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Chapter 6 - Government Influence on FX Rates

• FX Rate Systems

There are two pure FX Rate Systems:

- Flexible exchange rate (free float) system
- Fixed exchange rate system

One way to characterize these two systems is to look at the role of the Central Bank (CB) –i.e., the institution in charge of the domestic currency, domestic money supply and domestic interest rates.

• CB: Brief Review

A CB is a "bank." It holds:

- ◊ Assets: Foreign (international reserves of FC, mainly in FC bonds) + Gold + Domestic (mainly loans to domestic institutions and government securities)
- ◊ Liabilities: DC outstanding (backed by assets the CB owns) + Deposits of banks.

Note: Change in assets = Change in liabilities. That is, a purchase of an asset, say FC (or the unusual assets bought by CBs during the 07-08 financial crisis), results in an increase in the liabilities, through an increase in the domestic money supply (MS).

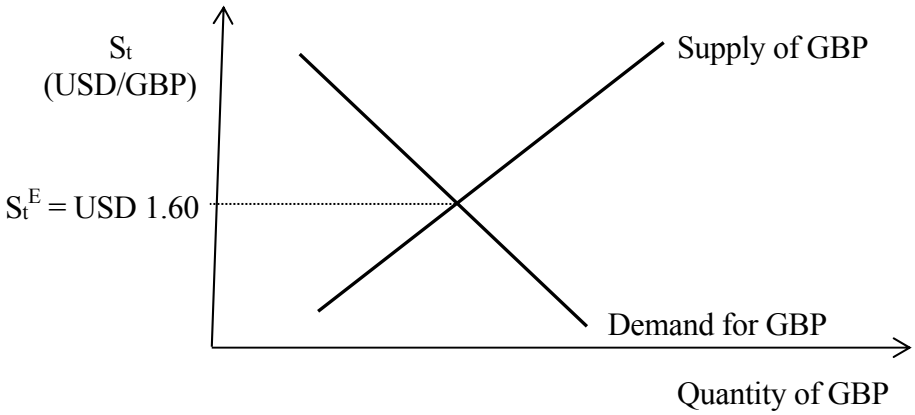
Originally, central banks were created as *lenders of last resort* ("bank of banks") and as supervisor of banks. This is the banking aspect of a central bank. But, today, central bank have other responsibilities: keep an eye on inflation (low) and the economy (full employment). This is the policy side of a modern central bank. Many times, both targets are conflicting targets (say, higher S_t promotes exports & economic growth, but increases I_d).

Around the world, CBs have different names: U.S. Federal Reserve System ("The Fed"), European Central Bank (ECB), Central Bank of UAE, Central Reserve Bank of Peru, Bank of Mexico, Swiss National Bank, Monetary Authority of Singapore, etc.

1. Flexible Exchange Rate System (Free Float)

In a *flexible FX rate system* the CB allows S_t to adjust to equate the supply and demand for foreign currency, as shown below in Figure 6.1:

Figure 6.1: Free Float - CB allows Supply and Demand to determine S_t



All the variables mentioned in Chapter 4 will affect S_t. In particular, international capital inflows (outflows) will decrease (increase) S_t. Whatever S_t is, the CB is fine with it.

- **Features of a Flexible FX System**
  - S_t reflects economic activity, through S & D for FC.
  - The exchange rate is subject to volatility.
  - Money supply is exogenous $\Rightarrow$ The CB can have an independent monetary policy.
  - Under certain assumptions (IS-LM model, perfect capital mobility) fiscal policy does not work.
  - External shocks (say, oil shocks or sudden outflows of capital) can be quickly absorbed by changes in S_t^E $\Rightarrow$ Quick(er) adjustments to shocks/disequilibrium.

With respect to the last point, Milton Friedman, Nobel Prize Winner, (1953) argued that under flexible exchange rates *"changes in S_t occur rapidly, automatically, and continuously and so tend to produce corrective movements before tensions can accumulate and a crisis develop."*

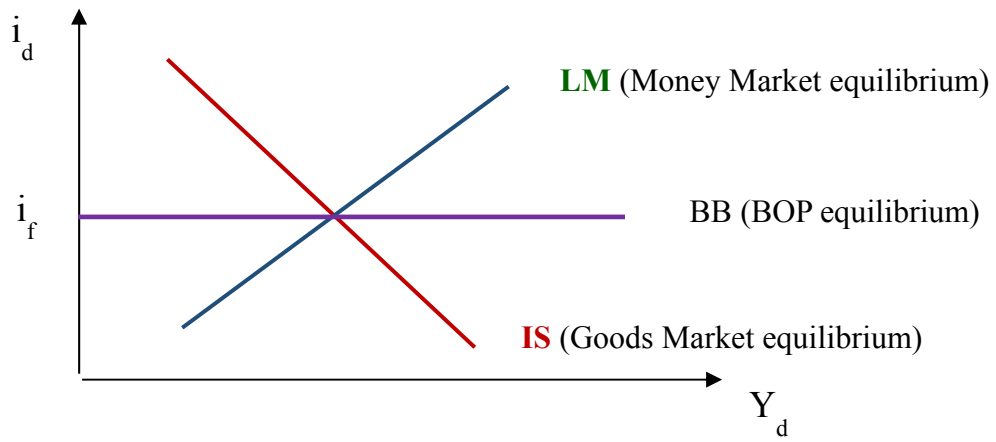
- **Brief Aside: The Mundell-Fleming Model = IS-LM + Perfect Capital Mobility**

Open macroeconomic model combining:
(1) Aggregate demand (IS and LM curves, representing equilibrium in goods and money markets)
(2) Aggregate supply (production function and labor market)
(3) BOP (=CA + KA)

The assumptions behind the Mundell-Fleming Model:
- Exchange rate regime: Flexible (Fixed, in the next section)
- Perfect capital mobility.
- Under utilized resources & no supply constraints –i.e., Keynesian world
- The Marshall-Lerner condition is satisfied –i.e., $S_t \uparrow (\downarrow) \Rightarrow CA \uparrow (\downarrow)$
- The price level, P_d, is fixed (in particular, no FX rate pass-through)
- No currency substitution (say, dollarization).
- Exchange rate expectations are static and/or there is no risk premium.
- P_f, Y_f, & i_f are given –i.e., not influenced at all by domestic changes.

