interest-Rate Parity (IRP)
     - Describes relationship between domestic-economy bonds and foreign-economy bonds
  4. Consolidated Flow Government Budget Constraint
     - A slight variation of what we saw in Chapter 16…
     - …amended to account for a government's holdings of foreign reserves and foreign bonds

Building Block 1

- Money Demand Function
  - Express in general form as $\frac{M_t}{P_t} = \phi(c_t, i_t)$
    - As in closed-economy case

- Auxiliary Assumption 1 (AA1)
  - Consumption is constant in every period (a "steady-state" analysis)
  - So, $c_t = \bar{c}$ in every period (i.e., $\bar{c}$ is a fixed, unchanging *number*)

→ Real money demand described by $\frac{M_t}{P_t} = \phi(\bar{c}, i_t)$

Recall real money demand depends positively on *c* and negatively on i_t (i_t is the opportunity cost of money)

Back to chp 31's outline

Real Exchange Rates

- Definition: A nominal exchange rate is the price of one currency in terms of another currency
  - Denote by E_t
- Definition: A real exchange rate is the price of one country's consumption basket in terms of another country's consumption basket. In particular, a real exchange rate is how many unit of domestic consumption can one unit of foreign consumption buy.
  - Denote by e_t

Real Exchange Rates

- Relation between real and nominal exchange rates

$$e_t = \frac{E_t P^\star}{P_t}$$

- Unit Analysis (i.e., analyze algebraic units of variables)
  - Units(E_t) = domestic currency/foreign currency
  - Units(P_t) = domestic currency/unit of domestic consumption
  - Units(P^*_t) = foreign currency/unit of foreign consumption
  - Units(e_t) =

Recall could define this in inverse way if we wanted…

$$\frac{(\text{dom. curr/for. curr}) \cdot (\text{for. curr/for. consumption})}{\text{dom. curr/dom. consumption}} = \frac{\text{domestic consumption}}{\text{foreign consumption}}$$

Back to chp 31's outline

BUILDING BLOCK 2

- Purchasing Power Parity (PPP)
  - Averaged over long periods of time (i.e., in steady state), $e = 1$
  - In the long run, one basket of goods in one country buys one basket of goods in another country
  - Assume PPP holds in *every* period of our model → $e_t = 1$ always

- $e_t = 1 \rightarrow E_t P_t^{\star} = P_t$

Building Block 2

- Auxiliary Assumption 2 (AA2)
  - Suppose $P^*_t = 1$ in every period
  - Strips out the effect of foreign inflation

→ In every period, $E_t = P_t$

  - $E_t = P_t$ illustrates a primary motivation behind why countries adopt fixed exchange rates (e.g., Argentina in 1991)
    - KILLS DOMESTIC INFLATION! (i.e., P_t never changes if E_t never changes)

Domestic and Foreign Assets

- How do domestic and foreign interest rates relate to each other?
- Example: Domestic investor with $1 to invest
  - Domestic country: U.S. Domestic nominal interest rate: i_t
  - Foreign country: Europe Foreign nominal interest rate: $i_t^\star$
  - Current nominal exchange rate: E_t
    - Units: domestic currency/foreign currency (i.e., \$/€) ← The convention we will adopt
  - Future nominal exchange rate: E_{t+1}
    - Units: domestic currency/foreign currency (i.e., \$/€) ← The convention we will adopt

Which is the better investment?

Domestic and Foreign Assets

	U.S. bond	**Euro bond**
Today	Buy \$1 worth of U.S. bonds	Convert \$1 into € $(1/E_t)$; Buy € $(1/E_t)$ worth of euro bonds
End of investment period (i.e., one period from today)	Receive back $\$(1+i_t)$	(WATCH UNITS!) Receive back € $((1+i_t^\star)/E_t)$; Convert into $\$(1+i_t^\star)$ (E_{t+1}/E_t)

- Comparing i_t only with $i_t^\star$ not sufficient
- Must also take into account the expected rate of change of the nominal exchange rate: E_{t+1}/E_t

Back to chp 31's outline

BUILDING BLOCK 3

- Interest Rate Parity (IRP)
  - When (domestic and foreign) financial markets are "functioning well" (i.e., no-arbitrage), interest rates are equalized after adjusting into common currencies
  - $1 + i_t = (1 + i_t^{\star})\left(\frac{E_{t+1}}{E_t}\right)$

Building Block 3

- Auxiliary Assumption 3 (AA3)
  - Suppose foreign real interest rate never changes (i.e., $r^*_t = r^*$ in every period) (i.e., r^* is a fixed, unchanging *number*)
  - Coupled with **zero foreign inflation rate** (see AA2), Fisher equation tells us $i^\star_t = r^\star_t + \pi^\star_t = r^\star$ in every period

In every period,

$$1 + i_t = (1 + r^\star)\frac{E^e_{t+1}}{E_t}$$

A little more precisely: replace E_{t+1} with *expected* future nominal exchange rate E^e_{t+1} because time t+1 events unknown at time t.

