Chapter Overview

Chapter 5 focuses on the parity conditions that link the spot and forward exchange markets with the international money and bond markets. It begins with a reprise of the international parity conditions. It then develops the theory and reviews the empirical evidence of the interest rate parity condition. Interest rate parity (IRP) is the purest form of arbitrage in international financial markets. The interest rate parity line establishes the break-even line where the return on a foreign currency investment covered against exchange rate risk is identical with the return on a domestic currency investment.

The Fisher conditions are covered next. The International Fisher Effect establishes the break-even line between investments in domestic securities and investments in foreign securities where the exposure to currency risk is not covered. The International Fisher Effect predicts that high interest rate currencies tend to depreciate while low interest rate currencies tend to appreciate.

The forward rate unbiased condition naturally follows the IRP and International Fisher Effect. The empirical evidence suggests that over the long periods, the forward rate appears to be unbiased in the sense that periods of positive and negative bias offset each other.

The chapter closes with a discussion of the impact that these financial parity conditions have on decisions by private and public policymakers.

Chapter Outline

The Usefulness of the Parity Conditions in International Financial Markets: A Reprise
Interest Rate Parity: The Relationship between Interest Rates, Spot Rates, and Forward Rates
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Interest rate parity (IRP)

\[ F_{de/fc} = S_{de/fc} \frac{1 + i_{de}}{1 + i_{fc}} \]  \hspace{1cm} (1)

Example: \( F_{S/DM} = S_{S/DM} (1 + i_S) / (1 + i_{DM}) \)

Alternatively, IRP can be expressed as

\[ \frac{F_{de/fc}}{S_{de/fc}} = \frac{1 + i_{de}}{1 + i_{fc}} \]  \hspace{1cm} (2)

Example: \( F_{S/DM} / S_{S/DM} = (1 + i_S) / (1 + i_{DM}) \)

Or

\[ \frac{F_{de/fc} - S_{de/fc}}{S_{de/fc}} = \frac{i_{de} - i_{fc}}{1 + i_{fc}} \]  \hspace{1cm} (3)

Note that the left hand side is nothing but the forward premium.

Often the formula for IRP may be approximated as

\( FP_{DM} \approx i_S - i_{DM} \)

Or

\( i_S \approx i_{DM} + FP_{DM} \)

Note these are measured in percentage terms (not in $ as in our previous calculation). \( i_S \) is the cost of buying spot (the $ interest you give up) while \( i_{DM} + FP_{DM} \) is the cost of buying forward (the DM interest you forego and the extra cost or premium in the forward market).

With continuous compounding

\[ F_{de/fc,t+1} = S_{de/fc,t} e^{d_{de/fc}/s_{t+1}} \]  \hspace{1cm} (4)

Or
\[ f_{dc,f,t+1} = s_{dc,f,t} + i_{dc,t} + i_{fc,t} \]  \hspace{1cm} (5)

where \( f \) and \( s \) are the logarithms of \( F \) and \( S \) respectively.

**International Fisher Effect**

\[ S_{dc,f,t+1} = S_{dc,f,t} \left( 1 + i_{dc,t} \right) / \left( 1 + i_{fc,t} \right) \]  \hspace{1cm} (6)

With continuous compounding

\[ E[S_{dc,f,t}] = S_{dc,f,t} e^{i_{dc,t} T_{dc/fc}} / e^{i_{fc,t} T_{dc/fc}} \]  \hspace{1cm} (7)

Or

\[ E[S_{dc,f,t}] = S_{dc,f,t} + i_{dc,t} T_{dc/fc} - i_{fc,t} T_{dc/fc} \]  \hspace{1cm} (8)

**The Forward Parity (The Forward Unbiasedness Hypothesis)**

\[ E[S_{dc,f,t}] = F_{dc,f,t} \]  \hspace{1cm} (9)

Or

\[ E[S_{dc,f,t}] = f_{dc,f,t} \]  \hspace{1cm} (10)

Or

\[ E[S_{dc,f,t}] = S_t = f_{dc,f,t} - i_{fc,t} \]  \hspace{1cm} (11)

**International Fisher and PPP combined: real interest rate parity**

Based on PPP, the expected percentage change in the exchange rate

\[ \frac{S_T - S_t}{S_t} = \pi_S - \pi_{DM} \]  \hspace{1cm} (12)

where the exchange rates are expressed as U.S. dollars per DM.