Mundell-Fleming Model in a Free Float Economy
Monetary Policy: Increase in the Money Supply (MS↑) ⇒ LM (curve) ↓
Fiscal Policy: More government spending (G ↑) ⇒ IS (curve) ↑ .
Figure 6.2 shows the typical equilibrium IS-LM curves + BB (BOP equilibrium, $i_d = i_f$):

Figure 6.2: Equilibrium under Mundel-Fleming model - IS-LM + BB



• Why does monetary policy work (expand money supply, MS ↑)?
MS ↑ ⇒ **LM ↓** ⇒ i_d ↓ ⇒ Foreign Capital outflows ⇒ S_t ↑
⇒ CA ↑ **(IS ↑)** ⇒ Y_d ↑
• Why doesn't fiscal policy work (more government spending, G ↑)?
G ↑ ⇒ **IS ↑** ⇒ i_d ↑ ⇒ Foreign Capital inflows ⇒ S_t ↓
⇒ CA ↓ ⇒ **IS ↓** (back to original position)

2. Fixed Exchange Rate System

In a *fixed FX rate system* the CB is ready to buy and sell unlimited amounts of foreign currency at a fixed price, say S*= 3 DC/FC.

Sometimes, the CB pegs the value of the DC to a *basket of currencies*, say S*= 1.273 DC/FC_{Basket}, where FC_{Basket} is the price of a basket of exchange rates, usually trade-weighted.

Example: Hong Kong has a fixed exchange rate (a peg) system since October 17, 1983. The exchange rate is 7.8052 HKD/USD.

Note: The HKD is not fixed against all currencies, only against the USD. When the USD moves, the HKD moves. From 2010 to 2015, the USD moved widely against the EUR, taking the HKD for a ride, going from 11.50 HKD/EUR (April 24, 2011) to 9.15 HKD/EUR (January 8, 2015). ¶

In order to support the fixed parity S*, a CB needs enough FC reserves to make the system viable. At least, a CB needs to have enough reserves to purchase the total currency circulating in the public plus required bank's reserves at the CB −i.e., *high-powered monetary base*− at the fixed exchange rate, S*. When a CB holds this amount, it holds 100% FC reserves.

Having enough reserves may be a problem for CBs. A CB *credibility* plays a big role. If there is not enough FC reserves and the demand for FC cannot be met, the CB has a problem: *A currency crisis*.

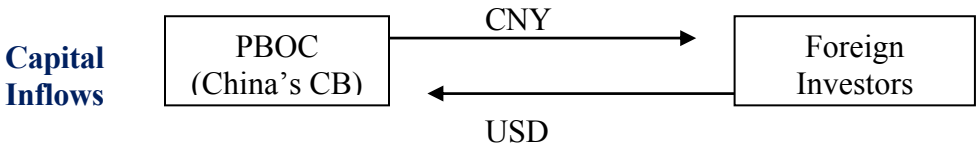
A solution to the potential lack of FC reserves is to keep 100% reserves outside the reach of a CB/government. This arrangement is called *Currency Board*. Small Caribbean countries (Grenada, Saint Lucia, Dominica, etc.) have a fixed exchange rate system (pegged to the USD) with a currency board.

Every time somebody buys FC from the CB, the domestic money supply decreases. Every time somebody sells FC to the CB, the domestic money supply increases. Thus, the domestic money supply is endogenous. Thus, international capital flows will affect the domestic money supply.

A CB gives up the control of the MS under a fixed system.

Example: International capital inflows
For most of the past 30 years, China has maintained a fixed FX rate system and received vast amounts of capital inflows. Under this situation, the People's Bank of China (PBOC, China's CB) exchanges yuans (CNY) for FC, say USD. Exhibit 6.1 displays the currency exchange between the PBOC and foreign investors in China:

Exhibit 6.1: Effect of Capital Inflows under a Fixed FX System



That is, international capital inflows increase not only the PBOC's international reserves of FC, but also China's money supply. The PBOC will invest the received USD and buy U.S. government securities, say T-bills.

Note: The PBOC may not like this increase in the money supply (along with lower interest rates and inflationary pressures) and may take some counteraction to nullify or mitigate the increase in China's money supply. A CB counteraction is called *sterilization.* For example, the PBOC can increase the bank's reserve-requirement ratio. ¶

• **Terminology**: Devaluation/Revaluation
A *devaluation* (*revaluation*) occurs when the price of FC under a fixed FX rate regime is increased (decreased) by the CB. (Remember: depreciation/appreciation occurs in a flexible FX rate system.)

Example: During the previous decade, China's yuan (CNY) was fixed at 8.27 per USD. On July 21, 2005, it was revalued to 8.11 CNY/USD, following the removal of the peg to the USD. ¶

Note: In a Fixed FX rate system, the possibility of a currency crisis creates risk: *devaluation risk*. The magnitude of this risk depends on the CB credibility –i.e., very credible CB, devaluation risk is zero.

• Fixed FX System: Variations

Some CBs have a fixed exchange rate system, but S_t is not really fixed:

- "*Target zone system*," where the exchange rate is kept within a band (the *target zone*).
- "*Crawling peg system*," where the fixed exchange rate is regularly adjusted, usually to keep up with domestic inflation.

Example: On July 21, 2005, the People's Bank of China (China's CB) announced that the CNY would be pegged to a basket of foreign currencies, rather than being only tied to the USD.

The CNY would trade within a narrow 0.3% band against the basket of currencies. The basket is dominated by the USD, EUR, JPY and KOW.

The Central Bank of Chile, in 1983 (adjusted in 1984), adopted a crawling peg with a fluctuation band of ±0.5. The CLP/USD was adjusted according to the previous month's inflation minus an estimate of U.S. inflation (around 2% annually). ¶

• Black Market

In some countries, the exchange rate is fixed by the government, say at S*. But, it is *not* a fixed exchange rate system. The government sells FC at the official rate only for some transactions, for example, "favored" imports. For all non-official transactions, a *free market* -or in some cases, a *black market*- is created. Obviously, S* is set below the equilibrium S_t^E.

Example: In 2013, Argentina had three loosely recognized exchange rates. The official ("white") rate was 6.205 ARS/USD; the tourist rate (official + 35% tax) 9.377 ARS/USD and the black market rate ("blue") was 9.62 ARS/USD.

If Argentina were to have a true fixed exchange rate system, an equilibrium exchange rate can be easily found: Monetary Base (in ARS)/CB Reserves (in USD). For 2013,

$S_{fixed=2013}$ (fixed equilibrium) = ARS 342,132/USD 31,100 = 11.001 ARS/USD. ¶

• Features of a Fixed FX Rate System

- Money supply is endogenous (A CB does not have an *independent* monetary policy!).
- Exchange rate has no/low volatility; actually, S_t inherits the volatility of the FC the CB fixes the DC against. (No or low volatility: Good for trade, investments and inflation control.)
- Under certain assumptions (same as above), fiscal policy works.
- If a CB does not have enough reserves, *credibility* is crucial.
- Since S_t is fixed, external shocks have to be absorbed through prices (including wages).

