International financial markets

Lecture 10, ECON 4330

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Outline

Basics

In the lectures, we will follow Rødseth's convention in refering to foreign currency as dollars, while the domestic currency is kroner.

- The exchange rate, E, is the price dollars in units of kroner

For the Norwegian audience: E er valutakursen. $1/E$ er kronekursen.

Basics II

Roughly speaking, we can divide the participants in the FX market into two groups. On the one hand, the general public (home and abroad), and on the other the central bank. We ignore the foreign central bank for now. The equilibrium value of E is determined in many ways just as a normal market. The price is E. But what is the quantity? Old theories used to think of the *flow* of currency. However, it is more appropriate to think in terms of the *stock* of currencies.

Remember that:

- The krone appreciates when it becomes worth relatively more: $E \downarrow$
- and it depreciates when it becomes worth relatively less: $E \uparrow$

Outline

Balance sheet

To keep track of all the variables, let us put up the balance sheet. This also makes it clear which sectors we consider, and what notation we use for the different variables.

	Sector			
Assets	Government	Private	Foreign	Sum
Kroner assets	B_g	B_p	B_*	0
Dollar assets	F_g	F_p	B_*	0
Sum in kroner	$B_g + EF_g$	$B_p + EF_p$	$B_* + EF_*$	0

In the table we've incorporated the assumption that all assets sum to zero:

$$B_g + B_p + B_* = 0 \tag{1}$$

$$F_g + F_p + F_* = 0 \tag{2}$$

One sector's asset is another's liability.

Balance sheet II

To introduce the exchange rate was one novelty. Another is to consider explicit price levels. Let P be that of home, and P_* that of foreign. Real wealth of the three sectors:

$$W_g = \frac{B_g + EF_g}{P} \tag{3}$$

$$W_p = \frac{B_p + EF_p}{P} \tag{4}$$

$$W_* = \frac{B_*/E + F_*}{P_*} \tag{5}$$

Furthermore, from the two market clearing assumptions, it follows that

$$W_g + W_p + QW_* = 0$$

(as indicated by the balance sheet), where $Q = \frac{EP_*}{P}$ is the real exchange rate.

Timing

In our models, we will think of any period as relatively short, such that capital accumulation is ignored and all trades take place at the same price. Hence each sector is only able to re-balance its portfolio, and the end-of-period wealth must have the same value as initial wealth. Formally:

$$B_i + EF_i = B_{i0} + EF_{i0}$$

for $i = g, p, *$. Hence within one period investors can change the composition of its portfolio, but its total nominal value can only be affected by exchange rate movements. (Changes in the price level will affect the real value.)

Demand for currencies

To discuss demand for currencies, the most relevant variables are:

- The kroner rate of interest i
- The dollar rate of interest i_*
- The expected rate of depreciation $e_e = \dot{E}/E$

Measured in kroner, the rate of return from investing in kroner is i, while the return from dollars is $i_* + e$.

Demand for currencies II

With perfect capital mobility, the well-known condition **uncovered interest rate parity** (UIP) must hold:

$$i = i_* + e_e \tag{6}$$

This is because a situation with $i \neq i_* + e$ will cause infinite demand for one of the currencies. (6) must hold in any equilibrium.

Q: What is 'covered interest rate parity'? It is the equivalent no-arbitrage condition between spot and forward contracts. More likely to hold than UIP.

Demand for currencies III

However, there are also many reasons to think that capital mobility is imperfect.

