The Foreign Exchange Market: Interest and Purchasing Power Parity

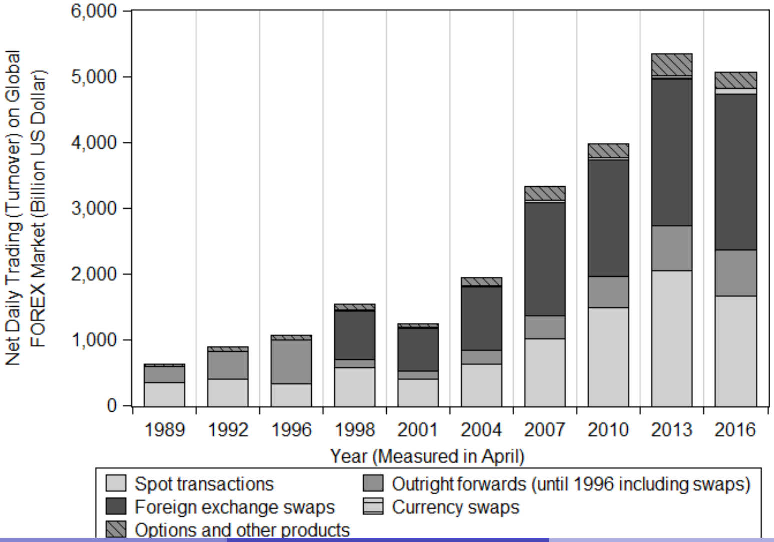
Dr. Nils Herger

Study Center Gerzensee

Background and Motivation

- Financial transactions between different currencies occur on the **foreign exchange market**.
- The foreign exchange market matters since:
  - The liberalisation of international financial transactions and progress in IT have lead to tremendous growth in the foreign exchange market, which is one of the largest financial markets worldwide.
  - The foreign exchange market fulfills important economic functions including (i.) the international transfer of purchasing power, (ii.) the management of foreign exchange risk, and (iii.) the dissemination of information about economic developments.
  - On foreign exchange markets, the exchange rate is determined which affects the goals of monetary policy such as a country's international competitiveness (**terms-of-trade**) or price level (**exchange rate pass-through**). Hence, central banks might want to intervene in the foreign exchange market, though the degree and regularity of this differs between currency systems with **fixed and floating exchange rates**.

Figure: Growth in the Foreign Exchange Market (Data: BIS)



Exchange Rates:

Exchange Rate Definitions

The **nominal exchange rate** S at time t is the relative price between a domestic currency, C, and a foreign currency, C^*, that is

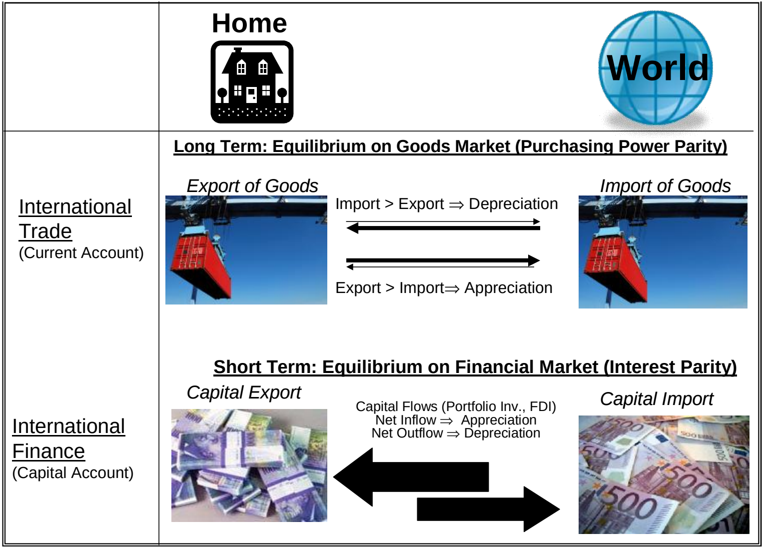
$$S_t = C_t / C_t^*.$$

$S \uparrow\downarrow$ represents, respectively, a nominal **depreciation** and **appreciation** of the domestic currency. The **spot exchange rate** S applies to immediate transactions whilst the **forward exchange rate**, F_{t+1}, applies to transactions at future date $t+1$. The **real exchange rate** Q uses price levels P^*/P to adjust the nominal rate for international differences in purchasing power, that is

$$Q_t = S_t(P_t^*/P_t).$$

$Q \uparrow\downarrow$ designates, respectively, a real de- and appreciation that can result from changes in prices as well as the nominal exchange rate. Central banks can fix the nominal, but not the real exchange rate.