Note: The last point tends to be the Achilles heel of the fixed FX rate system. Since prices tend to be rigid (especially, wages), adjustments to shocks and/or imbalances tend to be slower, and, usually, have contractionary effects.

• Mundell-Fleming Model in a Fixed FX Rate Economy

Why dose fiscal policy work (more government spending, G ↑)?

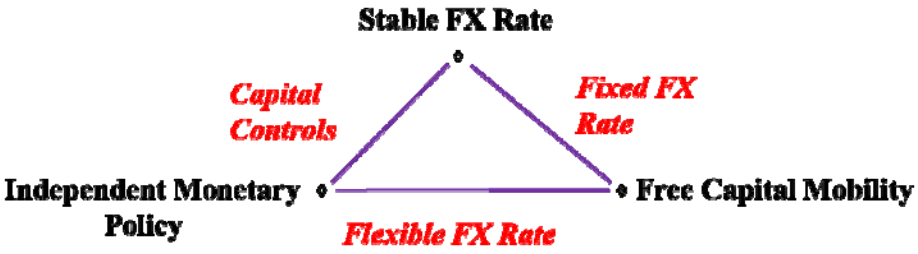
$G \uparrow \quad \Rightarrow \mathbf{IS} \uparrow \Rightarrow i_d \uparrow \Rightarrow$ Foreign Capital inflows $\Rightarrow$ MS ↑

$\Rightarrow$ **LM** $\downarrow$ expansion of MS amplifies effect on Y_d
(fiscal + monetary effects!)

• **Trilemma** (due to Robert Mundell (1962), Nobel Prize Winner)
It is impossible for a country to have at the same time:
- ◊ A stable (fixed) FX regime.
- ◊ Free international capital mobility -i.e., no capital controls.
- ◊ An independent monetary policy.

A country that attempts to have these three policies at the same time is said to have an *inconsistent* fixed exchange rate system. Only two of the three are possible, as illustrated in Figure 6.2. This policy trilemma is also called "*the impossible trinity*."

Figure 6.2: The Impossible Trinity



Typical Trilemma problems
Under a fixed exchange rate regime, the local government substantially increases the domestic money supply (MS_d) to finance deficit spending or to mitigate an external shock: Higher $MS_d \Rightarrow i_d \downarrow \Rightarrow (i_d - i_f) \downarrow \Rightarrow$ Capital will leave the country (international capital outflows) $\Rightarrow$ CB's FC reserves $\downarrow$. In a free float, $S_t \uparrow$ (>S*).

Under a fixed exchange rate regime, international interest rates increase (say, $i_{USD} \uparrow$), but, the CB, to avoid its negative effect on GDP, does not match this increase (and, thus, attempts an independent monetary policy!): International interest rates increase $\Rightarrow i_f \uparrow \Rightarrow (i_d - i_f) \downarrow \Rightarrow$ International capital outflows $\Rightarrow$ CB's FC reserves $\downarrow$.

In both situations, in a free float, $S_t \uparrow$ (>S*). But, the exchange rate is fixed at S*: Now, in DC terms things are undervalued relative to rest of the world.

Note: If we think of the free float S_t as the "true equilibrium" (or "shadow") exchange rate, the divergence between S_t and the fixed S* signals a potential profit opportunity for speculators.

• **Currency crisis**
When faced with an increasing gap between the shadow S_t and S*, speculators realize that if the CB abandons the fixed FX rate system, a sizable profit can be made from buying FC at S* (usually, by borrowing DC to buy FC).

Q: Why would a CB stop supporting S*? Because it is running out of FC reserves or because the costs

of supporting S* are higher than the benefits. Then, when a CB does not have enough reserves and/or loses credibility, speculators (and everybody else!) run to exchange DC for FC at the fixed exchange rate, S*. This is called a "*currency run*" or "*speculative attack*." Unless some measures are taken to stop the run, the CB soon runs out of FC (currency crisis).

Usual solution: In general, domestic residents and governments do not like devaluations of the DC, since it increases inflation, decreases real wages, and has contractionary effects on the real economy. Governments often try to make it difficult to buy FC, imposing a set of restrictions on FC transactions. Typical measures: import bans, new capital outflows regulations and travel restrictions. These measures are, at best, temporary solutions. They create a black market, with an increasing gap between the shadow S_t and S*.

Definite solution to a currency crisis*:* Float the currency.

Example of the "usual" solution: In January 2016, the Nigerian President, Muhammadu Buhari, rejected a devaluation of the naira (NGN). During the previous months, the Central Bank of Nigeria (CBN) restricted the supply of USD, banned the import of a long list of goods, from shovels and rice to toothpicks. In January 2016, the official exchange rate was 199 NGN/USD, while the black market rate was around 300 NGN/USD.

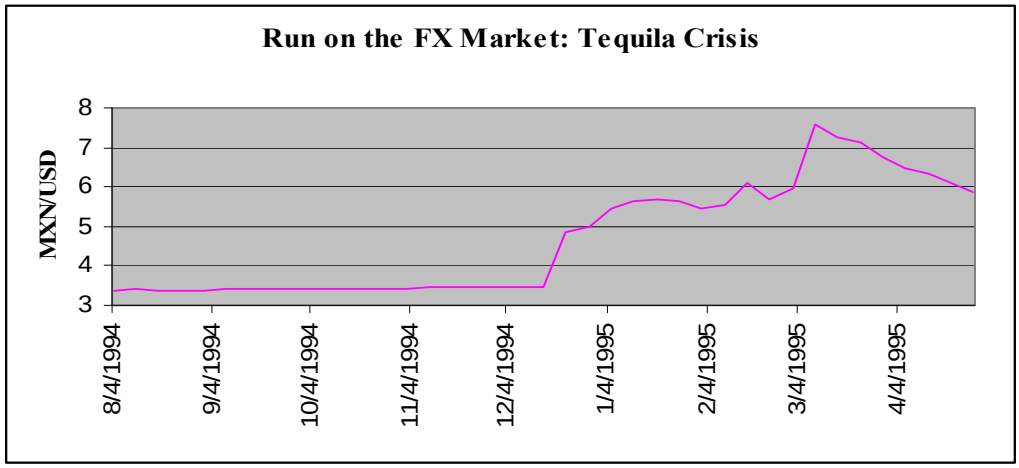
Finally, in June 2016, the CBN decided to float the currency, which quickly depreciated to 285 NGN/USD. ¶

Currency crises are not uncommon. Laeven and Valencia (2012) report 218 currency crisis during the period 1970-2011. They are often related to an "*inconsistent*" fixed FX system. In these cases, the credibility of a CB monetary policy weakens and the likelihood of a speculative attack increases. Understanding what may trigger a currency crisis can be very profitable!

