7

Foreign exchange risk

7.1 Exchange-rate risk and exchange-rate regimes

In Chapter 6 we introduced a technique to find a discount rate that is commensurate with the riskiness of future cash flows. This discount reflects investors’ impatience to consume, inflation and uncertainty over future cash flows. When a company is trading internationally a further risk needs to be considered – transaction exposure. Transaction exposure is the risk faced by companies that trade internationally, when exchange rates change after a company has entered into an agreement, leading to higher domestic currency costs or lower domestic currency revenue.

However, different countries operate various exchange-rate regimes. Below we detail the exchange-rate regime for (i) China, (ii) the Czech Republic, (iii) France, (iv) the UK and (v) the United Arab Emirates.

China

China officially maintains a de jure managed floating exchange rate arrangement with a view to keeping the RMB exchange rate stable at an adaptive and equilibrium level based on market supply and demand with reference to a basket of currencies to preserve the stability of the Chinese economy and financial markets. The floating band of the RMB’s trading prices is 2% against the U.S. dollar in the interbank foreign exchange market—i.e., on each business day, the trading prices of the RMB against the U.S. dollar in the market may fluctuate within a band
of ±2% around the midrate released that day by China’s Foreign Exchange Trading System (CFETS).¹

**Czech Republic**

The de jure exchange rate arrangement is floating. The external value of the koruna is determined by supply and demand in the interbank foreign exchange market, in which the Czech National Bank (CNB) participates.²

**France**

The de jure exchange rate arrangement of the euro area is free floating. France participates in a currency union (EMU) with, as of January 1, 2015, 18 other members (previously 17) of the EU and has no separate legal tender. The euro, the common currency, floats freely and independently against other currencies.³

**United Kingdom**

The de jure and de facto exchange rate arrangements are free floating. The exchange rate of the pound sterling is determined on the basis of supply and demand in the foreign exchange market.⁴

**United Arab Emirates**

The de jure exchange rate arrangement is a conventional peg. The dirham was pegged to the U.S. dollar in 1980. A January 2003 decision made the peg official. The dirham is pegged to the U.S. dollar, the intervention currency, at the midrate of Dh 3.6725 per dollar (1 dirham = US$0.2723).⁵

Hence, the extent to which a company has exposure to exchange-rate risk depends upon which country it is trading with.

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² 2016 Annual Report, P. 1006.
⁴ 2016 Annual Report, P. 3595.
⁵ 2016 Annual Report, P. 3580.
In the language of the FX market, it is convention to use the terms ‘appreciation’ and ‘depreciation’ rather than ‘rise’ and ‘fall’. For example, if we consider the exchange rate between the US dollar and the pound sterling, the exchange rate fell from US$1.4558/GBP on 24 June 2016 (the day after the EU referendum) to US$1.2288/GBP at the end of 2016. Since one pound now buys fewer US dollars, we say that the pound has depreciated. In contrast, it now requires fewer US dollars to buy pounds and hence we say that the dollar has appreciated.

In November 2012, the exchange rate between the Japanese yen and the US dollar was 82.15 JPY/US$1. In October 2017, it was 112.39 JPY/US$1. Hence the JPY has depreciated, as more JPY are required to buy US$1. Likewise, the US dollar has appreciated, as US$1 buys more JPY in 2017 than it did in 2012.

### 7.2 How big is the foreign exchange market?

When one hears the word “market” one typically thinks of a physical location, especially as stock exchanges and futures exchanges were once exciting and vibrant places to visit. However, nowadays the vast majority of trades are matched electronically rather than by what was known as open outcry. By contrast, the foreign exchange market has never resided in a physical location and has always relied upon technology to facilitate transactions. In fact the US dollar/GBP exchange rate is still referred to as Cable in deference to a time when the rate was transmitted via cable along the bottom of the Atlantic Ocean. While nowadays, with the advent of electronic trading, most financial markets operate 24 hours a day, the foreign exchange market has long been open beyond traditional business hours due to the overlapping of time zones. Apart from public holidays and weekends, there is nearly always one financial centre open. Foreign exchange activity is carried out in all financial centres around the world, though some centres are more important than others. According to the Bank for International Settlements’ triennial survey (2016), 36.9% of activity takes place in the UK, followed by 19.5% in the United States, 7.9% in Singapore and 6.7% in Hong Kong.6

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This diagram summarises the unique nature of the foreign exchange market. It is evident that the United Kingdom’s trading times overlap with the United States, mainland Europe, the Middle East and India. This, and the use of English, partially explains the UK’s dominant share of daily foreign exchange turnover.

