IS-LM Model with Open Economy

**Why Waited** - most closed economy results follow through so it was easier to get them with closed economy

**Currencies**

<table>
<thead>
<tr>
<th></th>
<th>Dollar</th>
<th>SFranc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switzerland</td>
<td>1.3161</td>
<td></td>
</tr>
<tr>
<td>U.S.</td>
<td>0.75980</td>
<td></td>
</tr>
</tbody>
</table>

**Cross Rates** - e.g. from WSJ:
Two was to present same thing; first one is from point of view of buyer of dollars (i.e., 1.3161 Swiss francs per dollar); second one is from point of view of buyer of Swiss francs (i.e., $0.75980/SFranc); Note: this numbers are reciprocals: 1/1.3161 = 0.75980

**Analogy** - usually convention for prices looks from point of view of person with paper in hand (i.e., dollars); buying gas is priced in $/gal (e.g., $1.50/gal); from point of view of gas station though, they're exchanging gal/$ (e.g., 2/3 gal/$)

**Two Country Model** - look at home country vs. foreign country (rest of the world)

**Exchange Rate** ($E$) - price of foreign currency in domestic currency (e.g., if U.S. is the home country, use $E = $0.75980/SFranc); $E$ with worthless unless you know who is the host country (and foreign country)

- **$ Depreciates** - $E↑$ ⇒ value of dollar↓; takes more to buy a SFranc
- **$ Appreciates** - $E↓$ ⇒ value of dollar↑; takes fewer to by a SFranc

**Real Exchange Rate** ($e$) - have to account for price levels in both countries: $e = E^*P/P$
- $P$ - price level in home country
- $P^*$ - price level is foreign country

**Example** - if $P^*$ is constant and both $E$ and $P$ double, there is effectively no difference on trade; from point of view of Swiss, U.S. goods costs the same: they're price is twice as high, but they can buy twice as many dollars for each SFranc; from point of view of U.S., Swiss goods effectively double in price because of $E$, but U.S. goods also doubled in price

**Floating Exchange Rate** - governments don't try to maintain a certain level; $E$ free to adjust

**Trade**

**Supply-Demand** - $Y = C + I + G$; not complete

- **Exports** ($EX$) - goods made in home country, but bought somewhere else; captured in $Y$, but not in $(C + I + G)$
- **Imports** ($IM$) - goods bought in home country, but made somewhere else; captured in $(C + I + G)$, but not in $Y$

**Net Exports** ($NX$) - exports minus imports; $NX = EX - IM$

**Function** - $NX = X(e, Y - T, Y^* - T^*)$

- $e$ - real exchange rate tells if goods are relatively more or less expensive in home or foreign country; $e↑$ means home currency weaker so imports are more expensive and exports are cheaper (i.e., $NX↑$)
- $Y - T$ - disposable income in home country; more income means you can afford more imports.; $(Y - T)↑$ ⇒ $NX↓$
- $Y^* - T^*$ - disposable income in foreign country; more income means they can afford more of home country’s exports.; $(Y^* - T^*)↑$ ⇒ $NX↑$

**Completed** - $Y - EX = C + I + G - IM$ ⇒ $Y = C + G + G + EX - IM$ ⇒ $Y = C + I + G + NX$
Trade Deficit - Imports > Exports (i.e., \( NX < 0 \))

Drag on Demand - if disposable income increases, \( Y \uparrow \) from \( MPC (C') \), but it's offset by marginal propensity to import \( (X_i) \); this is a drag on demand, but trade deficit has more important impact in capital flows

Equilibrium? - if imports "sell home currency" and exports "buy home currency", how is it possible to have a trade deficit or surplus? Capital flows are actually more important than trade in currency markets

Capital Flows

Capital Inflows - foreign investment in home country assets (land, firms, gov’t securities, etc.)
Capital Outflows - home country investment in foreign assets
Net Capital Inflow (\( CF \)) - capital inflows - capital outflows
Supply-Demand for Currency - have supply and demand for home country currency; price of currency is \( E \); supply is determined by exports plus capital inflows; demand is determined by imports plus capital outflows