Predictors of a currency crisis ("*early warning signals*"): Low FC reserves, low real exchange rate (DC overvalued, often due to high domestic inflation), high government deficits, weak financial system, high short-term debt, asset/real estate bubbles financed by easy credit, etc.

Examples of currency crises: India '91, U.K. '92 (Black Wednesday), Mexico '94 (Tequila crisis), Thailand/Malaysia '97 (Rice crisis), Russia '98 (vodka crisis), Argentina '01 (Tango crisis), Iceland '08, Nigeria '16. Exhibit 6.2 shows the MXN/USD before and after the Tequila crisis (mid-Dec '94).

Exhibit 6.2: USD/MXN and the Tequila Crisis



Mexican USD reserves went from USD 18 billion in October 1994 to USD 5 billion in December 1994, when the decision to abandon the fixed exchange rate against the USD was made.

Overall, Mexico spent USD 25B in FC reserves and borrowed USD 25B (from the U.S. Fed) to defend the peso's USD peg. ¶

On average, a currency crisis is followed by a 30% drop of the value of DC. In many cases there is a temporary higher drop (say, 50%), before reverting to a value closer to the average. When a crisis is very serious, a 75% or higher drop is possible (Indonesia '97, Argentina '01).

• Twin Ds

In general, a currency crisis is a product of serious macro-economic problems. These macro-economic problems often lead to liquidity problems for the government and, in these situations, sovereign defaults –a government decides not to pay its debt, usually bond debt- are not rare. Sovereign defaults may also trigger a large devaluations. These are the "*Twin Ds*": *Default* and *Devaluation*.

Reinhart (2002) reports that over the period 1970-1999 the probability of a devaluation, once a country had a default event, is 84%; while without a default even the probability of a devaluation is only 17%. A default is usually followed by a large devaluation: in a 6-year window around a default event, the change in value of the domestic currency is 45% compared to no default events.

Using more data, Na, Schmitt-Grohe, Uribe and Yue (2017) estimate the probability of devaluation conditioned on a default event is lower: 48%.

Na et al. (2017) suggest that large devaluations around default events are needed to realign real wages to avoid widespread unemployment. In their simulations, if a country does not devalue its currency unemployment increases by 20%.

• Fixed FX Rate Regime in Emerging Markets: Importing good behavior

A fixed FX rate is considered transparent and a simple anchor for monetary policy. Countries with

weak institutions, usually less developed/emerging markets, can "import" monetary credibility by anchoring to a currency with a credible central bank, say the Fed or the ECB.

Another advantage for emerging markets: A fixed FX regime tends to reduce transaction costs and FX risk. In countries with less developed financial sectors, economic agents may not have the financial tools to hedge long-term currency risks. A fixed FX regime will help in this regard.

• Fixed or Floating?
Both regimes have pros and cons. There is no clear winner. Regime choices should reflect the individual characteristics of an economy. However, we do observe that large economies with sound monetary and fiscal policies and good institutions (say, an independent CB) prefer a flexible FX rate regime. This is fine: a flexible FX rate regime tends to insulate better a country from external shocks and/or imbalances.

On the other hand, we also observe that small or less developed countries with a history of poor institutions and/or credibility problems have relied on fixed FX rate regimes to fix problems. Some of these countries have had consistent monetary policies since the adoption of the fixed FX rate, and the fixed FX rate regime has served them well. For this reason, they have been reluctant to change the FX rate regime.

As Timothy Adams, Treasury Under Secretary for International Affairs, said in 2006, regarding the choice of FX regime: *"In particular, there is no substitute for sound fiscal and monetary policies and resilient institutions."*

The International Monetary Funds classifies the different currency arrangements of its members. In 2017, the IMF classified 54% of currencies as "*anchored*" (fixed FX rate), another 20% as "*stabilized*" (with an anchor, but allowed to vary in some way), and 26% as "*floating*" (occasional CB Intervention, see below, is acceptable).

3. Mixed FX System

In practice, the exchange rate system in many countries is a mixture: *managed* floating (also called, *dirty floating*):

> A CB allows the FX Market to determine S_t. But, from time to time, the CB takes some actions with the intention to influence S_t. These actions are called *Central Bank intervention* in the FX Market. For example, the central bank buys or sells foreign currency to change S_t.

This is the usual FX rate system in developed countries.

• Central Bank Intervention
CBs have economic models to determine what they believe is an equilibrium S_t. Using these models, a CB determines a range for S_t (a *trading band)* $\Rightarrow$ S_t should move between $S_{t,L}$ and $S_{t,U}$.

If S_t is within the range ($S_{t,L} < S_t < S_{t,U}$), CB does nothing (free float system!)
If S_t is above $S_{t,U}$ ($S_t > S_{t,U}$), CB determines FC is overvalued (or "too" expensive) $\Rightarrow$ CB intervention

If S_t is under $S_{t,L}$ ($S_t < S_{t,L}$), CB determines FC is undervalued (or "*too cheap*") ⇒ CB intervention

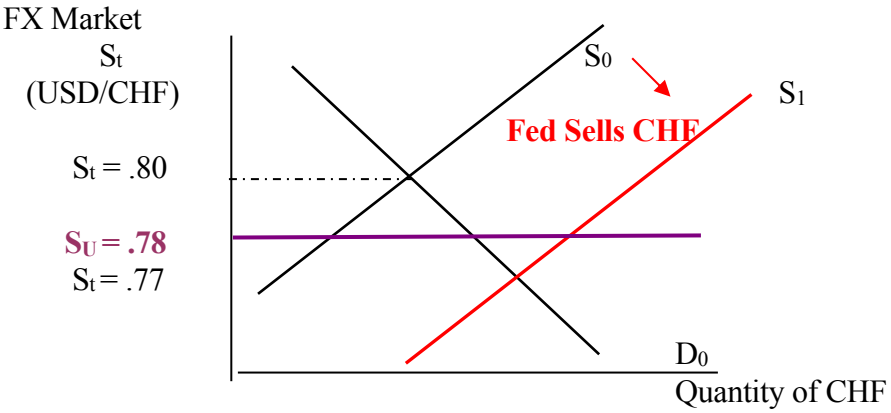
Summary: CB Intervention

"Appreciating" FC ($S_t > S_{t,U}$) ⇒ CB sells FC.
"Depreciating" FC ($S_t < S_{t,L}$) ⇒ CB buys FC.