- Risk aversion
- Different expectations
- Transaction costs
- Liquidity considerations
- Exchange controls

Demand for currencies IV

In the imperfect mobility case, it makes sense to assume that there exist well-defined demand functions for stocks of currencies. Let

$$r = i - i_* - e_e \tag{7}$$

denote the expected rate of return differential. Assume that the domestic public sector has real demand for dollars given by

$$\frac{EF_p}{P} = f(r, W_p) \tag{8}$$

while its demand for kroner follows from the 'budget constraint':

$$\frac{B_p}{P} = W_p - f(r, W_p) \tag{9}$$

We can think of $f(r, W_p)$ as coming out of the problem where the public sector chooses an optimal portfolio-combination given its total wealth. 'Reasonable' restrictions on f are:

$$0 < f'_W < 1$$
$$f'_r < 0$$

Demand for currencies V

Assume that the foreigners face a similar portfolio-problem, only in foreign and not domestic terms. Hence their demand for kroner in real terms is:

$$\frac{B_*}{EP*} = b(r, W_p) \tag{10}$$

while their dollar demand follows as

$$\frac{F_*}{P_*} = W_* - b(r, W_*) \tag{11}$$

where we also add that

$$0 < b'_W < 1$$
$$b'_r > 0$$

Expectations

We are already starting to see how the modeling approach differs from O&R. Another characteristic difference is how expectations are dealt with. In general, we will here assume that the expected rate of depreciation is given by a well-defined function

$$e_e = e_e(E) \tag{12}$$

This differs dramatically from rational expectations (RE). RE has now come to dominate the academic literature, but I think models with simpler expectational assumptions may be useful as well.

Expectations II

We will refer to expectations as:

- *Regressive* when $e_e' < 0$
- *Extrapolative* when $e_e' > 0$
- and constant when $e_e' = 0$

Simple portfolio model

Connecting the dots, we have a portfolio model for the exchange rate (when floating) or the central bank's FX reserves (when fixed). First, (4) and (5) give the definitions of financial wealth at the beginning of the period:

$$W_p = \frac{B_{p0} + EF_{p0}}{P}$$
$$W_* = \frac{B_{*0}/E + F_{*0}}{P_*}$$

Again: The levels of wealth are 'almost' exogenously given, but they can be affected by changes in E.

Second, we need the definition of r in (7), and e_e from (12)

$$r = i - i_* - e_e$$
$$e_e = e_e(E)$$

Simple portfolio model II

Thirdly, we add the demand for dollars from (8) and (11):

$$\frac{EF_p}{P} = f(r, W_p)$$
$$\frac{F_*}{P_*} = W_* - b(r, W_*)$$

The equilibrium condition

$$F_g + F_p + F_* = 0$$

will be the final condition we need.

Simple portfolio model III

The model has 7 equations and will determined 7 variables: $W_p, W_*, F_p, F_*, r, e_e$ and E or F_g. If the government decides to fix E, then F_g will have to adjust in order to secure market clearing at this exchange rate. If on the other hand E is floating, the government stands free to do whatever it likes with F_g. Note that both interest rates are assumed to be fixed by the respective central banks (although the foreign central bank is not explicitly modeled elsewhere). The price levels are also taken as given.

Supply side

We know that the domestic central bank will face a net supply of foreign currence and will change the exchange rate or it's holdings of foreign currency facing the market clearing condition. The easiest way to think about the model is to use the first 6 equations to define the supply of foreign currency to the central bank as

$$\begin{aligned} S &= -F_p - F_* \\ &= -\frac{P}{E} f(r, W_p) - P_* [W_* - b(r, W_*)] \\ &= -\frac{P}{E} f(i - i_* - e_e(E), \frac{B_{p0} + EF_{p0}}{P}) \\ &\quad - P_* [\frac{B_{*0}/E + F_{*0}}{p_*} - b\left(i - i_* - e_e(E), \frac{B_{*0}/E + F_{*0}}{P_*}\right)] \end{aligned}$$

(see equation 1.18 in Rødseth).

Supply side II

The slope of the supply curve is:

$$\frac{\partial S}{\partial E} = \frac{1}{E}[F_p - f_W F_{p0} + (1 - b_W)B_{*0}/E] + [(P/E)f_r - P_* b_r]e'_e$$

To interpret the slope, it is often wise to consider the slope at the intial point ($F_p = F_{p0}$, $B_* = B_{*0}$). In that case:

$$\frac{\partial S}{\partial E}^0 = \frac{P}{E^2}\gamma - \frac{P}{E}\kappa e'_e$$

where

$$\gamma = (1 - f_W)\frac{EF_{p0}}{P} + (1 - b_W)\frac{B_{*0}}{P}$$
$$\kappa = -f_r + \frac{EP_*}{P}b_r$$

Supply side III

$$\gamma = (1 - f_W)\frac{EF_{p0}}{P} + (1 - b_W)\frac{B_{*0}}{P}$$

γ measures the portfolio composition effect.
We've already assumed that f_W and b_W are between zero and one (which also limits speculative behavior). The sign of γ is nevertheless ambiguous.