Equilibrium - supply = demand \( \Rightarrow EX + CI = IM + CO \Rightarrow (EX - IM) + (CI - CO) = 0 \Rightarrow NX + CF = 0 \)

Interest Rates - difference between home country interest rate \( (i) \) and foreign country interest rate \( (i^*) \) influence \( CF \); if \( (i - i^*) > 0 \), home country has higher interest rates so that would attract more net investment (i.e., \( CF > 0 \)); relative changes from equilibrium:

\( (i - i^*) \uparrow \Rightarrow CF \uparrow \Rightarrow e \downarrow \Rightarrow NX \downarrow \); this is why \( e(i - i^*) \) has \( e' < 0 \)

Saving - income you don’t spend

Government Saving (\( S_G \)) - net taxes minus government purchases; \( S_G = T - G \); negative for any government running a budget deficit

Private Saving (\( S_P \)) - after-tax income minus consumption; \( S_P = Y - T - C \)

Substitute \( Y = C + I + G + NX \ldots S_P = C + I + G + NX - T - C \)

Rearrange to get \( I \) by itself... \( I = S_P + T - G - NX \)

Realize \( S_G = T - G \) and \( NX = -CF \ldots I = S_P + S_G + CF \)

Interpretation - investment is based on private saving, government saving, and net capital inflow (saving from rest of world available to the home country)

Example - suppose \( G \uparrow \) by 100:

\[ I = S_P + S_G + CF \]

Closed Economy
\[ -100 \quad 0 \quad -100 \quad \text{n/a} \]

Closed w/ \( C(Y - T, i - \pi) \)
\[ -90 \quad 10 \quad -100 \quad \text{n/a} \quad C_i < 0 \text{ so } i \uparrow \Rightarrow C \downarrow \text{ (i.e., } S_P \uparrow) \]

Ricardian
\[ -80 \quad 20 \quad -100 \quad \text{n/a} \quad G \uparrow \text{ with no } \Delta T \Rightarrow S_P \uparrow \]

Open
\[ -60 \quad 0 \quad -100 \quad +40 \]

Since \( i \uparrow \) in home country, \( S_P^* \) (foreign saving) is drawn to that country through \( CF \)

Trade Deficit Revisited - common explanations for trade deficit include trade barriers, interest rates, exchange rates, etc., but root cause is savings: \( I = S_P + S_G + CF \)

Case 1 - Rich vs. Poor - expect capital flows from rich countries to poor countries because the less developed countries have better investment opportunities (assuming stable political environment); rich country lends to poor country and \( CF > 0 \) for poor country; so \( NX < 0 \) (i.e., trade deficit)

Example - UK vs. US during 1800s

Case 2 - Rich vs. Rich - rich home country with lower \( S_P \) than rich foreign country; the foreign country’s higher savings result in lower \( i \) so expect capital flows from high \( S_P \) country to low \( S_P \) country

Example - US vs. Japan during 1980s
Imperfect Capital Flows - barriers or rules restrict capital flow
Perfect Capital Flows - slightest difference in interest rates bring huge capital inflow and large change in  and NX;  → -∞

Result - implies that  would be the same everywhere; IS curve would be horizontal at same level for every country; if  home country borrows more (); money comes from everywhere so there is very little crowding out

Why  ≠  - risk; expected changes in

Investment vs. Savings - look at graph of investment as percentage of GDP (I/Y) and savings as percentage of GDP (S/Y); if there is perfect capital flow, there should be no relationship (i.e., slope zero); if there is a relationship that means people invest more domestically rather than looking for higher I in foreign country

45° Line - denotes were savings equals investment; countries below the line have more saving than investment so they are net lenders of money (i.e., trade surplus); countries above the 45° line are net borrowers (i.e., trade deficit)

Endogenous vs. Exogenous  - out model assumes  in home country doesn’t affect * (i.e., exogenous); to account for the changes (i.e., make it endogenous), we have to add equations for foreign country:  =  +  +  + NX*, etc.