Example: The Fed (U.S. CB) considers the CHF overvalued or $S_t > S_{t,U}$.

⇒ The Fed intervenes in the FX market to stop the appreciation of the CHF against the USD, as shown below in Figure 6.3:

Figure 6.3: Central Bank Intervention in the FX Market



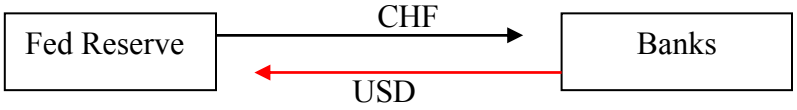
The Fed determined $S_U = .78$ USD/CHF.

Now, demand for CHF has increased –suppose Swiss interest rates are up. New $S_t = .80$ USD/CHF. The Fed determines the $S_t = .80$ USD/CHF is too high (CHF too expensive) since $S_t > S_{t,U}$.

Fed FX intervention ⇒ Sell CHF

Exhibit 6.3: CB Intervention in the FX Market – Effect on Money Supply

FX Int



As shown in Exhibit 6.4, the Fed's FC reserves (CHF) and the U.S. Money supply are decreased.

Note: The arrows above are a simplification of three transactions. Technically speaking, the Fed sells Swiss government securities (in CHF) to a Swiss commercial bank, which pays the Fed through a deposit in a U.S. commercial bank. Then, the Fed debits the reserves of the U.S. commercial bank. ¶

In general, CB FX intervention is justified by arguing that the CB has better information (CB knows the true model for S_t) to determine S_t^E –i.e., the equilibrium value for S_t. If this is not the case, the CB may be setting a "*wrong rate*," which can have side effects.

• CB FX Intervention Issues:

1. Implicit notion of "overvaluation/undervaluation" in FX market. The *wrong rate* problem.
   ⇒ Q: Do CB have "superior" information –i.e., do they know better than the FX Mkt?
   A: Not clear consensus in the academic literature: Sometimes CBs lose millions, sometimes CBs make millions. However, there is some evidence that shows that CB purchases of FC tend to be associated with subsequent FC appreciation. This evidence is taken to support the *leaning-against-the wind* behavior by CBs.
2. CB can generate FX instability:
   ⇒ Uncertainty over CB actions increases FX volatility and risk (what a CB dislikes!)
   Academic studies tend to find that CB intervention does increase FX volatility.
3. Potential conflict with other countries:
   ⇒ When a CB intervenes in the FX market to depreciate the DC to boost domestic exports, trading partners will be affected. This type of FX intervention is called *beggar-they-neighbor* devaluation. Popular in the 1930s.

Despite these issues and the academic sentiment that FX intervention is not worth it, central banks do intervene in FX markets. In a 1999 BIS survey of CBs, the percentage of business days on which CB report intervening from 0.5% to 40% percent, with a 4.5% median.

The largest player by far is Japan. For example, between April 1991 and December 2000, the Bank of Japan bought USD on 168 occasions for a cumulative amount of USD 304 billion and sold USD on 33 occasions for a cumulative amount of USD 38 billion.

Japanese interventions dwarf all other countries' official intervention in the foreign exchange market; for example, it exceeds U.S. intervention over the same period by a factor of more than 30.

• CB Intervention: Details

According to a 1999 BIS survey, CB interventions transactions almost always (95%) are conducted at least partially in spot markets. Some CBs also use the forward market, perhaps in conjunction with the spot market to create a swap transaction.

During FX intervention, CBs tend to deal with major domestic and, less often, foreign banks.

Some countries have large FX reserves, which can be used to influence the value of exchange rates. For example, by the end of 2014, China and Japan had the largest FX reserves in the world, USD 3.9 trillion and USD 1.2 trillion, respectively. Saudi Arabia was in third place with USD 0.74 trillion (& the U.S. was in 13th place with USD 0.13 trillion.)

But, large FX reserves are not necessary in many markets. In emerging markets, CBs have a huge potential “firepower,” since the ratio of official reserves to average daily turnover is very high. On average, official reserves were 15 times the size of daily turnover in emerging market currencies, compared with less than half in smaller industrial countries.

When a CB has firepower, sometimes just a rumor or the verbal threat of CB FX intervention can bring the FX market in line with the CB's desired valuation. This type of verbal intervention is referred as *jawboning*. It is cheap and, sometimes, effective.

Example: Jawboning at work
On September 6, 2011, the Swiss National Bank (SNB) announced a "minimum" exchange rate of 1.20 CHF/EUR, saying that the SNB would buy "unlimited quantities of foreign currency." The CHF fell from 1.11 CHF/EUR to 1.20 CHF/EUR almost immediately. ¶

The actual size of a CB FX intervention depends on the reaction of the FX market. In general, if the CB finds the initial response to be positive, the size of the intervention will be cut. Neely (2001) found, in a sample of 24 countries, that in 39% of cases it took just a few minutes to observe the desired effect –but, in 49% it took a few days or more!

On average, during 2002-2004, the size of an FX intervention –as a percentage of average daily FX market turnover– was in the interval 5% to 12%.

Most central banks intervene secretly, releasing actual intervention data with a lag, if at all. Some authorities, like the SNB, always publicize interventions at the time they occur.

3.1 CB Intervention: Sterilized and Non-Sterilized

FX Intervention affects Money Markets $\Rightarrow$ Money supply is affected (& also interest rates).

A CB might not like to change interest rates in the domestic economy, especially increasing interest rates if the economy is in a recession or decreasing interest rates if the economy is doing well.