Based on International Fisher,
Therefore, \[ \frac{S_{r}^T - S_{r}}{S_{r}} = i_{s} - i_{DM} \] (13)

\[ \pi_{r} = i_{s} - i_{DM} \] (14)

\[ i_{DM} - \pi_{DM} = i_{s} - \pi_{DM} \] (15)

**Interest Parity**

*with bid/ask spreads*

Now 8 variables are involved: the bid and ask prices for each of the previous 4 variables.

| Forward rate: | \( Fb(t,T) \) | \( Fa(t,T) \) |
| Spot rate: | \( Sb(t) \) | \( Sa(t) \) |
| Interest on domestic currency: | \( ib(T/360) \) | \( ia(T/360) \) |
| Interest on foreign currency: | \( i^*b(T/360) \) | \( i^*a(T/360) \) |

To see if riskless profit exists, there are two approaches:

**Borrow domestic currency**

1. Borrow domestic currency at the ASK price of the interest rate on domestic currency:

   \[ \frac{1}{1 + ia(T/360)} \] (9)

2. Convert this amount into foreign currency at ASK price of spot rate:

   \[ \frac{1}{1 + ia(T/360)} \times \frac{1}{Sa(t)} \] (10)

3. Place this amount of foreign currency at the BID price of interest rate on foreign currency:

   \[ \frac{1}{1 + ia(T/360)} \times \frac{1}{Sa(t)} \times [1 + i^*b(T/360)] \] (11)

4. At the same time, sell the above amount of foreign currency forward at the BID price:

   \[ \frac{1}{1 + ia(T/360)} \times \frac{1}{Sa(t)} \times [1 + i^*b(T/360)] \times Fb(t,T) \] (12)
If this is greater than 1, profit opportunity exists. To eliminate arbitrage, the following must hold:

\[ Fb(t,T) \leq Sa(t) \frac{1 + ia(T/360)}{1 + i^* b(T/360)} \]  

(20)

**Borrow foreign currency**

1. Borrow foreign currency at the ASK price of the interest rate on foreign currency:

\[ \frac{1}{1 + i^* a(T/360)} \]  

(213)

2. Convert this amount of foreign currency into domestic currency at BID price of spot rate:

\[ \frac{1}{1 + i^* a(T/360)} \times Sb(t) \]  

(22)

3. Place this amount of domestic currency at the BID price of interest rate on domestic currency:

\[ \frac{1}{1 + i^* a(T/360)} \times Sa(t) \times [1 + ib(T/360)] \]  

(23)

4. At the same time, sell the above amount of domestic currency forward at the ASK price (of the foreign currency):

\[ \frac{1}{1 + i^* a(T/360)} \times Sa(t) \times [1 + ib(T/360)] \times \frac{1}{Fa(t,T)} \]  

(24)

If this is greater than 1, profit opportunity exists. To eliminate arbitrage, the following must hold:

\[ Fa(t,T) \geq Sb(t) \frac{1 + ib(T/360)}{1 + i^* a(T/360)} \]  

(25)
**Answers to end-of-chapter questions**

1. Describe how covered interest arbitrage acts to enforce Interest Rate Parity. Describe the impact of each transaction on interest rates and exchange rates. Provide one example using the data in Appendix B.


Covered interest arbitrage transactions put pressure on prices, at the margin, that restore interest rate parity. In Figure 3.3, a capital outflow tends to raise $S$, lower $F$, raise $i_S$ and lower $i_{foreign}$. A capital inflow has the opposite effects on $S$, $F$, $i_S$ and $i_{foreign}$. These effects unambiguously cause a decrease in the deviation from interest rate parity.

2. Define the Fisher Effect and the Fisher International Effect (Uncovered Interest Parity). How are these effects similar and how are they different?

The Fisher Effect states that the nominal interest rate reflects a real interest rate and an anticipated rate of inflation. The Fisher International Effect (Uncovered Interest Parity) states that the nominal interest rate differential between two countries reflects the anticipated rate of currency depreciation of the exchange rate. The two Fisher effects are similar in that they both claim that interest rates reflect anticipations of future economic events. The two Fisher effects are different since the first Fisher Effect applies to a single economy, while the second Fisher International Effect applies to two economies.

3. Describe the Forward Rate Unbiased condition.

The Forward Rate Unbiased condition states that over a large number of observations, the average deviation between today's forward rate ($F_{t,n}$) and the spot rate when the forward contract expires ($S_{t+n}$) will not be significantly different from zero -- that is, it will be unbiased.

4. "If the Forward Rate Unbiased condition is true, then the forward rate should not vary from the future spot rate by more than 1%." True or false. Explain.

False. The Forward Rate Unbiased condition applies to the average of many observations. Any individual outcome could produce a deviation of 1%, 2%, 3% or more.