Why Not - (1) it’s hard; (2) other results still good; (3) if home country is small,  doesn’t impact the rest of the world much so exogenous  is good enough (small country model)

IS-LM Model with Open Economy

Bomberger - "Romer suffers from an excess in generality"

Our Model - floating exchange rate, imperfect capital mobility, & small country

Basically adding 3 equations and 3 unknowns to the IS-LM model (short-run or long-run)

Equations

\[ \begin{align*}
NX &= X(e, Y - T, Y^* - T^*) \\
e &= e(i - i^*) \\
e &= EP*/P
\end{align*} \]

Differentials

\[ \begin{align*}
dNX &= X_e de + X_T dY - X_Y dT + X_{Y^*} dY^* - X_{Y^*} dT^* \\
de &= e'di - e'di^* \\
de &= (P*/P)dE + (E/P)dP* - (EP*/P^2)dP
\end{align*} \]

Also modify:  =  +  + + G + NX

Long-Run Multipliers - more important than short-run and easier to calculate

Monetary Policy (ΔM) - end result is same as closed economy:

\[ \begin{align*}
dP/dM &= P/M > 0; \\
dY/dM &= dIl/dM = dI/dM = 0
\end{align*} \]

New Terms

\[ \begin{align*}
de/dM &= E/M \\
dE/dM &= 0... e = EP*/P; ΔE countered by ΔP so real exchange rate doesn’t change (e.g., M^↑ 10% ⇒ P^↑ 10% and E^↑ 10%) \\
dNX/dM &= 0... follows from no change in real exchange rate
\end{align*} \]

Impact - monetary policy has no long-run effect other than to increase the price level; the higher prices are offset in domestic and world markets by an increase in nominal exchange rates so real exchange rates remain unchanged (i.e., foreign and domestic products effectively cost the same relative to each other)
**Fiscal Policy ($\Delta G$)** - with open economy IS curve is flatter so interest rates don't rise as much and there isn't as much crowding out as there is in a closed economy

<table>
<thead>
<tr>
<th>Multiplier</th>
<th>Closed Economy</th>
<th>&lt;&gt; (abs)</th>
<th>Open Economy</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \frac{dY}{dG} )</td>
<td>0</td>
<td>=</td>
<td>0</td>
</tr>
<tr>
<td>( \frac{di}{dG} )</td>
<td>(-\frac{1}{I'} &gt; 0)</td>
<td>&gt;</td>
<td>(-\frac{1}{I'+X_e e'} &gt; 0)</td>
</tr>
<tr>
<td>( \frac{dI}{dG} )</td>
<td>(-1 &lt; 0)</td>
<td>&gt;</td>
<td>(-I' )</td>
</tr>
<tr>
<td>( \frac{dP}{dG} )</td>
<td>(- \frac{P^2 L_i}{M I'} &gt; 0)</td>
<td>&gt;</td>
<td>(- \frac{P^2 L_i}{M (I'+X_e e') &gt; 0)</td>
</tr>
<tr>
<td>( \frac{dNX}{dG} )</td>
<td>n/a</td>
<td>(&lt; 0)</td>
<td>(- \frac{X_e e'}{I'+X_e e'} &lt; 0)</td>
</tr>
</tbody>
</table>

**Example** -

Open: \( Y = C + I + G \)
Closed: \( Y = C + I + G + NX \)

<table>
<thead>
<tr>
<th></th>
<th>Open</th>
<th>Closed</th>
</tr>
</thead>
<tbody>
<tr>
<td>( Y )</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>( I )</td>
<td>-100</td>
<td>-60</td>
</tr>
<tr>
<td>( G )</td>
<td>100</td>
<td>+100</td>
</tr>
<tr>
<td>( NX )</td>
<td>-60</td>
<td>-40</td>
</tr>
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![Graph showing IS and LM curves for Open and Closed Economies]