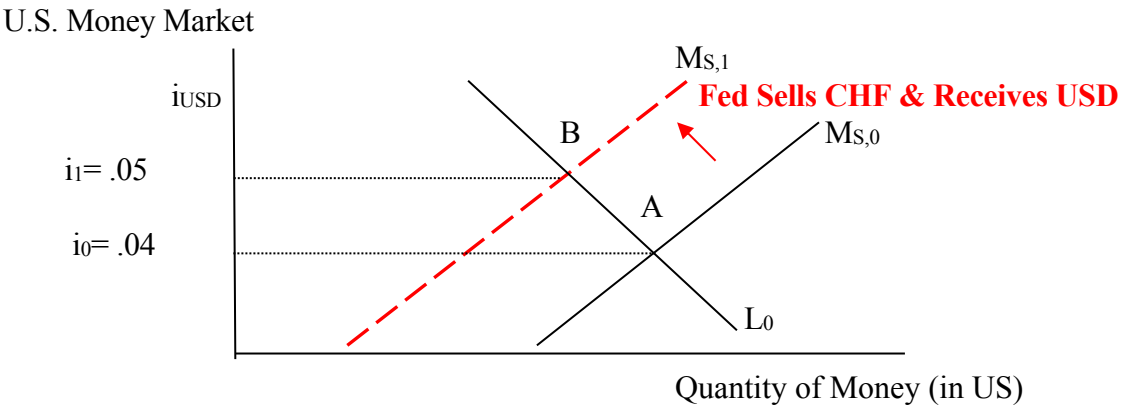
The counter actions taken by the CB to neutralize/mitigate the effect of CB FX intervention in domestic Money Market are called *sterilization*. If the CB coordinates FX Intervention with a counteraction to mitigate the effects on domestic Money Markets, the intervention is called *sterilized.* If, on the other hand, the CB allows the FX Intervention to affect domestic Money Markets, the intervention is called *non-sterilized.*

Usual sterilization tools: Open Market Operation (OMO), bank reserve-requirement ratios.

Example (continuation): The Fed considers the CHF overvalued :
Fed FX intervention $\Rightarrow$ Fed Sells CHF & Receives USD

As shown in Figure 6.4 and Exhibit 6.4 the effect of the Fed's intervention is a decrease in the U.S. money supply, increasing interest rates from 4% to 5%.

Figure 6.4: CB Intervention in the FX Market - Effect on Money Markets



Fed's unwanted effect from FX Intervention (Fed sells CHF): $M_S \downarrow \Rightarrow$ interest rates (i_{USD}) $\uparrow$

Sterilization: The Fed uses an OMO to counteract the effect of FX intervention in Money Markets.
$\Rightarrow$ OMO: Fed buys T-Bills to increase M_S (*sterilized intervention*), as shown in Exhibit 6.3.

Exhibit 6.4: OMO to Sterilize Effect of CB Intervention on FX Market

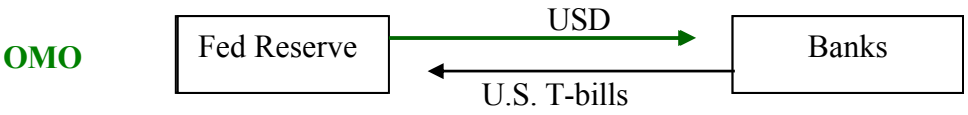


Figure 6.5 shows the sterilizing effect on the U.S. Money Supply of the OMO:

Figure 6.5: CB Sterilized Intervention – No Effect on Money Markets

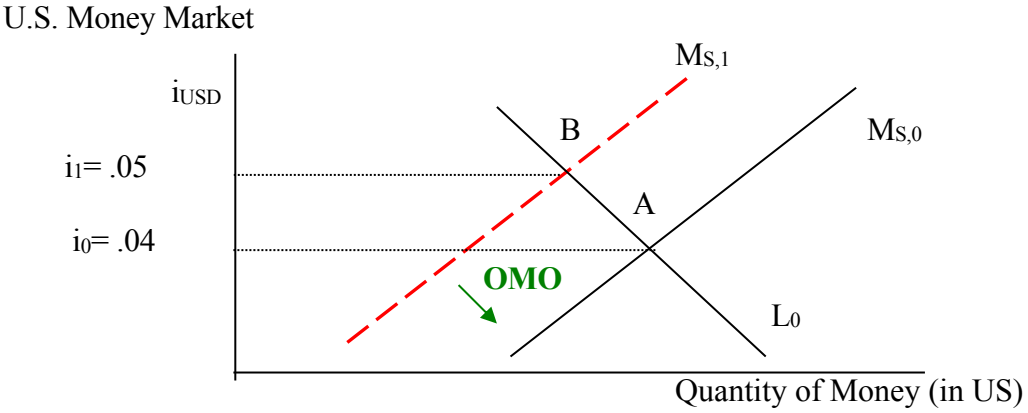
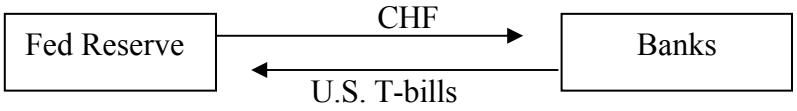


Exhibit 6.5 shows the net effect of a well executed sterilized intervention.

Exhibit 6.5: Net effect: OMO + Fed FX Intervention



Note: Instead of using an OMO, the Fed can decrease the bank reserve-requirement ratio. This will also increase the U.S. money supply. ¶

• Sterilized Interventions: Side Effects

Although sterilized intervention does not change the domestic MS, it does change the composition of the Fed's (and, in equilibrium, the public's) mix of domestic and foreign assets. This creates a *balance sheet effect.* Depending on the rates of return of the assets involved, this effect can be positive or negative for the CB. In general, for major currencies, this effect is very small. But for minor currencies, the balance sheet effect can be substantial.

Another side effect may materialize if the CB can successfully maintain for a while S_t artificially high/low and, then, keep money markets out of sync with the FX Market. For example, suppose a CB keeps sterilizing to keep S_t low (DC overvalued). Then, the CB is forcing the economy, as whole, to subsidize the import sector (and domestic consumption) and leaving its domestic producers in a tough competitive situation.

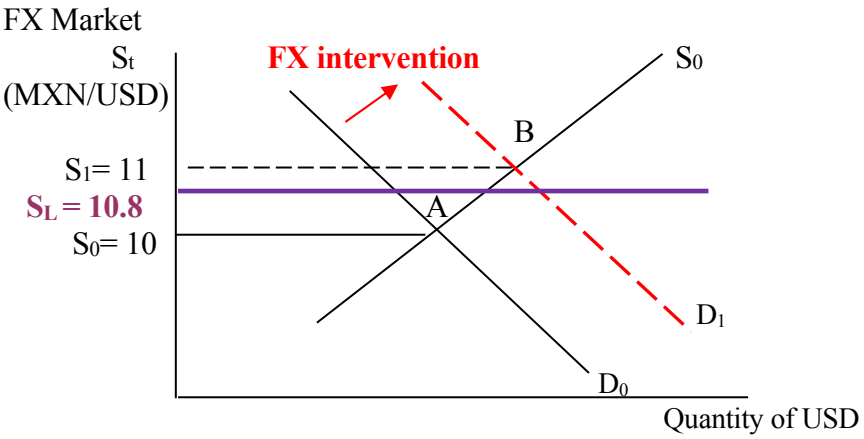
For a short time, the side effects can be tolerated; for a long time, they can lead to resource allocation problems.