Expectations play an important role in currency crises (a.k.a. balance of payment crisis)…

BUILDING BLOCK 4

(i.

- Government Budget Constraint (GBC)
  - Recall: the period-t consolidated (i.e. fiscal-monetary) budget constraint in chapter 16:

$$P_t G_t = T_t + (P_t^b B_t - B_{t-1}) + M_t - M_{t-1}$$

  - where the governments' revenue to fund spending is from tax, T_t, printing money $M_t - M_{t-1}$ and net borrowing from public, $P_t^b B_t - B_{t-1}$ (new borrowing minus debt payment).
  - Please note here B stands for government's borrowing.

BUILDING BLOCK 4

- Government Budget Constraint (GBC)
  - Focus on developing countries
  - In developing countries, most of government assets are foreign reserves
  - In turn, foreign reserves typically held as foreign-dominated bonds (rather than foreign currency)
    - May as well earn interest on foreign reserve holdings…
  - Let's assume here that the government does not (or maybe, cannot) borrow from the public.

Building Block 4

- Government Budget Constraint (GBC)
  - *Denote government's foreign reserves at time t to be B^G_t (note, it is not B_t)*
  - So government rely on four sources for spending:
    - Printing money $M_t - M_{t-1}$
    - Tax, T_t
    - Interests earned from foreign reserves $= E_t r^\star B^G_{t-1}$
    - Drawing from foreign reserves to spend $= E_t(B^G_{t-1} - B^G_t)$

Building Block 4

- …
  - …
  - Notation:
    - E_t : nominal exchange rate (domestic currency/foreign currency)
    - P_t : domestic price level (domestic currency/domestic goods)
    - B^G_t: foreign reserve holdings at end of period t/start of period t+1 -- units are foreign currency!
    - G_t : real domestic government purchases
    - T_t : nominal tax revenue (assume lump-sum for simplicity)
    - M_t : nominal domestic money in circulation at end of period t/start of period t+1

Building Block 4

- Government Budget Constraint (GBC)
  - *So the consolidated Government Budget constraint is now given as:*

$$P_t G_t = T_t + (M_t - M_{t-1}) + E_t r^\star B^G_{t-1} + E_t\left(B^G_{t-1} - B^G_t\right)$$

$$P_t G_t - E_t\left(B^G_{t-1} - B^G_t\right) = T_t + (M_t - M_{t-1}) + E_t r^\star B^G_{t-1}$$

$$P_t G_t + E_t\underbrace{\left(B^G_t - B^G_{t-1}\right)}_{\Delta B^G_t} = T_t + (M_t - M_{t-1}) + E_t r^\star B^G_{t-1}$$

BUILDING BLOCK 4

- **Government Budget Constraint (GBC)**
  - **…**
  - $$E_t\left(B_t^G - B_{t-1}^G\right) + P_t G_t = T_t + (M_t - M_{t-1}) + E_t r^\star B_{t-1}^G$$

1. **Note that $E_t = P_t$ (Building Block 1)**
2. **Divide through by P_t**
3. **Regroup terms**

$$B_t^G - B_{t-1}^G = \frac{M_t - M_{t-1}}{P_t} - \left[G_t - \frac{T_t}{P_t} - r^\star B_{t-1}^G\right]$$

Back to chp 31's outline

BUILDING BLOCK 4

$$E_t\left(B_t^G - B_{t-1}^G\right) + P_t G_t = T_t + (M_t - M_{t-1}) + E_t r^\star B_{t-1}^G$$

$$P_t\left(B_t^G - B_{t-1}^G\right) + P_t G_t = T_t + (M_t - M_{t-1}) + P_t r^\star B_{t-1}^G$$

$$B_t^G - B_{t-1}^G + G_t = \frac{T_t}{P_t} + \frac{(M_t - M_{t-1})}{P_t} + r^\star B_{t-1}^G$$

$$B_t^G - B_{t-1}^G = \frac{(M_t - M_{t-1})}{P_t} + \frac{T_t}{P_t} - G_t + r^\star B_{t-1}^G$$

$$B_t^G - B_{t-1}^G = \frac{M_t - M_{t-1}}{P_t} - \left[G_t - \frac{T_t}{P_t} - r^\star B_{t-1}^G\right]$$

In every period, GBC is

$$B_t^G - B_{t-1}^G = \frac{M_t - M_{t-1}}{P_t} - DEF_t$$

Back to chp 31's outline

BUILDING BLOCK 4

$$B_t^G - B_{t-1}^G = \frac{M_t - M_{t-1}}{P_t} - \left[G_t - \frac{T_t}{P_t} - r^\star B_{t-1}^G \right]$$

- $\left[G_t - \frac{T_t}{P_t} - r^\star B_{t-1}^G \right]$, rewritten as DEF_t, is fiscal *deficit:*
  - G_t is the expenditure
  - $\frac{T_t}{P_t}$ is the real tax REVENUE
  - $r^\star B_{t-1}^G$ is the real income/REVENUE earned from investing the foreign reserves in foreign countries.