Partial Equilibrium Exchange Rate Theories (Parity Conditions):



Short-Term: Exchange Rate and Interest Rates

Covered Interest Parity (CIP) Condition:

- Interest parity conditions establish a nexus between the foreign exchange and the domestic and foreign money markets. Exchange rates are thought to absorb international differences between (short-term) interest rates.
- **Capital mobility** tends to equalise the return on **substitutable** (e.g. similar) foreign and domestic assets. With exchange rate movements covered by the forward rate, the following arbitrage condition arises.

Covered Interest Parity (CIP)

$$\left(1 + R_t\right) = \left(1 + R_t^*\right) \frac{F_{t+1}}{S_t}$$

where R and R^* denote, respectively, domestic and foreign interest rates and F_{t+1} is the forward rate with maturity $t + 1$.

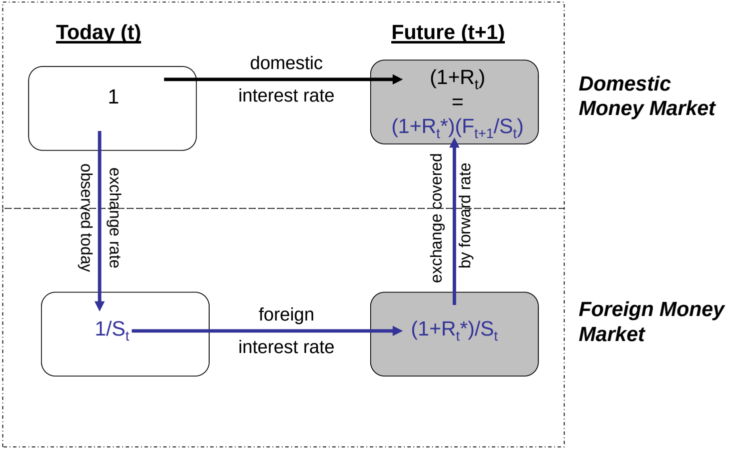


Figure: Covered Interest Parity (CIP)

- Log-linearisation with $s_t \approx \ln(S_t)$, $i_t \approx \ln(1+R_t)$, $i_t^* \approx \ln(1+R_t^*)$ and $f_{t+1} \approx \ln(F_{t+1})$ yields approximately:

Approximating CIP

$$i_t \approx i_t^* + f_{t+1} - s_t \qquad \text{or} \qquad i_t - i_t^* \approx f_{t+1} - s_t$$

where $f_{t+1} - s_t$ reflects the **forward premium** (quoted e.g. as swap rate).

- CIP is an **arbitrage condition** eliminating risk-free (with respect to currency risk) profit opportunities in international asset returns.
- Aside from episodes of financial turbulence (Taylor, 1989)[1], and as long as transaction costs are low[2], forward premia are almost perfectly correlated with international differences in interest rates.

[1] Baba and Packer (2009) have documented the deviations from UIP during the global financial crises around the year 2008.

[2] Recently, deviations from CIP have arguably been caused by the stricter capital requirements imposed on commercial banks (see Sushko *et al.*, 2016).

Uncovered Interest Parity (UIP) Condition:

- The nexus between the foreign exchange and money market can also be left to the expected future spot exchange rate S^e_{t+1}. Of course, the vagaries of future developments create (time-varying) risk premia Φ_t driving a wedge between S^e_{t+1} and the forward rate F_{t+1}, that is

$$F_{t+1} = S^e_{t+1} \times \Phi_t$$

- Substituting into the CIP yields the uncovered interest parity (UIP).