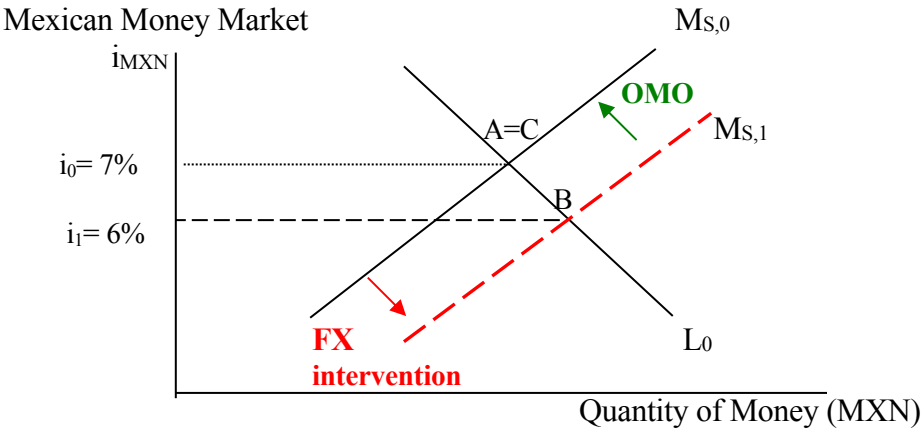
In addition, banks may not like the situation of having to hold large amounts of government bills (T-bills) and/or having high reserve-requirement ratios. Both situations will reduce bank's profits.

Example: The Banco de México (Banxico, México's CB) considers the USD undervalued, say $S_t < S_L$, with S_L=10.8 MXN/USD

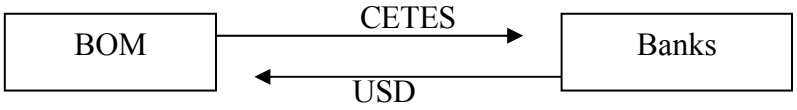
⇒ Banxico decides to intervene, but does not want to affect local interest rates. Thus, it will use an OMO (CETES: Mexican T-bills).

Original Situation:	Point A (S_0= 10 USD/MXN & i_0=7%)
Banxico intervention in FX market (Buy USD/Sell MXN)	Point B (S_1= 11 USD/MXN & i_1=6%)
Sterilization intervention (OMO: Buy MXN/Sell CETES)	Point C (S_1= 11 USD/MXN & i_0=7%)





Net effect: OMO + Banxico FX Intervention



Banxico will invest the USD in U.S. T-bills, which have a lower effective yield than the CETES (now, with even a greater yield: 7%!) creating a negative balance sheet effect (if sterilization works the change in S_t is zero).

Note: If Banxico keeps sterilizing for a long time, keeping $S_t > S_t^E$, Mexico subsidizes its export sector (and protects its domestic sector from foreign competition). In addition, for the given S_t, Mexican interest rates will be higher, affecting consumption and investments. ¶

• Sterilized Interventions: Durable Effects on S_t

There are two main channels through which sterilization can have a more durable effect on S_t: (1) the *portfolio balance channel* and (2) the *signaling channel*.

(1) *Portfolio balance channel*: Suppose Banxico intervenes to support the USD. Then, banks buy CETES and sell USD, which used to be held in T-bills. Then, the relative supply of domestic to foreign bonds increases. If domestic and foreign bonds are *imperfect substitutes*, then, their relative prices would change in favor of the foreign bonds, increasing S_t.

(2) *Signaling channel*: Agents perceive a CB intervention as signaling a CB's intentions, regarding its future monetary policy.

• Sterilized Interventions: Do They Work?

In the short-run, sterilizations work, affecting S_t in the direction the CB wanted. But the evidence regarding lasting effects on S_t is mixed and it tends to be on the negative side, especially for major currencies.

Sustaining sterilizations can be costly, due to the balance sheet effects. In Banxico's example, CETES yield 7%, while US T-bills have a substantial lower yield. Over time, these costs can be difficult to bear.

Mohanty and Turner (2005) report that, between 2000 and 2004, the CBs of Korea, the Czech Republic, and Israel issued currency-stabilizing bonds of values equivalent to 300%, 200% and, 150% of their respective reserve money for the purpose of sterilization operations. Interest payments, when domestic interest rates go up, render sterilization operations too costly to last.

CHAPTER 6 - BONUS COVERAGE: CENTRAL BANKS

A CB is a "bank." It holds assets (foreign exchange, gold, and other financial assets) and liabilities (mainly the currency outstanding, backed by assets the CB owns, and deposits by financial institutions). A CB may "create" new money, usually backed by the full faith and credit of the government.

CBs generally earn money by issuing currency notes and "selling" them to the public for interest-bearing assets, such as government bonds. Since currency usually pays no interest, the difference in interest generates income. In most CB systems –for example, in the U.S. and in Europe-, this income is remitted to the government.

Although a CB generally holds government debt, in some countries the outstanding amount of government debt is smaller than the amount the CB may wish to hold. In many countries, CBs hold significant amounts of assets denominated in foreign currency, rather than assets in their own national currency, particularly when the national currency is fixed to other currencies.

Any central bank purchase (sale) of assets automatically results in an increase (decrease) in the domestic money supply.

Table Appendix 6
U.S. Federal Reserve Balance Sheet (December 2017)

Consolidated U.S. Fed Balance Sheet (in USD billions)			
Liabilities		***Assets***	
Federal Reserve Notes	1,569.1	U.S. Treasuries	2,454.2
Reverse Repurchase Agreements	386.8	Mortgage Backed Securities	1,764.9
Deposits	2,445.1	Gold	11.0
Other liabilities	6.3	SDR	5.2
Total	***4,407.3***	Foreign Currency Denominated Assets	21.2
		Central Bank Liquidity Swaps	12.0
Capital Account	***41.4***	Other assets	180.2
Capital paid in	31.4	***Total***	***4,448.7***
Surplus	10.0		

The difference between the Assets and Liabilities represents the Capital Account (USD 41.4 billion) –i.e., the earnings of the U.S. Fed. In the Capital Account, the surplus represents the retained earnings not paid to the Department of Treasury (USD 10 billion).

