Intermediate Macroeconomics, EC2201

L5: Exchange rates

Anna Seim

Department of Economics, Stockholm University

Spring 2017
Contents and literature

- Exchange rates over different horizons.
- Exchange rate regimes.

Real and nominal exchange rates

• Real exchange rate: the relative price of goods in different countries.

• Nominal exchange rate: the relative price of different currencies.
Nominal exchange rates

Express the (spot) nominal exchange rate, $E$, in domestic currency (krona) per unit of foreign currency (€).\(^1\)

$\Delta E > 0$: a depreciation (devaluation) of the krona.

$\Delta E < 0$: an appreciation (revaluation) of the krona.

\(^1\)We will use this definition throughout the course. Jones (2014) defines the nominal exchange rate in foreign currency per unit of domestic currency, so that an increase corresponds to an appreciation.
### The Swedish exchange rate, February 2, 2017

<table>
<thead>
<tr>
<th>Foreign currency</th>
<th>Domestic currency/foreign currency</th>
<th>Foreign currency/domestic currency</th>
</tr>
</thead>
<tbody>
<tr>
<td>EURO</td>
<td>9.42</td>
<td>0.11</td>
</tr>
<tr>
<td>USD</td>
<td>8.72</td>
<td>0.12</td>
</tr>
<tr>
<td>GBP</td>
<td>11.03</td>
<td>0.09</td>
</tr>
<tr>
<td>NOK</td>
<td>1.06</td>
<td>0.94</td>
</tr>
</tbody>
</table>
The real exchange rate

Recall the definition of the real exchange rate, \( q \), from Lecture 4:

\[
q = \frac{EP^*}{P}, \tag{1}
\]

where \( P \) denotes the price level and * henceforth indicates foreign.

Real depreciation: \( \Delta q > 0 \). Domestic goods become relatively cheaper.

Real appreciation: \( \Delta q < 0 \). Domestic goods become relatively more expensive.
Real exchange rate dynamics

• Since prices tend to be sticky, the relative price tends to be given in the short run.

• The nominal exchange rate the most important determinant of the real exchange rate in the short run.

• Understanding nominal exchange rates key to understanding the real exchange rate in the short run.
Month-to-month variability of the dollar/yen exchange rate and of the US/Japan price level ratio 1980-2009


The nominal exchange rate in the long run

- Goods-market approach.
- Purchasing power parity.
- The monetary approach to the exchange rate.
Purchasing power parity (PPP)

- Theory of long-run exchange rate determination.
- Stresses the importance of goods markets.
- Developed by Swedish economist Gustaf Cassel (1866-1945) in 1920.
Absolute and relative PPP

The law of one price for a single good $i$:

$$P_{it} = E_t P_{i^*} \iff E_t = \frac{P_{it}}{P_{i^*}}.$$  \hspace{1cm} (2)

Absolute PPP:

$$E_t = \frac{P_t}{P^*_t}.$$  \hspace{1cm} (3)

Relative PPP:

$$\frac{E_t - E_{t-1}}{E_{t-1}} = \pi_t - \pi^*_t,$$  \hspace{1cm} (4)

where $\pi_t = \frac{P_t - P_{t-1}}{P_{t-1}}$ is inflation.
Causes of deviations from PPP

- Transportation costs and trade barriers.
- Differences in consumption baskets.
- Imperfect competition, price discrimination.
- Two types of goods and services: tradables and non-tradables.
# The Economist’s Big Mac index

<table>
<thead>
<tr>
<th>Country</th>
<th>Big Mac price in local currency</th>
<th>Exchange rate per dollar ($)</th>
<th>Big Mac price in dollars</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>4.37 dollars</td>
<td>1.00 dollars/$</td>
<td>4.37</td>
</tr>
<tr>
<td>Norway</td>
<td>42.96 kroner</td>
<td>5.48 kroner/$</td>
<td>7.84</td>
</tr>
<tr>
<td>Euro area</td>
<td>3.61 euros</td>
<td>0.74 euros/$</td>
<td>4.88</td>
</tr>
<tr>
<td>Japan</td>
<td>319.62 yen</td>
<td>91.06 yen/$</td>
<td>3.51</td>
</tr>
<tr>
<td>Mexico</td>
<td>36.95 pesos</td>
<td>12.74 pesos/$</td>
<td>2.90</td>
</tr>
<tr>
<td>China</td>
<td>15.99 yuan</td>
<td>6.22 yuan/$</td>
<td>2.57</td>
</tr>
<tr>
<td>Russia</td>
<td>73.02 rubles</td>
<td>30.05 rubles/$</td>
<td>2.43</td>
</tr>
<tr>
<td>South Africa</td>
<td>18.37 rand</td>
<td>9.05 rand/$</td>
<td>2.03</td>
</tr>
<tr>
<td>India</td>
<td>89.18 rupees</td>
<td>53.40 rupees/$</td>
<td>1.67</td>
</tr>
</tbody>
</table>

Extracted from: Jones (2014).
The Economist’s Big Mac index

[Diagram showing the Big Mac index with countries listed horizontally and their relative prices against the dollar.]
The Balassa-Samuelson effect

Consider a small open economy, consisting of a tradables sector, indexed $T$, and a non-tradables sector, indexed $N$.