Uncovered Interest Parity (CIP)

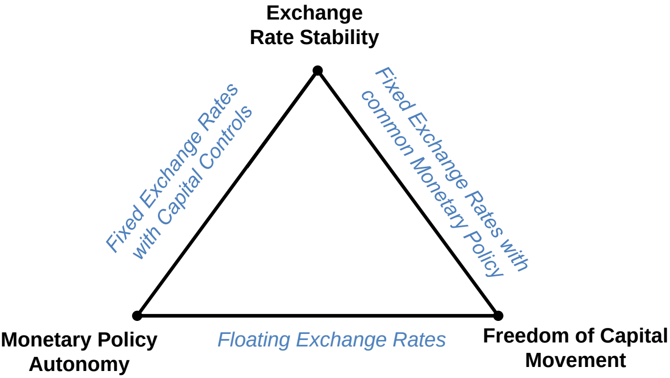
$$\left(1 + R_t\right) = \left(1 + R^*_t\right) \frac{S^e_{t+1}\Phi_t}{S_t}$$

Approximately,

$$i_t \approx i^*_t + s^e_{t+1} - s_t + \phi_t .$$

$s^e_{t+1} - s_t$ is the expected depreciation rate and ϕ_t the risk premium (in ln).

- UIP is a useful **theoretical equilibrium condition**, suggesting that
  - .. given foreign interest i_t^* and exchange rate expectations s_{t+1}^e, an increase in domestic interest rates appreciates $s_t \downarrow$ the currency.
  - ... the **trilemma of international finance** arises e.g. only two of the following three goals can be achieved: 1. fixed exchange rates ($s_{t+1}^e = s_t$), 2. autonomy to set interest rates i, 3. free capital flows.



- Empirically, UIP is widely thought to be rejected by the data. Yet, there are some exceptions to this view:
  - Chaboud and Wright (2005) suggest that UIP holds in the very short-term (intraday data/overnight maturity). UIP works, but not for long.
  - At the other end of the spectrum, Lothian and Wu (2011) found evidence for the UIP when looking at 200 years worth of (annual) data.
  - Furthermore, UIP seems to work partly when exchange rate movements are limited by a target-zone such as the European Monetary System (Flood and Rose, 1995) or the classical gold standard (Herger, 2018).
  - UIP works fairly well when panel data methods include time specific fixed effects controlling for the risk premium ϕ_t (Herger, 2016).
- Since variables such as exchange rate expectations or risk premia are unobservable, it is not trivial to empirically "tests" the UIP.
- Thereto, economic concepts such as **rational expectations** are warranted imposing e.g. the assumption that forecast errors ϵ occur randomly (not systematically). This implies that

$$\epsilon^e_{t+1} = s^e_{t+1} - s_{t+1} = 0.$$

- Risk premia can be gauged by statistical or by economic models linking exchange rate uncertainties with underlying financial or economic variables.
- Taken together, rational expectations and the proxy for risk premia $\widehat{\eta}_t$ imply that

$$s_{t+1} - s_t = i_t - i_t^* + \widehat{\eta}_t + \epsilon_{t+1}^e \qquad \text{with} \quad \epsilon_{t+1}^e = 0.$$

⇒ In words: Controlling for exchange rate risk pertaining to foreign investments, international differences in interest rates should, on average, be offset by countervailing exchange rate changes.

- Of course, deviations from this proposition do not reveal which of the underlying hypothesis (UIP, rational expectations, definition of risk premium) is violated. However, this has far-reaching implications for the interpretation of such a result.

Either Exchange rates are not proportionally related to international interest rate differences due to capital controls, transaction costs, differences in default risks, or taxation. Probably, alleged inconsistencies with UIP can always be blamed on some friction.

Or Deviations from UIP are due to psychological factors distorting the formation of expectations. **Behavioural finance theories** argue that there are trends in the foreign exchange market leading to differences between s_{t+1} and s^e_{t+1}. Technical analysis claims to provide tools to uncover such trends. If true, it should be possible to formulate **mechanical trading rules** that systematically outperform UIP.

- Examples are carry trades, MA-filters, or calender trading rules.
- It is almost impossible to determine the intrinsic merit of a trading rule. In particular, when there are many conceivable rules, success in terms of generating abnormal returns can also arise due to luck.