In every period, GBC is →

$$B_t^G - B_{t-1}^G = \frac{M_t - M_{t-1}}{P_t} - DEF_t$$

DEF > 0: fiscal authority is running deficit

DEF < 0: fiscal authority is running surplus

Both monetary policy and fiscal policy matter for foreign reserve holdings

Back to chp 31's outline

THE FISCAL THEORY FRAMEWORK

- Four Building Blocks of the Fiscal Theory of Exchange Rates (combined with three auxiliary assumptions)

1. Money Demand Function $\frac{M_t}{P_t} = \phi(\bar{c}, i_t)$
2. Purchasing Power Parity (PPP) $E_t = P_t$
3. Interest-Rate Parity (IRP) $1 + i_t = \frac{(1 + r^\star)E^e_{t+1}}{E_t}$
4. Consolidated Flow Government Budget Constraint

$$B^G_t - B^G_{t-1} = \frac{M_t - M_{t-1}}{P_t} - DEF_t$$

THE FISCAL THEORY FRAMEWORK

- Next: Several "case studies" using Fiscal Theory
- Main Application: Study how a balance-of-payments crisis (BOP crisis) unfolds
- Several "case studies"
  - In each, track the dynamics over time of various macroeconomic measures by looking at all the four building blocks in each period.

CASE 1

- Case 1: Fixed exchange rate in place and individuals expect it will always remain in place
  - $E_t = \bar{E}$ and $E^e_{t+1} = \bar{E}$ always (i.e., $\bar{E}$ is a fixed, unchanging *number*)

Period1:

- Fixed exchange rate: $E_1 = \bar{E}; E_2^e = \bar{E}$
- Using IRP condition to find i_t: $1 + i_1 = (1 + r^\star)\frac{E_2^e}{E_1} \Longrightarrow i_1 = r^\star$
- Using money demand function to find M_t:

$$M_1 = P_1\phi(\bar{c}, i_1) = E_1\phi(\bar{c}, r^\star) \because P_1 = E_1$$

$$M_1 = \bar{E}\phi(\bar{c}, r^\star)$$

Case 1

Period 2:

- Fixed exchange rate

$$E_2 = \bar{E}; E_3^e = \bar{E}$$

- Using IRP condition to find i_t:

$$1 + i_2 = (1 + r^\star)\frac{E_3^e}{E_2} \Longrightarrow i_2 = r^\star$$

- Using money demand function to find M_t:

$$M_2 = P_2\phi(\bar{c}, i_2) = E_2\phi(\bar{c}, r^\star) \because P_2 = E_2$$

$$M_2 = \bar{E}\phi(\bar{c}, r^\star)$$ ← *Same with* M_1

- Seignorage revenue:

$$SR_2 = \frac{M_2 - M_1}{P_2} = 0$$

$\because M_2 = M_1$ *(see above)*

Case 1

Period 3:

- Fixed exchange rate

$$E_3 = \bar{E}; E_4^e = \bar{E}$$

- Using IRP condition to find i_t:

$$1 + i_3 = (1 + r^\star)\frac{E_4^e}{E_3} \Longrightarrow i_3 = r^\star$$

- Using money demand function to find M_t:

$$M_3 = P_3\phi(\bar{c}, i_3) = E_3\phi(\bar{c}, r^\star) \because P_3 = E_3$$

$$M_3 = \bar{E}\phi(\bar{c}, r^\star)$$ ← *Same with* M_2

- Seignorage revenue:

$$SR_3 = \frac{M_3 - M_2}{P_3} = 0$$ $\because M_3 = M_2$ *(see above)*

Back to chp 31's outline

CASE 1 (Summary table)

- **Case 1: Fixed exchange rate in place and individuals expect it will always remain in place**
  - **$E_t = \bar{E}$ always and $E^e_{t+1} = \bar{E}$ always (i.e., $\bar{E}$ is a fixed, unchanging number)**