Originally, central banks were created as *lenders of last resort* ("bank of banks") and as supervisor of banks. This is the banking aspect of a central bank. But, later central bank were given other responsibilities: keep an eye on inflation (low) and the economy (full employment). Many times, these are conflicting targets. For example, in a recession, a lower S_t promotes exports and, thus, economic growth, but, a lower exchange rate increases the prices of imports and, thus, inflation.

• Policy instruments

A CB has two main targets: keep inflation low and the economy close to full employment. To achieve these goals, CBs have several monetary policy instruments. The most important ones are:

- ◊ Open market operation (OMO)
- ◊ Bank reserve requirement

- ◊ Interest rate policy

• OMO (Open Market Operations)

Through OMO, a CB puts money in and takes money out of the banking system. This is done through the sale and purchase of government securities (in the U.S., U.S. Treasury bills). Each time it buys securities, exchanging money for the security, it raises the money supply. Conversely, selling of securities lowers the money supply. Buying of securities thus amounts to printing new money while lowering supply of the specific security.

The main OMOs are:

- ◊ Temporary lending/borrowing of money for collateral securities ("Reverse Operations" or "repurchase operations", otherwise known as the "*repo*" market). These operations are carried out on a regular basis, where fixed maturity loans are auctioned off.
- ◊ Buying or selling government securities ("direct operations") on ad-hoc basis.
- ◊ Foreign exchange operations such as FX swaps.

All of these interventions can also influence the FX market and, thus, S_t. For example the People's Bank of China and the Bank of Japan have on occasion bought several hundred billions of U.S. Treasuries, in order to stop the decline of the USD against the CNY and the JPY, respectively.

• Interest Rate Policy

CBs attempt to balance I_d and Y_d; following a *policy rule*:

$$i_d = f(I_d, Y_d - Y_{\text{Full Employment}})$$

In practice, CBs tend to follow a *Taylor rule*:

$$i_d = \omega + \lambda I_d + \theta \, Y\_gap$$

using the following parameters:

$\omega = r^* + \gamma (-I_d^*) = 2\% + .5 * (-2\%) = 1\%$

$\gamma = 0.5$

$\lambda = 1 + \gamma = 1.5$

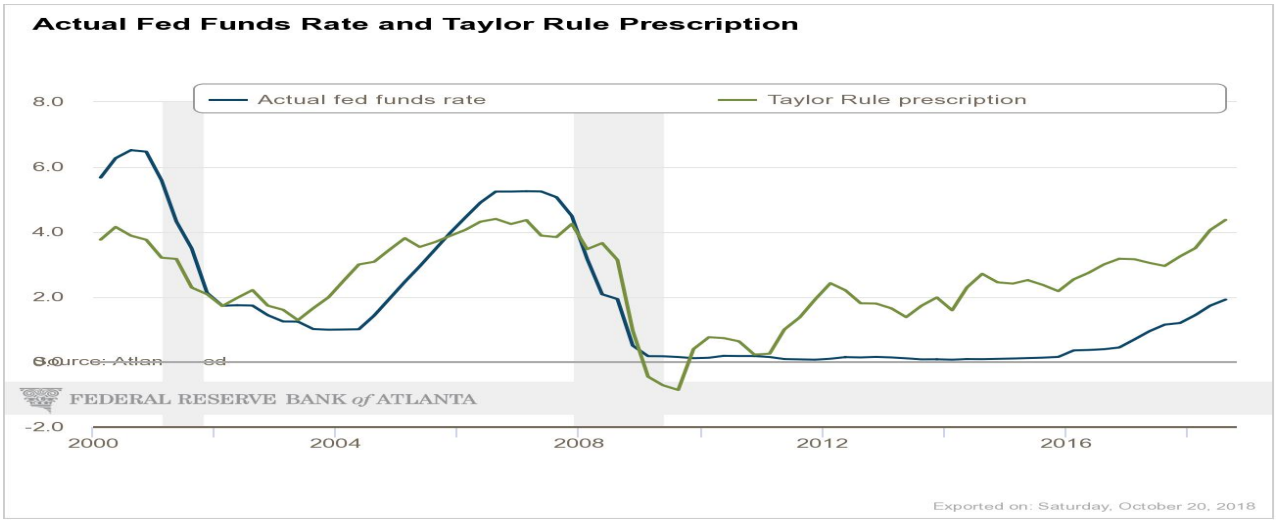
$\theta = 0.5$

r^* = real interest rate = 2%

I_d^* = CB's target I_d = 2%

$Y\_gap = Y_d - Y_{\text{Full Employment}}$

Below, we show the prescribed by the Taylor rule and the actual Fed rates. (According to the Taylor rule, i_d is low now (2018 Q2): It should be 4.20%, but it is 2%.)


Actual Fed Funds Rate and Taylor Rule Prescription
Actual fed funds rate
Taylor Rule prescription
8.0
6.0
4.0
2.0
0.0
-2.0
2000
2004
2008
2012
2016
FEDERAL RESERVE BANK of ATLANTA
Exported on: Saturday, October 20, 2018

CHAPTER 6 – BRIEF ASSESMENT

1. Compare the effect of capital outflows in S_t and the FX Central Bank reserves under a floating exchange rate system and a fixed exchange rate system.

2. Brunei has fixed its currency, the Brunei dollar (BND), to the Singapore dollar (SGD), fixing the parity at 1. During the recent past, oil prices have decrease substantially. Brunei's economy is heavily dependent on oil.
(a) Describe the pressures the BND faces due to the increase in oil prices? What does the CB of Brunei have to do in order to support the fixed FX exchange rate? Do the FX reserves increase or decrease in the BND?
(b) What is the impact on Brunei's domestic money supply and interest rates?
(c) How can the CB neutralize (sterilize) the effect of low oil prices on Brunei's money supply?

3. Before a national election, many governments engage in expansionary policies to stimulate the economy. Suppose that one of these countries has a fixed exchange rate system. Describe how an expansionary monetary policy can generate a currency crisis. If a government decides to keep the fixed exchange rate system and the expansionary monetary policy, what measures can the government take to delay a currency run?

4. The Banco Central de Chile (BCC) considers the USD overvalued. BCC decides to intervene, but does not want to affect local interest rates. Using graphs, describe the effect of central bank intervention on the CLP/USD exchange rate, on CLP interest rates and on Chilean money supply. (CLP: Chilean peso.)