- The big question is: Why are abnormal returns not be arbitraged away?

Long-Term Exchange Rate Theory

- The long-term is characterised by constant portfolios and flexible prices. Therefore, the exchange rate adjusts, in a gradual manner, according to the conditions on the international goods market.

The Purchasing Power Parity (PPP) Condition

- Without trade-barriers, consumers would be indifferent between buying identical goods in a given country/currency. Under this scenario, the **law-of-one-price** holds in the sense that arbitrage eliminates the differences between the domestic price P_m and foreign price P_m^* of a good m expressed in the same currency, that is

$$P_m = SP_m^*.$$

- For the long-term when prices are flexible, the purchasing power parity condition lifts the law-of-one-price onto the aggregate level.

Purchasing Power Parity (PPP): Absolute Version

The price level of a consumer basket is identical when converted into the same currency, that is

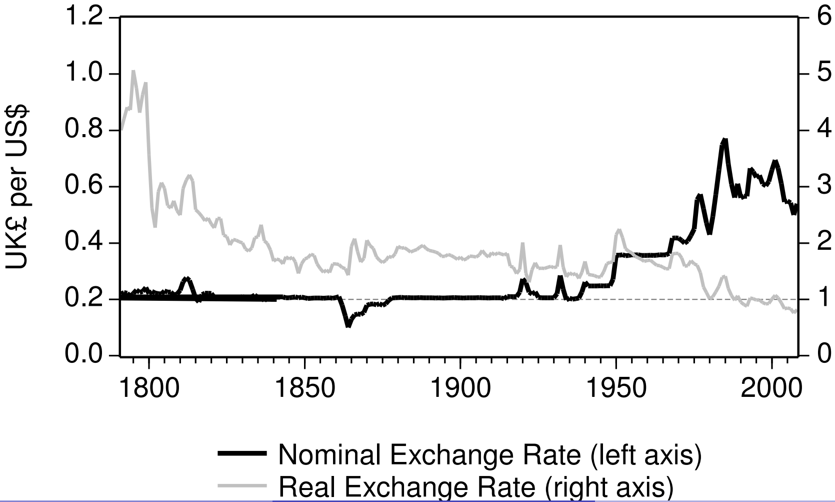
$$P = SP^*$$

- The empirical evidence for this absolute version of PPP is weak. In particular, the real exchange rate $Q_t = SP^*/P$ is neither constant, nor does it converge to a value of 1.
- Expressing the relationship between prices and exchange rates in terms of differences gives rise to the **relative version of PPP** according to which the rate of depreciation/appreciation Δs depends on international differences in (expected) inflation π:

Purchasing Power Parity (PPP): Relative Version

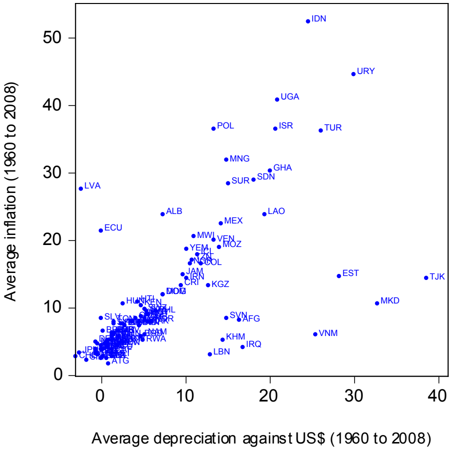
$$\Delta s = \pi - \pi^*$$

Figure: Little Evidence on Absolute Version of PPP



- There is more empirical support for relative PPP, in particular when inflation is high, exchange rates are fixed, and trade barriers are low.