As the FX market is not in one physical location, it is not easy to quantify the size of the market. However, every three years the Bank for International Settlements (BIS) conducts a triennial survey. The findings of the April 2016 survey stated “Trading in foreign exchange markets averaged $5.1 trillion per day in April 2016. This is down from $5.4 trillion in April 2013, a month which had seen heightened activity in Japanese yen against the background of monetary policy developments at that time.”

The same survey found that in 2016 the following currencies were most dominant:

- USD – 87%
- EUR – 33.4%
- JPY – 23.1%
- GBP – 11.8%

As two currencies are involved in each transaction, the sum of shares in individual currencies will total 200%. Therefore, out of every 200 transactions, approximately 155 involved just four currencies: USD, EUR, JPY and GBP. In fact, of these 200 transactions, the same survey

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concluded that 24.1% involved the USD against the EUR, which makes this the most important currency pair.\(^8\)

### 7.3 Spot and forward markets and currency quotations

Buying a currency at the spot exchange implies “immediate” delivery and payment. At the time of writing, the spot quotation for the USD against the GBP was:

\[
1.3182 - 1.3184 \text{ US$}/\text{GBP}
\]

The way to interpret this is as follows: 1 GBP would buy US$1.3182, whereas if you had USD and wanted 1 GBP you would need to give up US$1.3184. Ask yourself, why could you not buy USD at 1.3184 and sell USD at 1.3182? If this was the case and I had £1m available I could buy:

\[
\text{US$1.3184/GBP} \times 1\text{m GBP} = \text{US$1,318,400}
\]

which I could sell back at US$1.3182/GBP:

\[
\frac{\text{US$1,318,400}}{1.3182} = \text{£1,000,151.71}
\]

As you finish with more than you started with, you clearly cannot buy USD at the right-hand price and sell at the left. In fact, using the quotes in the correct manner, if you start with £1m you would end up with £999,848.30.

Earlier it was noted that in April 2016, 155 out of 200 transactions involved the USD, GBP, JPY or EUR. What then about a company wishing to exchange Thai bhat for Indonesian rupiah? How do we determine this exchange rate? A cross-exchange rate is defined as an exchange rate between two currencies which is derived from their common relationship with a third currency. As the majority of currencies are only quoted against the USD, GBP, EUR and JPY, we can obtain any cross-exchange rate by using the two currencies’ exchange rate against one of these currencies.

Consider this analogy:

If one pound buys 8 apples and one pound also buys 4 oranges, what is the relative value of apples to oranges? Clearly it is 1 orange = 2 apples.

At the time of writing, the exchange rate between the Indonesian rupiah and the USD was 13,504 IDR/USD, and the exchange rate between the Thai bhat and the USD was 33.10

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THB/USD. Using the apples and oranges analogy from above, the exchange rate between the Indonesian rupiah and the Thai bhat is then:

\[
13,504/33.10 = 407.98 \text{ IDR per THB.}
\]

This is the cross-exchange rate.

What if a trader was instead quoting 450 IDR per THB? What opportunities would exist for an investor with US$1m?

<table>
<thead>
<tr>
<th>IDR/USD rate</th>
<th>13,503 IDR/USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>THB/USD rate</td>
<td>33.1 THB/USD</td>
</tr>
<tr>
<td>IDR/THB</td>
<td>450 IDR/THB</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Investor</th>
<th>US$1,000,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convert to THB</td>
<td>THB33,100,000 @ 33.1 THB/USD</td>
</tr>
<tr>
<td>Convert to IDR</td>
<td>IDR14,895,000,000 @ 450 IDR/THB</td>
</tr>
<tr>
<td>Convert to USD</td>
<td>US$1,103,088.20 @ 13,503 IDR/USD</td>
</tr>
</tbody>
</table>

**Profit**  
**US$103,088.20**  
**Profit**  
**10.31%**

Hence an arbitrage profit of 10.31% can be earned by converting the USD to THB and then to IDR and then back to USD. This is known as triangular arbitrage. Once the exchange rate returns to 407.95 INR/THB, the arbitrage opportunity disappears.

There also exists a forward market where deals are for future delivery – usually one, three or six months’ ahead, although other durations are possible provided that the market in the currency has sufficient volume. Forward rates are used by companies to hedge against exchange risk. For example, if I have a payment of Japanese yen to make in three months’ time, I might prefer to agree the price now rather than being exposed to an appreciation of the JPY vis-à-vis the GBP. Likewise, if I am receiving CHF in six months’ time, I may prefer to agree the price now rather than be exposed to a depreciation in the value of the CHF vis-à-vis the GBP. Arranging to buy (or sell) at a price agreed now, but for delivery in the future to avoid exchange rate risk, is known as hedging.
Example

Consider a UK firm that has outsourced part of its manufacturing process to the Czech Republic. It must pay an invoice for 2.5m CZK in three months’ time. What exchange rate risk does it face and how can the company hedge this risk?