5. Discuss the impact of transaction costs on the Interest Rate Parity condition?

When transaction costs are present, the Interest Rate Parity condition need no longer hold exactly. Deviations as large as, but not larger than, transaction costs may exist, forming a neutral band around the parity line.
6. Discuss the impact of taxes on the Interest Rate Parity condition?

When taxes are present, arbitragers act to equalize the after-tax returns from domestic currency investments and foreign currency investments on a covered basis. If taxes fall evenly on capital gains and ordinary income, the conventional analysis of interest parity is not affected. However, if tax rates on capital gains differ from tax rates on ordinary income, the interest rate parity line will tilt away from its original 45° slope.

7. "We can measure the deviations from Interest Rate Parity on an *ex ante* basis, but we can only measure the deviations from the Fisher International Effect on an *ex post* basis." True or False? Discuss.

Deviations from Interest Rate Parity are computed using four prices (S, F, i\$ and i\textsubscript{foreign}) that can be observed before executing a trade. Deviations from Fisher International also involve four prices (S, E(S\textsubscript{t+n}), i\$ and i\textsubscript{foreign}). But the expected future spot rate cannot be observed beforehand. We only observe the actual future spot rate, S\textsubscript{t+n}, on an *ex post* basis.

8. Describe several alternative methods for testing the Interest Rate Parity condition. What is the most appropriate method?

The Interest Rate Parity condition could be tested using regression analysis (that is, regressing the forward premium on the interest rate differential) or by measuring the average deviation from parity. Neither of these methods gives a valid indication of how frequently parity is violated and profit opportunities are available. A better approach is to calculate the number of times that the four prices (S, F, i\$ and i\textsubscript{foreign}) lead to deviations that are larger than the cost of executing the arbitrage. To use this technique, we must be confident that the prices reflect true transaction prices at the same moment in time.

9. What empirical evidence tends to show that the Interest Rate Parity condition holds in the long-term?

Studies by Frenkel and Levich (1975, 1977) and others following them have verified that deviations from Interest Rate Parity tend to be small when based on Eurocurrency interest rates. Traders typically use the interest rate parity formula when asked to quote a forward rate, which is further evidence favoring the Interest Rate Parity condition.

10. "If the forward unbiased condition holds, financial managers should regularly hedge their foreign exchange exposure." Is this statement true or false? Why?

If the Forward Unbiased condition holds, then the expected value of foreign currency transactions that are hedged (at F\textsubscript{t,\textsubscript{n}}) is identical with those that are left exposed and converted at S\textsubscript{t+n}. Investors who lack forecasting expertise and are risk neutral would be indifferent between hedging and not hedging. If the manager has any risk aversion, hedging will be preferred since the volatility of the hedged stream of transactions will be lower without sacrificing any expected return.
11. "When Interest Rate Parity holds, it does not matter which currency you choose for borrowing or lending purposes?" Is this statement true or false? Why?

True, if we assume that all of the borrowing and lending is conducted on a fully covered basis.

12. Empirical evidence shows that there are sometimes deviations from Interest Rate Parity and the Fisher International Effect. What kind of threats and opportunities does this open up for financial managers?

Deviations from either parity condition offer opportunities to a financial manager. If Interest Rate Parity is violated, the manager can hope to identify moments with profitable arbitrage opportunities. The manager may also identify periods when one-way arbitrage is profitable. Deviations from Interest Rate Parity make synthetic US$ borrowing or swap-driven bond issues attractive to managers. If the Fisher Interest Effect is violated, the manager needs to know the mean, volatility and time pattern of deviations. If deviations can be predicted, then speculative strategies can be profitable. If the average deviation is non-zero and volatility is low, the manager may be attracted to a speculative strategy (such as borrowing in the low interest rate currency and investing in the high interest rate currency, expecting that the interest differential will more than compensate for the exchange rate change). But if deviations have a high volatility, managers will need to weigh the risk-return tradeoff.

13. In the case of a pegged exchange system, when would an interest rate differential appear between government securities of the two countries?

An interest rate differential between two currencies that are locked together in a pegged rate agreement may signify that there is some additional risk (of taxation, capital controls, higher inflation, and/or currency depreciation) in the higher interest rate currency. High Italian lire interest rates versus the DM in 1992, and high Mexican peso interest rates versus the US$ in 1994 are examples where this interpretation of greater risk was justified.