Figure: Some Evidence on Relative Version of PPP



- Transportation costs, tariffs, etc. could create deviations from PPP.
- Consider e.g. a case where a fraction $(1-\omega)$ of goods is not tradable (e.g. services). Let their price be the numeraire and denote the price of tradable goods with P_m. Then, $\phi = 1/P_m$ is an indicator for the competitiveness of the domestic sector relative to the open sector. Collecting structural factors with $\sigma = \omega + (1-\omega)\phi$ yields

$$S = \frac{P_m}{P_m^*} = \frac{P}{P^*}\frac{\sigma^*(\phi^*, \omega^*)}{\sigma(\phi, \omega)}.$$

  - Here, the exchange rate depends on nominal and structural factors. An uncompetitive domestic sector ($\phi \uparrow$, $\sigma \uparrow$) appreciates the exchange rate.
  - Imperfect competition and trade barriers can also explain why the **exchange-rate-pass-through** (the change of import prices due to a change in the nominal exchange rate) is usually incomplete.
  - The purchasing power of developing country currencies tends to be low. The **Balassa-Samuelson Effect** explains this with the low labour productivity in the tradables sector of developing countries, which would imply that $\sigma < \sigma^*$ (and vice versa for developed countries).

Some Extensions

A Monetary Model with Flexible Exchange Rates

- Money is closely connected with the price level, which according to the PPP determines the exchange rate. Suppose that the money market equilibrium is given by $M/P = L(Y, R)$, where M is money supply and $L(Y, R)$ money demand that depends positively on output Y and negatively on the interest rate R. Then

$$S = \frac{P}{P^*} = \frac{M}{M^*}\frac{L(Y^*, R^*)}{L(Y, R)}.$$

- Log-linearisation and inserting the UIP yields

$$s \approx \alpha(m - m^*) + \beta(y^* - y) + \gamma s^e,$$

where α, β, γ are parameters. With **flexible exchange rates**, s depends on **fundamental factors** (m, y) and the expectations s^e.

↷ E.g. an appreciating currency is per se neither good nor bad since this can be the result of both positive and negative economic developments.

Monetary Model of the Balance of Payments

- With a credible **fixed exchange rate**, $\overline{S} = S = S^e$. Then, according to the UIP, $R = R^*$ and, according to the PPP, $P = \overline{S}P^*$.
- Divide the money supply M into foreign exchange reserves RE and domestic credit component issued by the central bank D, that is

$$M = RE + D.$$

- Using again the money demand function $M = PL(Y, R^*)$ and solving for RE yields the **monetary model of the balance of payments**

$$RE = \overline{S}P^*L(Y, R^*) - D$$

A decline in output Y, an increase in domestic credit D, a decrease in foreign prices P^*, or an increase in foreign interest rates R^* all lower the reserves RE. A central bank can offset this by devaluing the currency $\overline{S} \uparrow$.

Summary

- Exchange rate determinants differ according to time horizon.
- During the **short-term**, the UIP relates the exchange rate with international developments on the capital market, on which the interest rate is determined. In terms of the balance of payments, the **capital account** dominates any movement in the current account.
- In the **long-term**, portfolios are constant, and the PPP relates the exchange rate with international developments on the goods market, on which the price level is determined. In terms of the balance of payments, the **current account** dominates.

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Derivation of UIP:

$$(1 + R_t) = (1 + R_t^*)\frac{S_{t+1}^e}{S_t}$$

$$R_t = R_t^*\left(\frac{S_{t+1}^e}{S_t}\right) + \frac{S_{t+1}^e}{S_t} - 1$$

$$R_t = R_t^*\left(\frac{S_{t+1}^e}{S_t}\right) + \frac{S_{t+1}^e - S_t}{S_t}$$

Log Linearisation with $i = \ln(R)$ and $s = \ln(S)$

$$i_t \approx i_t^* + s_{t+1}^e - s_t$$

Derivation of PPP with Non-Tradables:

$$P = \omega P_m + (1 - \omega)$$

$$P = P_m[\omega + (1 - \omega)\phi] \quad \text{with} \quad \phi = 1/P_m$$

$$P_m = \frac{P}{\omega + (1-\omega)\phi} = \frac{P}{\sigma}$$

$$S = \frac{P_m}{P_m^*} = \frac{P}{P^*}\frac{\sigma^*}{\sigma}$$

Derivation of Monetary Model of Balance of Payments:

$$P = \overline{S}P^*$$
$$M/L(Y,R) = P = \overline{S}P^*$$
$$M = RE + D = \overline{S}P^*L(Y,R)$$
$$RE = \overline{S}P^*L(Y,R) - D$$