	Period 1	**Period 2**	**Period 3**
E_t	**$E_1 = \bar{E}$**	**$E_2 = \bar{E}$**	**$E_3 = \bar{E}$**
E^e_{t+1}	**$E^e_2 = \bar{E}$**	**$E^e_3 = \bar{E}$**	**$E^e_4 = \bar{E}$**
i_t (using IRP condition)	$1+i_1 = (1+r^*)\frac{E^e_2}{E_1}$ $\longrightarrow$ $i_1 = r^*$	$1+i_2 = (1+r^*)\frac{E^e_3}{E_2}$ $\longrightarrow$ $i_2 = r^*$	$1+i_3 = (1+r^*)\frac{E^e_4}{E_3}$ $\longrightarrow$ $i_3 = r^*$
M_t (using money demand function)	$M_1 = P_1\phi(\bar{c}, i_1)$ $M_1 = E_1\phi(\bar{c}, r^*)$ (due to $P_1 = E_1$) $\longrightarrow$ $M_1 = \bar{E}\phi(\bar{c}, r^*)$	$M_2 = P_2\phi(\bar{c}, i_2)$ $M_2 = E_2\phi(\bar{c}, r^*)$ (due to $P_2 = E_2$) $\longrightarrow$ $M_2 = \bar{E}\phi(\bar{c}, r^*)$	$M_3 = P_3\phi(\bar{c}, i_3)$ $M_3 = E_3\phi(\bar{c}, r^*)$ (due to $P_3 = E_3$) $\longrightarrow$ $M_3 = \bar{E}\phi(\bar{c}, r^*)$
SR_t	---	$SR_2 = \frac{M_2 - M_1}{P_2}$ $= 0$ (due to $M_2 = M_1$)	$SR_3 = \frac{M_3 - M_2}{P_3}$ $= 0$ (due to $M_3 = M_2$)

Back to chp 31's outline

PREDICTIONS OF THE FISCAL THEORY

- Key Result #1: Domestic nominal interest rate is equal to foreign interest rate as long as peg is in place and is expected to remain in place

- Key Result #2: Seignorage revenue is zero as long as peg is in place and is expected to remain in place
  - Central bank not permitted to print money when peg is in place
  - Fixed exchange rate "ties the hands" of the central bank
    - Imposes discipline on money-creation
    - Which brings inflation down (recall monetarist link between money growth and inflation)

Predictions of the Fiscal Theory

- Key Result #3: If fiscal authority is running deficits (i.e., *DEF* > 0), foreign reserve level falls (i.e., BOP deficit)

= 0 while peg is in place

$$\underbrace{B_t^G - B_{t-1}^G}_{\text{< 0 if } DEF > 0} = \frac{M_t - M_{t-1}}{P_t} - DEF_t$$

Case 2

- Case 2: Unanticipated, one-time devaluation
  - Government unexpectedly weakens the domestic currency to a new fixed rate and promises (credibly) to never again change the exchange rate – new rate is $E' > \bar{E}$ (i.e., E' is a fixed, unchanging *number*)

Case 2

Period 4:

- Fixed exchange rate

$$E_4 = E' > \bar{E}; E_5^e = E'$$

- Using IRP condition to find i_t:

$$1 + i_4 = (1 + r^\star)\frac{E_5^e}{E_4} \Longrightarrow i_4 = r^\star$$

- Using money demand function to find M_t:

$$M_4 = P_4\phi(\bar{c}, i_4) = E_4\phi(\bar{c}, r^\star) \because P_4 = E_4$$

$$M_4 = E'\phi(\bar{c}, r^\star)$$

← *Bigger than M_3 since $E' > \bar{E}$*

- Seignorage revenue:

$$SR_4 = \frac{M_4 - M_3}{P_4} > 0$$

$\because M_4 > M_3$ *(see above)*

Back to chp 31's outline

Case 2

Period 5:

- Fixed exchange rate

$$E_5 = E'; E_6^e = E'$$

- Using IRP condition to find i_t:

$$1 + i_5 = (1 + r^\star)\frac{E_6^e}{E_5} \Longrightarrow i_5 = r^\star$$

- Using money demand function to find M_t:

$$M_5 = P_5\phi(\bar{c}, i_5) = E_5\phi(\bar{c}, r^\star) \because P_5 = E_5$$

$$M_5 = E'\phi(\bar{c}, r^\star)$$ ← *Same with* M_4

- Seignorage revenue:

$$SR_5 = \frac{M_5 - M_4}{P_5} = 0$$

$\because M_5 = M_4$ *(see above)*

Case 2

Period 6:

- Fixed exchange rate

$$E_6 = E'; E_7^e = E'$$

- Using IRP condition to find i_t:

$$1 + i_6 = (1 + r^\star)\frac{E_7^e}{E_6} \Longrightarrow i_6 = r^\star$$

- Using money demand function to find M_t:

$$M_6 = P_6\phi(\bar{c}, i_6) = E_6\phi(\bar{c}, r^\star) \because P_6 = E_6$$

$$M_6 = E'\phi(\bar{c}, r^\star)$$ ← *Same with* M_5

- Seignorage revenue:

$$SR_6 = \frac{M_6 - M_5}{P_6} = 0$$

$\because M_6 = M_5$ *(see above)*

CASE 2 (Summary table)

- **Case 2: Unanticipated, one-time devaluation**
  - **Government unexpectedly weakens the domestic currency to a new fixed rate and promises (credibly) to never again change the exchange rate – new rate is $E' > \bar{E}$ (i.e., E' is a fixed, unchanging *number*)**