- When positive?
- When negative?

The Portfolio composition effect captures the reaction to a change in your portfolio value. As you had already optimized your portfolio a change in E will take you away from that optimal composition.

- When the domestic currency depreciates(E up) all foreign currency assets increase in relative value.
- So, if you have positive holdings of both assets the depreciation make you richer, but only by increasing your foreign holdings.
- This makes you want to sell of some of the increase in your foreign holdings to find the optimal composition.
- This increases supply of the foreign currency and thus increase demand of the domestic currency.
- The answer could be different if your holding negative values of any of the assets.

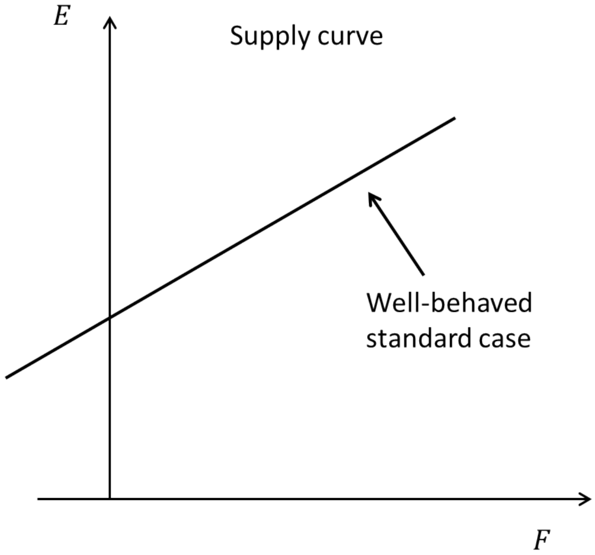
Supply side IV

$$-\kappa e_e' = [-f_r + \frac{EP_*}{P} b_r] e_e'$$

$-\kappa e_e'$ is the expectations effect. κ is always positive, since we have assumed that $f_r < 0$ and $b_r > 0$.

- If expectations are regressive, then expectations are contributing to an upward sloping supply curve
- But extrapolative elements ($e_e' > 0$) will in the same way as $\gamma < 0$ potentially make the supply curve downward sloping!

Supply side V



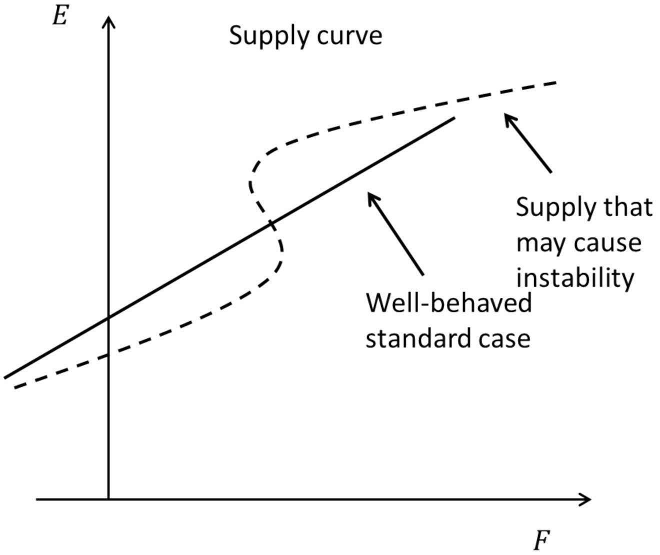
Supply side VI

Sufficient conditions for the well-behaved case are:

$$F_{p0} > 0, \;\; B_{*0} > 0, \;\; f_W < 1, \;\; b_W < 1, \;\; e_e' < 0$$

In general we assume that these hold, or at least that enough of them hold (it is not the set of necessary conditions!).