The law of one price holds for traded goods, so that:

$$P_T = EP_T^*.$$  \quad(5)

The consumer price level, $P_C$ is given by:

$$P_C = P_T^\alpha P_N^{1-\alpha},$$ \quad(6)

where $\alpha \in (0,1)$. 
Production in sector $j$, is given by $Y_j = A_j L_j$ where $A_j$ denotes labour productivity and $L_j$ denotes labour input.

Letting $W_j$ denote the wage, profits in sector $j$ are given by

$$P_j A_j L_j - W_j L_j.$$  \hfill (7)

Perfect competition implies:

$$A_N = \frac{W_N}{P_N}$$ \hfill (8)

and

$$A_T = \frac{W_T}{P_T}.$$ \hfill (9)
An assumption of perfect labour mobility across sectors implies:

\[ W_N = W_T. \]  \hspace{1cm} (10)

Let us solve for \( P_N/P_T \) using, in turn, (8), (10) and (9):

\[
\frac{P_N}{P_T} = \frac{1}{P_T} \frac{W_N}{A_N} = \frac{1}{P_T} \frac{W_T}{A_N} = \frac{A_T}{A_N}.
\]  \hspace{1cm} (11)
$P_T$ is exogenously given by (5).

$P_N$ is endogenously determined by $A_T/A_N$.

Taking logs of (6), shows that the elasticity of $P_C$ with respect to $P_N$ is $(1 - \alpha) > 0$.

$A_N$ roughly the same across countries.

Conclusion: $A_T$ main determinant of $P_C$. 
Why is this interesting?

Productivity *levels* in the tradables sector, $A_T$, tends to be higher in rich countries than in poor countries.

Productivity *growth* in the tradables sector, tends to be higher in poor countries than in rich countries.

The Balassa-Samuelson effect (11) predicts:

- Long-run real exchange rates affected by differences in relative productivity, $A_T/A_N$, across countries.
- When expressed in the same currency, price levels should be higher in rich countries than poor countries.
- If the nominal exchange rate is held constant, inflation should be higher in poor countries than in rich countries.
The monetary approach to the exchange rate

Given that PPP is a good approximation of nominal exchange rates in the long run, how are long-run prices determined?

Let \( M/P \) denote the real money supply, \( i \) the interest rate, \( Y \) income and \( L \) the money demand function.

Money-market equilibrium suggests:

\[
\frac{M}{P} = L(i, Y),
\]

(12)

Solving for the price level in (12), we obtain:

\[
P = \frac{M}{L(i, Y)}.
\]

(13)
Assuming that PPP holds, as suggested by (3), and that foreign prices also are determined by (13), we obtain:

$$E = \frac{P}{P^*} = \frac{M}{M^*} \frac{L(i^*, Y^*)}{L(i, Y)}.$$  \hspace{1cm} (14)

Equation (14), suggests that a permanent increase in the relative money supply, $M/M^*$, causes a nominal depreciation.
The nominal exchange rate in the short run

- Asset-market approach.
- Interest rate parity.
- Exchange rate overshooting.
The foreign exchange market

- The nominal exchange rate: a financial asset.
- Determined by the interaction of buyers and sellers in the foreign exchange market.
- Trading agents:
  - Commercial banks (interbank trading).
  - Multinational corporations.
  - Non-bank financial institutions (pension funds, hedge funds).
  - Central banks.
Arbitrage

- Highly integrated markets: arbitrage opportunities are short-lived.
- All exchange rates must be bilaterally consistent.
- In a world comprising $N$ countries, there are (at most) $N - 1$ currencies.
The demand for currency

- Acquiring wealth is about transferring purchasing power into the future: assess investment opportunities based on their expected real return.

- But only nominal returns matter to an investor from a given country.

- Investors thus consider:
  - Nominal return.
  - Risk.
  - Liquidity.
Interest rates on dollar and yen deposits 1978-2013

Source: Datastream. Three-month interest rates are shown.

Towards interest rate parity

Consider a Swedish investor, comparing returns in SEK.

$i_t$: Nominal Swedish interest rate.

$i_t^*$: Nominal Eurozone interest rate.

Expected exchange rate gain from a Euro investment:

\[
\frac{\Delta E_{t+1}^e}{E_t} = \frac{E_{t+1}^e - E_t}{E_t},
\]

where $E_{t+1}^e$ is the expected value of the nominal exchange rate in period $t+1$. 
Uncovered interest rate parity

An investor is indifferent between investing in SEK and in euros when the expected returns from the two investments are in parity:

\[ i_t = i^*_t + \frac{\Delta E^e_{t+1}}{E_t} \]  \hspace{1cm} (15)

The UIP condition (15) states that the expected return from investing in SEK, on the LHS, must be equal to the expected return from a euro investment, on the RHS.
Exchange rate overshooting

- Nominal exchange rates are extremely volatile in the short run.
- Exchange rates seem to overreact in response to policy changes or other shocks: they overshoot their new long-run equilibrium values.
A model of overshooting: Dornbusch (1976)

Simplified version, based on Klein (2016c).