	Period 4	**Period 5**	**Period 6**
E_t	$E_4 = E' > \bar{E}$	$E_5 = E'$	$E_6 = E'$
E^e_{t+1}	$E^e_5 = E'$	$E^e_6 = E'$	$E^e_7 = E'$
i_t (using IRP condition)	$1+i_4 = (1+r^*)\frac{E^e_5}{E_4}$ $\longrightarrow i_4 = r^*$	$1+i_5 = (1+r^*)\frac{E^e_6}{E_5}$ $\longrightarrow i_5 = r^*$	$1+i_6 = (1+r^*)\frac{E^e_7}{E_6}$ $\longrightarrow i_6 = r^*$
M_t (using money demand function)	$M_4 = P_4\phi(\bar{c}, i_4)$ $M_4 = E_4\phi(\bar{c}, r^*)$ (due to $P_4 = E_4$) $\longrightarrow M_4 = E'\phi(\bar{c}, r^*)$	$M_5 = P_5\phi(\bar{c}, i_5)$ $M_5 = E_5\phi(\bar{c}, r^*)$ (due to $P_5 = E_5$) $\longrightarrow M_5 = E'\phi(\bar{c}, r^*)$	$M_6 = P_6\phi(\bar{c}, i_6)$ $M_6 = E_6\phi(\bar{c}, r^*)$ (due to $P_6 = E_6$) $\longrightarrow M_6 = E'\phi(\bar{c}, r^*)$
SR_t	$SR_4 = \frac{M_4 - M_3}{P_4}$ > 0 (due to $M_4 > M_3$)	$SR_5 = \frac{M_5 - M_4}{P_5}$ $= 0$ (due to $M_5 = M_4$)	$SR_6 = \frac{M_6 - M_5}{P_6}$ $= 0$ (due to $M_6 = M_5$)

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PREDICTIONS OF THE FISCAL THEORY

- Key Result #4: Domestic nominal interest rate does not change when an unexpected, one-time change in the exchange rate occurs
  - Because i_t linked to expected changes in the exchange rate through IRP

- Key Result #5: A devaluation of the domestic currency causes positive seignorage revenue for the government (in the period of the devaluation)
  - Central bank's hands "untied" for that one period

Predictions of the Fiscal Theory

- Apply lessons from Case 1 and Case 2 to study the dynamics of Argentina's fixed exchange rate system between 1991 and 2002
- Balance of Payments (BOP) Crisis: a situation in which a government is unable (or unwilling) to meets its international financial obligations, often brought about by an unsustainable mix of fiscal and monetary policies
- Three phases of a BOP crisis
  - Pre-collapse phase
  - BOP crisis (bad terminology…)
  - Post-collapse phase

Fiscal Theory of Exchange Rates: BOP Crisis

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Balance of Payments Crisis

- Three phases of a BOP crisis
  - Pre-collapse phase (Argentina: 1991 – mid 2001)
  - BOP crisis (bad terminology…) (Argentina: late 2001)
  - Post-collapse phase (Argentina: since beginning of 2002)

Balance of Payments Crisis

- Notations/assumptions
  - The peg *actually* collapses at start of period T (capital T…)
  - Individuals/markets expect/understand collapse will occur in period T
    - Thus, expectations of the exchange rate matter
    - When peg collapses, people expect currency will depreciate at rate $\mu > 0$
  - Collapse happens when the country runs out of foreign reserves
    - i.e., when $B^G = 0$

CASE 3: BOP CRISIS

- Case 3: Country is maintaining fixed exchange rate $\bar{E}$ *and* **running fiscal deficit of *DEF* > 0 every period**
  - i.e., $\bar{E}$ and *DEF* are both fixed, unchanging *numbers*

CASE 3

- Let T be the period of crisis and see what happens 3 period before that

Period T-3:

- Fixed exchange rate $E_{T-3} = \bar{E}; E^e_{T-2} = \bar{E}$
- Using IRP condition to find i_t: $1 + i_{T-3} = (1 + r^\star)\frac{E^e_{T-2}}{E_{T-3}} \Longrightarrow i_{T-3} = r^\star$
- Using money demand function to find M_t:

$$M_{T-3} = P_{T-3}\phi(\bar{c}, i_{T-3}) = E_{T-3}\phi(\bar{c}, r^\star)$$

$$M_{T-3} = \bar{E}\phi(\bar{c}, r^\star)$$

- Seignorage revenue：(N.A. since we do not know M_{T-4})

- $B^G_{T-3} > 0$ (i.e., assume government has reserves)

CASE 3

- Let T be the period of crisis and see what happens 3 period before that

Period T-2:

- Fixed exchange rate $E_{T-2} = \bar{E}; E^e_{T-1} = \bar{E}$
- Using IRP condition to find i_t: $1 + i_{T-2} = (1 + r^\star)\frac{E^e_{T-1}}{E_{T-2}} \Longrightarrow i_{T-2} = r^\star$
- Using money demand function to find M_t:

$$M_{T-2} = P_{T-2}\phi(\bar{c}, i_{T-2}) = E_{T-2}\phi(\bar{c}, r^\star)$$

$$M_{T-2} = \bar{E}\phi(\bar{c}, r^\star) \quad \longleftarrow \textit{Same with } M_{T-3}$$

- Seignorage revenue : $SR_{T-2} = \frac{M_{T-2} - M_{T-3}}{P_{T-2}} = 0 \quad \because M_{T-2} = M_{T-3}$ *(see above)*

$B^G_t - B^G_{t-1} = \frac{M_t - M_{t-1}}{P_t} - DEF_t$

- Using GBC to derive B^G_t: $B^G_{T-2} = B^G_{T-3} + SR_{T-2} - \underbrace{DEF_{T-2}}_{>0} > 0 \longrightarrow B^G_{T-2} < B^G_{T-3}$

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CASE 3

Period T-1 (1):

- Fixed exchange rate $E_{T-1} = \bar{E}; E_T^e = (1+\mu)\bar{E}$

- Using IRP condition to find i_t:

$$1 + i_{T-1} = (1 + r^\star)\frac{E_T^e}{E_{T-1}} = (1 + r^\star)\frac{(1+\mu)\bar{E}}{\bar{E}}$$

$$\longrightarrow \quad 1 + i_{T-1} = (1 + r^\star)(1 + \mu)$$

$$\boxed{\Longrightarrow i_{T-1} > r^\star \ (\because \mu > 0)}$$

- Key Result #6: Domestic nominal interest rate rises when a devaluation is imminent

CASE 3

Period T-1 (2):

- Using money demand function to find M_t:

$$M_{T-1} = P_{T-1}\phi(\bar{c}, i_{T-1}) \longrightarrow M_{T-1} = E_{T-1}\phi(\bar{c}, i_{T-1})$$

$$\boxed{M_{T-1} = \bar{E}\phi(\bar{c}, i_{T-1})}$$

- Thus: $M_{T-1} = \bar{E}\phi(\bar{c}, i_{T-1}) < \bar{E}\phi(\bar{c}, i_{T-2})$ $(\because i_{T-1} > i_{T-2} = r^{\star})$

(this is because money demand function is decreasing in interest rate, i_t)

Key Result #7: Domestic nominal money supply *falls* when collapse is imminent

CASE 3

Period T-1 (3):

- Seignorage revenue : $SR_{T-1} = \frac{M_{T-1} - M_{T-2}}{P_{T-1}} < 0$ $\because M_{T-1} < M_{T-2}$ (prev. slide)

Key Result #9: Seignorage revenue is *negative* when collapse is imminent

A CURRENCY RUN! Holders of domestic currency try to switch into the more stable currency (foreign currency) before domestic currency depreciates. This causes domestic nominal money supply to *fall* as individuals trade in their domestic currency for foreign currency.

- Residents exchange domestic currency for foreign one at the fixed rate. Central bank (CB) must honor the commitment to fixed rate.
- Residents gets foreign curr., CB gets domestic curr. (causing M↓)

CASE 3

Period T-1 (4):

- Using GBC to derive B_t^G:

Now two sources of drain on foreign reserves: ***DEF > 0 and SR < 0****. Hence foreign reserves* ***fall even faster than before****.*

$$B_{T-1}^G = B_{T-2}^G + \underset{(-)}{SR_{T-1}} - \underset{(+)}{DEF_{T-1}}$$

$$\longrightarrow \quad B_{T-1}^G < B_{T-2}^G$$

Moreover, $B_{T-1}^G = 0$ **because we know peg collapses at start of period *T* (which means foreign reserves must be zero at the start of *T*)**

CASE 3: BOP CRISIS (summary table 1)

- **Case 3: Country is maintaining fixed exchange rate $\bar{E}$ *and* running fiscal deficit of *DEF* > 0 every period**
  - **i.e., $\bar{E}$ and *DEF* are both fixed, unchanging *numbers***