Supply side VII



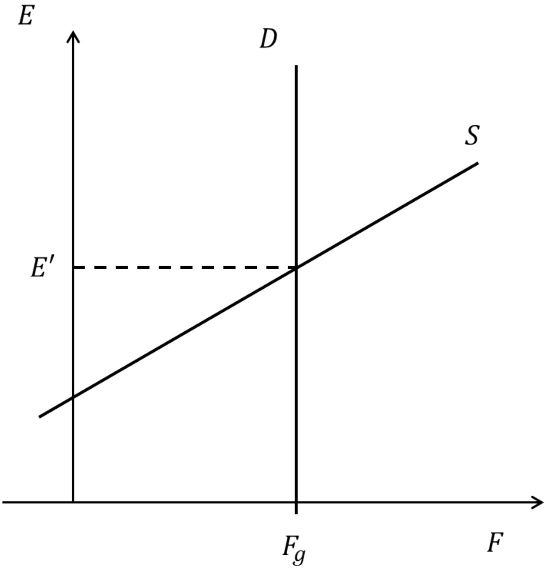
Equilibrium when E floats

Supply side is independent of exchange rate regime. If E floats, the demand for foreign currency coincides with the central bank's FX reserves.

$$D = F_g$$

Intersection between supply and demand gives the equilibrium exchange rate E'.

Equilibrium when E floats II

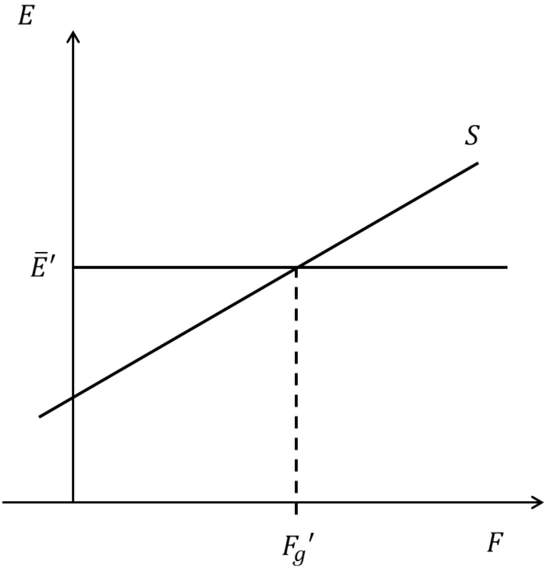


Equilibrium when E is fixed

If E is to be fixed at $\bar{E}$, then the CB must have an infinite demand for FX at this exchange rate. Gives a horizontal line at $E = \bar{E}$. Intersection between supply and demand gives the equilibrium levels of FX reserves F_g'.

Note: So far we have assumed that the interest rate peg can be maintained by changes in FX reserves. Not always feasible. Then the interest rate must be used as an instrument.

Equilibrium when E is fixed II



Market for kroner?

What about the market for kroner? By Walras' law, we know the kroner market clears as well. Why? Since there are two goods (kroner and dollar), all agents obey their budget constraints, and the dollar market clears. It follows that the kroner market must clear. In that market the private sector will *demand* kroner, while the central bank supplies kroner. Any shift in the supply of foreign currency will have an equal signed shift in the demand for kroner of the same amount.

Outline

In the simple portfolio model we assumed demand functions $f(r, W_p)$ and $b(r, W_*)$.

Now we model demand as the choice of home and foreign investors.

The choice is between home and foreign bonds and the relevant trade-off is between risk and returns. In both markets you have a certain interest rate return. In addition there is two sources of risk: Exchange-rate risk and inflation-risk.