All variables except the nominal interest rate are in logs.

Notation:

$m$: the money supply.
$p$: the price level.
$i$: the domestic nominal interest rate.
$i^*$: the foreign nominal interest rate.
$e$: the nominal exchange rate (in domestic currency per unit of foreign currency).
The model

Money market equilibrium:

\[ m(t) - p(t) = -hi(t), \]  \hspace{1cm} (16)

where \( h > 0 \).

UIP:

\[ i(t) = i^*(t) + \dot{e}(t). \]  \hspace{1cm} (17)

Inflation, \( \dot{p}(t) \), responds to deviations from PPP:\(^2\)

\[ \dot{p}(t) = a[e(t) - p(t)], \]  \hspace{1cm} (18)

where \( a > 0 \).

---

\(^2\)The foreign price level is normalised to unity so that the log foreign price level is zero.
For simplicity, assume that $a = 1$ and $h = 1/2$.

Combining (16) and (17), we obtain two dynamic equations:

$$
\dot{e}(t) = 2p(t) - 2m(t) - i^*(t),
$$

$$
\dot{p}(t) = e(t) - p(t).
$$

In the steady state, $\dot{e}(t) = \dot{p}(t) = 0$, and we obtain:

$$
e = p = m + \frac{i^*}{2}.
$$
Overshooting

Consider a sudden increase in the money supply, $m$.

According to (21), the economy will eventually reach a steady state where $e$ and $p$ have increased in proportion to $m$.

Since prices are sticky, $p$ does not respond immediately, meaning that $p$ is now below its new steady-state value, i.e. $p < m + i^*/2$. This implies $\dot{e}(t) < 0$ according to (19).

If the exchange rate is falling during its transition to the new steady state, it means that it immediately upon the shock must have jumped to a value above its new steady-state value, i.e. it overshoots.
Figure 1: The nominal interest rate

Extracted from: Klein (2016c).
Figure 2: The log money supply

Extracted from: Klein (2016c).
Figure 3: The log price level

Extracted from: Klein (2016c).
Figure 4: The log exchange rate

Extracted from: Klein (2016c).
Exchange rate regimes

- Floating exchange rates: reasonable description of many industrialised countries today.
- Systems of fixed exchange rates prevalent for most of the 20th century.
- Analyses of fixed exchange rates still relevant:
  - Currency unions and regional currency arrangements.
  - Managed floats and pegs to other currencies common.
  - Need to understand why fixed exchange rates failed.
A very brief history

- The gold standard: 1871-1915.
- The Economic and Monetary Union (EMU): 1999-
<table>
<thead>
<tr>
<th>Regime</th>
<th>Period</th>
<th>Devaluations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed</td>
<td>1945-73</td>
<td>1949</td>
</tr>
<tr>
<td></td>
<td>1973-77</td>
<td>1976</td>
</tr>
<tr>
<td></td>
<td>1977-91</td>
<td>1977,81,82</td>
</tr>
<tr>
<td></td>
<td>1991-92</td>
<td></td>
</tr>
<tr>
<td>Floating</td>
<td>1992-</td>
<td>Free float combined with inflation target</td>
</tr>
</tbody>
</table>
Interest rate parity under a fixed exchange rate

Under a (credibly) fixed exchange rate, $\Delta E_{t+1}^e/E_t = 0$ in (15), so that the interest rate parity condition becomes:

$$i_t = i_t^*.$$  \hspace{1cm} (22)

The central bank must make sure that (22) holds and can therefore not adjust domestic interest rates in attempts to achieve other policy goals.

Under a fixed exchange rate, stabilisation policy must be pursued using fiscal policy measures.
Maintaining a fixed exchange rate

• Under a fixed exchange rate, the central bank buys and sells foreign assets to meet the demand for domestic currency.

• The central bank’s transactions affect the money supply and therefore the domestic interest rate, which must be in parity with foreign rates according to (22).

• Crucial that the central bank maintains sufficient foreign exchange reserves.
Balance of payments crises

- A Balance of payments crisis occurs if suspicion arises that the central bank is unable to maintain the fixed exchange rate (insufficient reserves).

- If investors expect that the fixed exchange rate will be devalued, they will demand foreign assets instead of domestic assets (whose value is expected to fall).

- When investors start exchanging domestic currency for foreign currency, the central bank’s foreign exchange reserves are depleted further and the crisis is exacerbated.
Defending a fixed exchange rate

- Always technically possible to defend the fixed exchange rate by raising the interest rate in an attempt to prevent capital flight.
- Problem: the high interest rate implies great costs to the economy.
Key features of the EMU

- Attempt to make the regime immune to expectations of devaluations by relinquishing all monetary autonomy.

- Monetary policy delegated to the European Central Bank to circumvent the $N-1$-problem.
  - If $N$ countries maintain a fixed exchange rate between them, one country is free to pursue monetary policy.
  - The choice of money supply, and thereby interest rate, of this country affects the others according to (22).

What we did

- Exchange rates over different horizons.
- Exchange rate regimes.