An appreciation of the CZK would mean that the company would have to pay more GBP to obtain the 2.5m CZK in three months’ time. To hedge this risk, the company could arrange to buy the 2.5m CZK at a price agreed now, but for delivery in the future.

At the time of writing the CZK/GBP spot rate was 28.6970 and the CZK/GBP three-month forward rate was 28.7651.

<table>
<thead>
<tr>
<th>Exposure</th>
<th>2,500,000 Kč</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three months’ forward rate</td>
<td>28.7651 CZK/GBP</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Potential spot rate (CZK/GBP)</th>
<th>Unheded cost</th>
<th>Forward cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>£104,166.67</td>
<td>£86,910.87</td>
</tr>
<tr>
<td>25</td>
<td>£100,000.00</td>
<td>£86,910.87</td>
</tr>
<tr>
<td>26</td>
<td>£96,153.85</td>
<td>£86,910.87</td>
</tr>
<tr>
<td>27</td>
<td>£92,592.59</td>
<td>£86,910.87</td>
</tr>
<tr>
<td>28</td>
<td>£89,285.71</td>
<td>£86,910.87</td>
</tr>
<tr>
<td>29</td>
<td>£86,206.90</td>
<td>£86,910.87</td>
</tr>
<tr>
<td>30</td>
<td>£83,333.33</td>
<td>£86,910.87</td>
</tr>
<tr>
<td>31</td>
<td>£80,645.16</td>
<td>£86,910.87</td>
</tr>
<tr>
<td>32</td>
<td>£78,125.00</td>
<td>£86,910.87</td>
</tr>
<tr>
<td>33</td>
<td>£75,757.58</td>
<td>£86,910.87</td>
</tr>
<tr>
<td>34</td>
<td>£73,529.41</td>
<td>£86,910.87</td>
</tr>
</tbody>
</table>

Whatever happens, the company is locked into a cost of £86,910.87. If the CZK depreciates (i.e. the rate > 28.7651), the company might wish, in hindsight, that it had not hedged.

Example

Consider a UK firm that is to receive CHF 100m from an asset sale in Geneva in three months’ time. What exchange rate risk does it face? The three-month forward rate is 1.2775 CHF/GBP. Evaluate this hedge at spot rates of 1.2, 1.25, 1.3, 1.35 and 1.4 CHF/GBP.
The firm is worried about a depreciation of the CHF which would mean that it received less GBP than anticipated. To hedge this risk, the company could arrange to sell the 100m CHF at a price agreed now, but for delivery in the future.

<table>
<thead>
<tr>
<th>Exposure</th>
<th>CHF100,000,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three-month forward rate=</td>
<td>1.2775 CHF/GBP</td>
</tr>
<tr>
<td>Potential spot rate (CHF/GBP)</td>
<td>Unhedged revenue</td>
</tr>
<tr>
<td>1.2</td>
<td>£83,333,333.33</td>
</tr>
<tr>
<td>1.25</td>
<td>£80,000,000</td>
</tr>
<tr>
<td>1.3</td>
<td>£76,923,076.92</td>
</tr>
<tr>
<td>1.35</td>
<td>£74,074,074.07</td>
</tr>
<tr>
<td>1.4</td>
<td>£71,428,571.43</td>
</tr>
</tbody>
</table>

Whatever happens, the company is locked into a revenue of £78,277,886.50. If the CHF appreciates (i.e. the rate < 1.2775), the company might wish, in hindsight, that it had not hedged.

The spreadsheet for this exercise can be found [here](#). Please ensure you click on Section 7 and the 7.3a, 7.3b and 7.3c tabs at the bottom of the spreadsheet.

### 7.4 Calculating the forward rate

The forward rate between two currencies is not, in contrast to the spot rate, determined by the forces of supply and demand. Instead, it is determined by adjusting the spot rate according to the interest differential. It also draws upon the concept of no arbitrage. Arbitrage is an action taken by an investor whereby a positive return can be earned without bearing any risk. As detailed in Chapter 2, if no risk is borne then the maximum return should be the risk-free rate.

Let us assume that 12-month US interest rates were 5% per annum, 12-month UK interest rates were 2% per annum, the spot rate is US$1.5/GBP and the 12-month USD/GBP forward rate is US$1.56/GBP. A UK investor could then borrow £1m, convert to USD at US$1.5/GBP, invest at the higher US interest rate of 5% for 12 months, while simultaneously selling the proceeds forward at US$1.56/GBP. The outcome would be:

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Borrow</td>
<td>£1,000,000</td>
</tr>
<tr>
<td>Convert to USD</td>
<td>$1,500,000</td>
</tr>
<tr>
<td>Invest in USD</td>
<td>$1,575,000</td>
</tr>
<tr>
<td>Sell forward</td>
<td>£1,009,615.38</td>
</tr>
</tbody>
</table>
Repay loan £1,020,000
Profit –£10,384.62

Hence, if the forward rate was 1.56 USD per GBP there appears to be no arbitrage opportunity to borrow GBP’s, convert to USD’s, invest in USD’s whilst simultaneously selling the proceeds forward. However, clearly the forward market is not in equilibrium as if it were the profit should be zero. Considering instead an arbitrage of borrowing USD, converting to GBP, investing in GBP whilst simultaneously selling the proceeds forward we obtain:

<table>
<thead>
<tr>
<th>Borrow</th>
<th>$1,000,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convert to GBP</td>
<td>£666,666.67</td>
</tr>
<tr>
<td>Invest in GBP</td>
<td>£680,000</td>
</tr>
<tr>
<td>Sell forward</td>
<td>$1,060,800</td>
</tr>
<tr>
<td>Repay loan</td>
<td>$1,050,000</td>
</tr>
<tr>
<td>Profit</td>
<td>$10,800</td>
</tr>
</tbody>
</table>

If the forward rate was instead US$1.5441/GBP, the arbitrage opportunity would disappear. In the first example, 1.56 US dollars were required to sell forward for each pound, while in the second case 1.53 US dollars were required to sell forward for each pound. However, if 1.5441 US dollars are required, then the proceeds from selling US dollars forward are just sufficient to repay the loan and the arbitrage opportunity disappears.

Consider an investor who borrows A GBP at a rate of i\textsubscript{UK} for 12 months. They could convert these GBP into US dollars at S($/£) to obtain:

\[ A \times S($/£) \]

which they could invest at i\textsubscript{US} for 12 months to earn:

\[ A \times S($/£) \times (1 + i_{US}) \]

which they could then sell forward at F\textsubscript{12/12}($/£) to produce the following GBP amount:

\[ \frac{A \times S($/£) \times (1 + i_{US})}{F_{12/12} ($/£)} \]

To preclude arbitrage:

\[ \frac{A \times S($/£) \times (1 + i_{US})}{F_{12/12} ($/£)} = A \times (1 + i_{US}) \]

This can be rearranged thus:
\[
F_{12/12}(\$/E) = \frac{S(\$/E) \times (1 + i_{US})}{(1 + i_{US})}
\]

Note that the “As” cancel out:

Hence for the example above:

\[
F_{12/12}(\$/E) = \frac{1.5 \times (1 + 0.05)}{(1 + 0.02)} = 1.5441 \text{ USD per GBP}
\]

Equivalent equations exist to calculate the one-month, three-month and six-month forward rates:

\[
F_{1/12}(\$/E) = \frac{S(\$/E) \times \left(1 + \frac{i_{US}}{12}\right)}{(1 + \frac{i_{US}}{12})}
\]

\[
F_{3/12}(\$/E) = \frac{S(\$/E) \times \left(1 + \frac{i_{US}}{4}\right)}{(1 + \frac{i_{US}}{4})}
\]

\[
F_{6/12}(\$/E) = \frac{S(\$/E) \times \left(1 + \frac{i_{US}}{2}\right)}{(1 + \frac{i_{US}}{2})}
\]

**Example**

If the three-month US interest rate is 1% p.a., the three-month South African interest rate is 6% p.a. and the South African rand (ZAR) exchange rate to the USD is 13.50 ZAR per USD, then what is the three-month forward rate?

Here we need to modify the equation above in the light of the new currency:

\[
F_{3/12}(ZAR/USD) = \frac{S(ZAR/USD) \times \left(1 + \frac{i_{ZAR}}{4}\right)}{(1 + \frac{i_{US}}{4})} = \frac{13.5 \times \left(1 + \frac{0.06}{4}\right)}{(1 + \frac{0.01}{4})}
\]

\[= 13.6683 \text{ ZAR/USD}\]

The spreadsheet for this exercise can be found [here](#). Please ensure you click on Section 7 and the 7.4a and 7.4b tabs at the bottom of the spreadsheet.
Activity 7.1

The spot rate between the Danish krona and the euro is 7.4422 DKK/EUR. The 12-month euro and Danish krona interest rates are 1.22% p.a. and 1.6% p.a. respectively. What would the 12-month DKK/EUR forward rate be?