The mean-variance model

The representative home investor maximizes

$$U = \mathrm{E}(\pi) - \frac{R}{2} var(\pi) \tag{13}$$

subject to

$$\pi = (1 - f)i + f(i_* + e) - p \tag{14}$$

- R = relative risk aversion
- π = real rate of return
- $f = EF/PW$ = share of foreign currency in portfolio

Calculation of expected return and risk

$$\pi = (1 - f)i + f(i_* + e) - p$$

$$E(\pi) = (1 - f)i + f(i_* + \mu_e) - \mu_p \quad (15)$$

$$var(\pi) = f^2\sigma_{ee} + \sigma_{pp} - 2f\sigma_{ep} \quad (16)$$

- Stochastic variables e and p
- Expectations μ_e and μ_p
- Variances σ_{ee}, σ_{pp}
- Covariance σ_{ep}

First-order condition

$$\frac{dU}{df} = \frac{d\mathrm{E}(\pi)}{df} - \frac{1}{2}R\frac{dvar(\pi)}{df} = 0 \tag{17}$$

Solution

$$f = \frac{\sigma_{ep}}{\sigma_{ee}} - \frac{r}{R\sigma_{ee}} = f_M + f_S \tag{18}$$

$r = i - i_* - \mu_e$ is the risk premium on kroner

1. *The minimum-variance portfolio* $f_M = \sigma_{ep}/\sigma_{ee}$
2. *The speculative portfolio* $f_S = -r/R\sigma_{ee}$

The optimal portfolio

$$f_M = \frac{\sigma_{ep}}{\sigma_{ee}}$$

The minimum variance portfolio part of foreign investment is increasing in the covariance of the exchange rate with domestic prices and decreasing in exchange rate risk.

$$f_S = \frac{-r}{R\sigma_{ee}}$$

The speculative portfolio part of foreign investment depends negatively on the interest rate premium as a high r makes domestic bonds more profitable. The portfolio is scaled by a risk factor, $R\sigma_{ee}$.

The foreigners will have a symetric problem and their demand for domestic (foreign in their eyes) will be:

$$b = -\frac{\sigma_{ep_*}}{\sigma_{ee}} + \frac{r}{R\sigma_{ee}} \tag{19}$$

Outline

Foreign exchange market equilibrium

$$F_p + F_* + F_g = 0 \tag{20}$$

$$F_p = fPW_p/E = \left[\frac{\sigma_{ep}}{\sigma_{ee}} - \frac{r}{R\sigma_{ee}}\right] PW_p/E \tag{21}$$

$$F_* = (1-b)P_*W_* = \left[1 + \frac{\sigma_{ep_*}}{\sigma_{ee}} - \frac{r}{R\sigma_{ee}}\right] P_*W_* \tag{22}$$

Can be solved for E, F_g or r.

The equilibrium risk premium

$$r = R\sigma_{ee}(\bar{b} - \bar{b}_M) \tag{23}$$

where

$$\bar{b} = 1 - \frac{E(F_p + F_*)}{PW_p + EP_* W_*}$$

$$\bar{b}_M = 1 - \frac{f_M PW_p + (1 - b_M)EP_* W_*}{PW_p + EP_* W_*}$$

The equilibrium risk premium is a product of:

1. The exchange rate risk (σ_{ee})
2. The risk aversion of investors (R)
3. Risk exposure - the difference between the market portfolio and the minimum variance portfolio ($\bar{b} - \bar{b}_M$)

Market portfolio - mirror image of government portfolio

Observations on the risk premium

- Will be negative if the market contains less kroner than the MV portfolio
- $\sigma_{ee} = 0$ or $R = 0$ implies perfect capital mobility and $r = 0$ for any level of exposure.
- Interest rates are observed directly, expectations and risk premia difficult to measure.
- In surveys investors declare widely different expectations
- Interest rates often contain an (il)liquidity premium.

Outline

Today

- Introduced the nominal exchange rate
- Built a simple model of foreign exchange markets
- Modeled portfolio choice with exogeneous expectations
- Analyzed the risk premium in this market

Next week

- Refine the model used today to also include money.
- Combine this monetary portfolio model and a version of the Mundell-Fleming model
- Analyze the effect of shocks in this model
- Look at policy choices