	Period T-3	Period T-2	Period T-1	Period T
E_t	$E_{T-3} = \bar{E}$	$E_{T-2} = \bar{E}$		
E^e_{t+1}	$E^e_{T-2} = \bar{E}$	$E^e_{T-1} = \bar{E}$		
i_t (using IRP condition)	$1+i_{T-3} = (1+r^*)\frac{E^e_{T-2}}{E_{T-3}}$ $\rightarrow i_{T-3} = r^*$	$1+i_{T-2} = (1+r^*)\frac{E^e_{T-1}}{E_{T-2}}$ $\rightarrow i_{T-2} = r^*$		
M_t (using money demand function)	$M_{T-3} = P_{T-3}\phi(\bar{c}, i_{T-3})$ $M_{T-3} = E_{T-3}\phi(\bar{c}, r^*)$ $\rightarrow M_{T-3} = \bar{E}\phi(\bar{c}, r^*)$	$M_{T-2} = P_{T-2}\phi(\bar{c}, i_{T-2})$ $M_{T-2} = E_{T-2}\phi(\bar{c}, r^*)$ $\rightarrow M_{T-2} = \bar{E}\phi(\bar{c}, r^*)$		
SR_t	---	$SR_{T-2} = \frac{M_{T-2} - M_{T-3}}{P_{T-2}}$ $= 0$ (due to $M_{T-2} = M_{T-3}$)		
B^G_t (using GBC)	$B^G_{T-3} > 0$ (i.e., assume government has reserves)	$B^G_{T-2} = B^G_{T-3} + SR_{T-2} - DEF_{T-2}$ $\rightarrow B^G_{T-2} < B^G_{T-3}$ (Recall Key Result #3)		

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	Period T-2	Period T-1
E_t	$E_{T-2} = \bar{E}$	$E_{T-1} = \bar{E}$ (collapse hasn't happened yet...)
E^e_{t+1}	$E^e_{T-1} = \bar{E}$	$E^e_T = (1+\mu)\bar{E} > \bar{E}$ (...but individuals/markets expect it's imminent)
i_t (using IRP condition)	$i_{T-2} = r^*$	$1+i_{T-1} = (1+r^*)\frac{E^e_T}{E_{T-1}} = (1+r^*)\frac{(1+\mu)\bar{E}}{\bar{E}} \longrightarrow 1+i_{T-1} = (1+r^*)(1+\mu)$ $\longrightarrow i_{T-1} > r^*$ (due to $\mu > 0$) **Key Result #7: Domestic nominal interest rate rises when a devaluation is imminent**
M_t (using money demand function)	$M_{T-2} = \bar{E}\phi(\bar{c}, r^*)$	$M_{T-1} = P_{T-1}\phi(\bar{c}, i_{T-1}) \longrightarrow M_{T-1} = E_{T-1}\phi(\bar{c}, i_{T-1}) \longrightarrow M_{T-1} = \bar{E}\phi(\bar{c}, i_{T-1})$ KEY: $M_{T-1} = \bar{E}\phi(\bar{c}, i_{T-1}) < \bar{E}\phi(\bar{c}, i_{T-2})$ (due to $i_{T-1} > i_{T-2}$) (and because money demand function is ***decreasing*** in second argument) $\longrightarrow M_{T-1} = \bar{E}\phi(\bar{c}, i_{T-1}) < \bar{E}\phi(\bar{c}, i_{T-2}) = M_{T-2}$ **Key Result #8: Domestic nominal money supply *falls* when collapse is imminent**
SR_t	$SR_{T-2} = 0$	$SR_{T-1} = \frac{M_{T-1} - M_{T-2}}{P_{T-1}}$ < 0 (due to $M_{T-1} < M_{T-2}$) **A CURRENCY RUN! Holders of domestic currency try to switch into the more stable currency (foreign currency) before domestic currency depreciates. This causes domestic nominal money supply to *fall* as individuals trade in their domestic currency for foreign currency.** **Key Result #9: Seignorage revenue is *negative* when collapse is imminent**
B^G_t (using GBC)	$B^G_{T-2} < B^G_{T-3}$	$B^G_{T-1} = B^G_{T-2} + SR_{T-1} - DEF_{T-1}$ **Now two sources of drain on foreign reserves: *DEF* > 0 and *SR* < 0. Hence foreign reserves fall even faster than before.** $\longrightarrow B^G_{T-1} < B^G_{T-2}$ **Moreover,** $B^G_{T-1} = 0$ **because we know peg collapses at start of period *T* (which means foreign reserves must be zero at the start of *T*)**

CASE 3: BOP CRISIS (summary table 1 continued)

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CASE 3: BOP CRISIS (summary table 2)

- **Case 3: Country is maintaining fixed exchange rate $\bar{E}$ *and* running fiscal deficit of *DEF* > 0 every period**
  - **i.e., $\bar{E}$ and *DEF* are both fixed, unchanging *numbers***

	Period T-3	Period T-2	Period T-1	Period T
E_t	$E_{T-3} = \bar{E}$	$E_{T-2} = \bar{E}$	$E_{T-1} = \bar{E}$	
E^e_{t+1}	$E^e_{T-2} = \bar{E}$	$E^e_{T-1} = \bar{E}$	$E^e_T = (1+\mu)\bar{E}$	
i_t (using IRP condition)	$1+i_{T-3} = (1+r^*)\frac{E^e_{T-2}}{E_{T-3}}$ $\rightarrow i_{T-3} = r^*$	$1+i_{T-2} = (1+r^*)\frac{E^e_{T-1}}{E_{T-2}}$ $\rightarrow i_{T-2} = r^*$	$i_{T-1} > r^*$ (due to $\mu > 0$)	
M_t (using money demand function)	$M_{T-3} = P_{T-3}\phi(\bar{c}, i_{T-3})$ $M_{T-3} = E_{T-3}\phi(\bar{c}, r^*)$ $\rightarrow M_{T-3} = \bar{E}\phi(\bar{c}, r^*)$	$M_{T-2} = P_{T-2}\phi(\bar{c}, i_{T-2})$ $M_{T-2} = E_{T-2}\phi(\bar{c}, r^*)$ $\rightarrow M_{T-2} = \bar{E}\phi(\bar{c}, r^*)$	$M_{T-1} < M_{T-2}$	
SR_t	---	$SR_{T-2} = \frac{M_{T-2} - M_{T-3}}{P_{T-2}}$ $= 0$ (due to $M_{T-2} = M_{T-3}$)	$SR_{T-1} = \frac{M_{T-1} - M_{T-2}}{P_{T-1}}$ < 0 (due to $M_{T-1} < M_{T-2}$)	
B^G_t (using GBC)	$B^G_{T-3} > 0$ (i.e., assume government has reserves)	$B^G_{T-2} = B^G_{T-3} + SR_{T-2} - DEF_{T-2}$ $\rightarrow B^G_{T-2} < B^G_{T-3}$ (Recall Key Result #3)	$0 = B^G_{T-1} < B^G_{T-2}$	

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CASE 3: BOP CRISIS

- **Case 3: Country is maintaining fixed exchange rate $\bar{E}$ *and* running fiscal deficit of *DEF* > 0 every period**
  - **i.e., $\bar{E}$ and *DEF* are both fixed, unchanging *numbers***

	Period T-3	Period T-2	Period T-1	Period T
E_t	$E_{T-3} = \bar{E}$	$E_{T-2} = \bar{E}$	$E_{T-1} = \bar{E}$	
E^e_{t+1}	$E^e_{T-2} = \bar{E}$	$E^e_{T-1} = \bar{E}$	$E^e_T = (1+\mu)\bar{E}$	
i_t (using IRP condition)	$1+i_{T-3} = (1+r^*)\frac{E^e_{T-2}}{E_{T-3}}$ → $i_{T-3} = r^*$	$1+i_{T-2} = (1+r^*)\frac{E^e_{T-1}}{E_{T-2}}$ → $i_{T-2} = r^*$	$i_{T-1} > r^*$ (due to $\mu > 0$)	WHAT HAPPENS HERE?
M_t (using money demand function)	$M_{T-3} = P_{T-3}\phi(\bar{c}, i_{T-3})$, $M_{T-3} = E_{T-3}\phi(\bar{c}, r^*)$ → $M_{T-3} = \bar{E}\phi(\bar{c}, r^*)$	$M_{T-2} = P_{T-2}\phi(\bar{c}, i_{T-2})$, $M_{T-2} = E_{T-2}\phi(\bar{c}, r^*)$ → $M_{T-2} = \bar{E}\phi(\bar{c}, r^*)$	$M_{T-1} < M_{T-2}$	Depends on how monetary policy is conducted post-collapse…
SR_t	---	$SR_{T-2} = \frac{M_{T-2} - M_{T-3}}{P_{T-2}} = 0$ (due to $M_{T-2} = M_{T-3}$)	$SR_{T-1} = \frac{M_{T-1} - M_{T-2}}{P_{T-1}} < 0$ (due to $M_{T-1} < M_{T-2}$)	Topic(s) for a course in international finance
B^G_t (using GBC)	$B^G_{T-3} > 0$ (i.e., assume government has reserves)	$B^G_{T-2} = B^G_{T-3} + SR_{T-2} - DEF_{T-2}$ → $B^G_{T-2} < B^G_{T-3}$ (Recall Key Result #3)	$0 = B^G_{T-1} < B^G_{T-2}$	

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Balance of Payments Crisis

- 1991-mid-2001 (Pre-collapse phase)
  - Persistent fiscal deficits – no political will to balance budgets
  - Persistent decline in foreign reserves.
  - Low inflation – direct consequence of fixed exchange rate
- Late 2001 (BOP crisis)
  - Decline in foreign reserves worsened due to currency run
  - Argentine nominal interest rates rose in response to imminent deprecation
  - Fixed exchange rate abandoned in January 2002
    - (Temporarily reset its fixed rate to 1.4 peso/$, but soon after allowed it to float freely)
  - Floating rate ≈ 3 peso/$

Balance of Payments Crisis

- Since 2002 (Post-collapse phase)
  - Mixed record on inflation
  - Strong GDP growth following severe recession in 2002
  - High unemployment
  - Political independence of central bank still in question