Answers to end-of-chapter exercises

INTEREST RATE PARITY

1. Suppose the US and UK three-month interest rates are respectively 6% and 8% per annum and that the spot rate is $1.55/£.

   a. Calculate the forward premium (or discount) on the £ expressed on a per annum basis.

   b. What value of the three-month forward rate establishes Interest Rate Parity?
SOLUTIONS:

2. Suppose the spot rate is $ 0.20/FF. The US one-year rate is 6%. The forward rate is $0.1923/FF.

a. What is the current one-year French interest rate that will satisfy the Interest Rate Parity?

b. Suppose the one-year French interest rate is 12% instead. What kind of arbitrage would you perform to take advantage of this opportunity?

c. Suppose the US tax rate on capital gains and the tax rate on interest earned and paid are respectively 15% and 40%. What is the new forward rate (F') that would satisfy IRP on an after-tax basis?

d. Suppose all the variables took the values from part (a). Would there be any arbitrage opportunity on an after-tax basis?

SOLUTIONS:

a. \( F/S = (1 + i_S)/(1 + i_{FF}); \) so \( i_F = (1 + i_S) \frac{S}{F} - 1; \) \( i_F = (1.06) \frac{0.20}{0.1923} - 1 = 10.24\% \)

b. An interest rate of 12% is greater than the rate that results in interest rate parity. Arbitrage with a capital outflow to FF: borrow $ at 6%, buy FF spot, invest FF at 12%, sell FF forward for US$.

c. \( (F' - S)/S = (i_S - i_{FF})/(1 + i_{FF}) * (1 - t_y)/(1-t_k); F' = 0.194570 \frac{S}{FF}; \) or 5.139535 FF/$

d. On an after-tax basis, there is an arbitrage profit opportunity by moving capital from FF to US$: borrow FF at 10.24%, sell FF spot at $0.20/FF, invest US$ at 6.0%, buy FF forward at $0.1923/FF.

3. Assume that the Citibank trading room is dealing on the following quotations Spot Sterling = $1.5000, Euro-Sterling interest rate (6-months) = 11.00% p.a. Euro-$ interest rate (6-months) = 6.00% p.a. and that Barclays Bank is quoting Forward Sterling (6-months) at $1.4550.
a. Describe the transactions you would make to earn risk-free covered interest arbitrage profits?

b. How much profit would you expect to make?

SOLUTIONS:

The implied, or synthetic, forward rate that Citibank is quoting is

\[ F_{\text{Citi}} = S \frac{1 + i/2}{1 + i^*/2} \]

\[ = $1.50 \times 1.03 / 1.055 = $1.4645 / £ \]

Since \( F_{\text{Barclays}} = $1.4550 / £ \), it follows that forward contracts at Barclays are cheap and synthetic forward at Citibank are dear.

a. The arbitrager should BUY forwards at Barclays and SELL synthetic forwards (i.e. borrow £, sell £ spot, and lend $) at Citibank to earn a profit.

b. The profit would be $0.0095/£ or about 0.63% on capital.

FISHER INTERNATIONAL EFFECT

4. The following data were taken from the July 28, 1994 issue of the Currency and Bond Market Trends by Merrill Lynch:

<table>
<thead>
<tr>
<th></th>
<th>JAPAN</th>
<th>BRITAIN</th>
<th>U.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spot exchange rates:</td>
<td>98.75 ¥/$</td>
<td>$1.53/£</td>
<td>----</td>
</tr>
<tr>
<td>5-year bonds:</td>
<td>3.73%</td>
<td>7.94%</td>
<td>6.88%</td>
</tr>
<tr>
<td>10-year bonds:</td>
<td>4.34</td>
<td>8.24</td>
<td>7.24</td>
</tr>
<tr>
<td>20-year bonds:</td>
<td>4.70</td>
<td>8.26</td>
<td>7.40</td>
</tr>
</tbody>
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Compute the break-even exchange rate for investors weighing the choice between $-bonds and Yen-bonds, and between $-bonds and Pound sterling bonds for each of the three maturities. (Note: Assume that interest is paid twice yearly.)

SOLUTIONS:
5. In 1986, The Seagram Company Ltd. (Canada) issued Swiss franc bonds (SFr 250,000,000) due September 30, 2085 with a 6% coupon. Assume that a similar bond denominated in $ would have required a 9% coupon and that the spot rate on issue day was $0.50/SFr.

a. Compute the break-even exchange rate for the redemption of the Seagram's bond at maturity.

b. Discuss why Seagram's may have issued this bond rather than a US$ denominated bond.

SOLUTIONS:
6. Suppose that the interest rates in question #5 reflect a 0.5% per annum currency risk premium for bond investors to willingly hold US$-denominated bonds.

   a. Compute the expected exchange rate on the maturity date of the bond in this case.

   b. How does the currency risk premium affect the choice by Seagram's to issue a US$ or SFr denominated bond?

SOLUTIONS: