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Chapter 5 - Currency Derivatives (FX Management Tools)

Currency Derivatives can reduce the risk in FX transactions.

1. Currency Futures/Forwards
2. Currency options
3. Money Market (Replication of IRP. Chapter 10)
4. Other hedging tools (Ch 10-12): - Pricing in DC
   - Risk-sharing
   - Matching Outflows & Inflows

This Lecture

We will present two FX Derivatives:

- Currency Futures/Forwards (agreement to buy/sell FC at a given price at time T)
- Currency Options (right to buy/sell FC at a given price during a period of time, t to T)

• Currency Risk

Definition: The risk that the value of an asset/liability/financial instrument will (negatively) change due to changes in FX rates. (Financial risk applied to international finance!)

Example: ABYZ, a U.S. company, imports wine from France. ABYZ has to pay EUR 5,000,000 on January 2. Today, September 4, the exchange rate is 1.29 USD/EUR.

Situation: Payment due on January 2: **EUR 5,000,000.**
$S_{Sep\ 4}$ = **1.29 USD/EUR**.

Problem: S_t is difficult to forecast ⇒ Uncertainty.
Uncertainty ⇒ Risk.
Example: on January 2, $S_{t=Jan\ 2}$ > or < **1.29 USD/EUR**.

At $S_{Sep\ 4}$, ABYZ total payment would be: EUR 5M x 1.29 USD/EUR = USD 6.45M.

On January 2 we have two potential scenarios relative to Sep 4:

If the $S_{Jan\ 2}\downarrow$ (USD appreciates) ⇒ ABYZ will pay less USD.
If the $S_{Jan\ 2}\uparrow$ (USD depreciates) ⇒ ABYZ will pay more USD.

The second scenario introduces *Currency Risk*. ¶

If the value of an asset/liability does not change "a lot" when S_t moves, we will consider the

asset/liability to have low currency risk. (Of course, if it does not change in value at all, it does not face currency risk.)

In finance, we relate "a lot" to the variance or volatility. For currency risk, we will look at the volatility of FX rates: => more volatile currencies, higher currency risk.

Example (continuation): Consider the following situations:
(A) $S_{Jan\ 2}$ can be with 50% either scenario:
(i) 1.28 USD/EUR, for a total payment: **EUR 5M** * 1.28 USD/EUR = USD 6.40M.
(ii) 1.30 USD/EUR, for a total payment: **EUR 5M** * 1.30 USD/EUR = USD 6.50M.

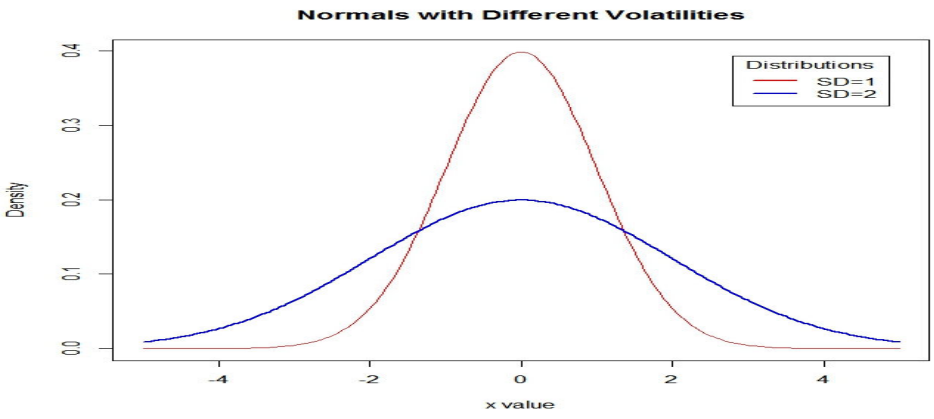
(B) $S_{Jan\ 2}$ can be with 50% either scenario:
(i) 1.09 USD/EUR, for a total payment: **EUR 5M** * 1.09 USD/EUR = USD 5.45M.
(ii) 1.49 USD/EUR, for a total payment: **EUR 5M** * 1.49 USD/EUR = USD 7.45M.

Both situations have the same expected value (expected payment: USD 6.45 M), but different levels of risk. Situation B is riskier (more volatile) for ABYZ, since it may result in a higher payment.

Note: Under situation B, ABYZ may end up paying a lot less than in situation A. That's the usual risk/reward trade-off in finance: No pain (risk, volatility), no gain (in this case, lower payments)! ¶

Currency (financial) risk is evaluated using probability distributions. For example, the normal distribution. Two different normal distributions are plotted in Figure 5.1 with the same mean (0), but different volatilities (standard deviations, SD). The blue distribution (SD=2) would be considered riskier than the red distribution.

Figure 5.1: Normal Distributions with Different Standard Deviations



Recall that a probability distribution completely describes the behavior of a random variable. (For us: the random variable: S_t. The behavior we want to be described: the variability of S_t.)

Before making decisions regarding FX derivative instruments, a company should take into consideration the distribution (the behavior) of future S_t. In the previous example, under Situation A, ABYZ can ignore FX risk; but under Situation B, ignoring FX risk is risky!

• Brief Aside: Characteristics of the Distribution of FX Rates

Below, Table 5.1 shows the distribution of percentage changes in FX Rates, $e_{f,t}$, for selected currencies (annualized mean & SD), using 1990-2017 monthly data (336 observations).

TABLE 5.1: Descriptive Statistics for selected currencies (1990-2017) using monthly data

Currency	Mean	Standard Deviation	Skewness	Excess Kurtosis	Normal?
GBP/USD	0.0090	0.0951	0.9681	3.4004	No
CHF/USD	-0.0097	0.1101	0.2171	1.3365	No
DKK/USD	0.0118	0.1030	0.4803	1.2113	No
EUR/USD	0.0166	0.1102	0.5253	1.2145	No
INR/USD	0.0565	0.0820	3.0932	24.1434	No
JPY/USD	-0.0010	0.1056	-0.1936	1.9347	No
KRW/USD	0.0295	0.1247	1.7968	15.9320	No
THB/USD	0.0179	0.1055	2.6493	32.3567	No
SGD/USD	-0.0095	0.0563	0.5677	2.9251	No
CNYUSD*	-0.0122	0.0160	-0.4484	7.9325	No
KWD/USD	0.0024	0.0446	2.1568	74.9592	No
SAR/USD	0.0000	0.0030	3.3228	119.9623	No
CAD/USD	0.0106	0.0792	0.8378	5.7371	No
MXN/USD	0.0818	0.1359	5.0008	51.7441	No
ZAR/USD	0.08053	0.14163	0.08053	2.1010	No
EGP/USD*	0.04084	0.05303	0.04084	216.7728	No
NGN/USD*	0.1666	0.5804	15.7821	259.9828	No
AUD/USD	0.01062	0.11436	0.01062	4.3249	No

Average	**0.0349**	**0.1180**	**2.7443**	**38.4349**	**No**

Notes: * shorter sample: CNY (9/1994-12/2017), EGP (1/1995-12/2017) & NGN (1/1994-12/2017).

- On average, since 1990, the USD appreciated against international currencies at an annualized mean of 3.49%. The average annualized SD is 11.80%.
- USD against developed currencies (in blue): 0.5% annualized appreciation, with a 9.51% SD.
- *Excess Kurtosis.* It describes the fatness of the tails. Under normality, excess kurtosis equals 0. All the currencies show excess kurtosis, that is, the tails are fatter than the tails of a normal –i.e., probability of a tail event is higher than what the normal distribution implies. The tails are very thick, reflecting higher extremes, in emerging markets.
- *Skewness*. If the distribution is symmetric (mean=median, for example, a normal), skewness is 0. Almost all the currencies show positive skewness (mean>median); that is, the fat part of the curve is on the left. Again, emerging market currencies show higher skewness.
- From the last column, which shows the results of a test of normality, the Jarque-Bera (1980) test, we can say that $e_{f,t}$ does not follow a normal distribution. Not a surprising result, given the big skewness and excess kurtosis.

The last three results are typical of financial time series.

• Currency Futures or Forward Contracts

FX Forward/Futures are agreements that set, today, the price of the exchange rate at a given future date. The agreement specifies a given quantity.

• Basic Terminology

◊ Short: Agreement to Sell.
◊ Long: Agreement to Buy.
◊ Contract size: Number of units of foreign currency in each contract.
◊ Maturity (T): Date in which the agreement has to be settled.
◊ Futures/Forward price ($F_{t,T}$): Price at which the forward transaction at maturity will be executed.

• Forwards vs Futures

◊ Forward markets: Tailor-made contracts.
Location: none (OTC traded contracts).
Reputation/collateral guarantees the contract.

◊ Futures markets: Standardized contracts (standardized duration, size, collateral).
Location: organized exchanges (CME, Euronext (LIFFE), Tokyo FX)
Clearinghouse guarantees the contract.

CME Standardized sizes: GBP 62,500, AUD 100,000, EUR 125,000, JPY 12.5M. There is a smaller sized-contract (E-micro), the size is 10% of standardized size.

CME expiration dates: Mar, June, Sep, and Dec + Three nearby months.

Margin account: Amount of money you deposit with a broker to cover your possible losses involved in a futures/forward contract. Two important quantities:

- Initial Margin: Initial level of margin account.
- Maintenance Margin: Lower bound allowed for margin account.

Mechanism: If margin account goes below maintenance level, a *margin call* is issued:

$\Rightarrow$ Funds have to be added to restore the account to the initial level.

Example: GBP/USD CME futures
Initial margin: USD 2,800
Maintenance margin: USD 2,100

If losses do not exceed USD 700, no margin call will be issued.
If losses accumulate to USD 850, USD 850 will be added to account. ¶

Table 5.2 summarizes the main differences between the two contracts.

TABLE 5.2: Comparison of Futures and Forward Contracts

	Futures	Forward
Amount	Standardized	Negotiated
Delivery Date	Standardized	Negotiated
Counter-party	Clearinghouse	Bank
Collateral	Margin account	Negotiated
Market	Auction market	Dealer market
Costs	Brokerage and exchange fees	Bid-ask spread
Secondary market	Very liquid	Highly illiquid
Regulation	Government	Self-regulated
Location	Central exchange floor	Worldwide

• Real Life Examples of Forwards and Futures

Pizza delivery: Customer buys future pizza; pays with USD (domestic currency)
Pizza Hut sells future pizza; gets paid with USD (domestic currency)

Terms of contract:

Size: One pizza
Duration: 30' or less.
Collateral: Credit card or None

• Using FX Forwards and Futures

Q: Who buys/sells FX Forward and Futures Contracts?

A: Hedgers and Speculators

Example: IBM has to pay in 90 days EUR 5M to a French supplier.

Problem: IBM is concerned about a depreciation of the USD against the EUR in the near future.

Solution: IBM buys from Chase a EUR forward contract.

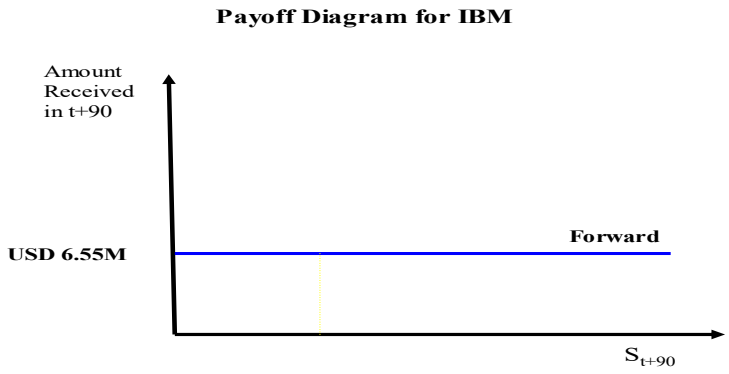
Size = EUR 5M

Maturity = 90 days.

$F_{t,90}$ = 1.31 USD/AUD

Note: IBM knows that, in 90 days, it will pay USD 6.55M (=EUR 5M*1.31 USD/EUR) to the supplier. As shown in Figure 5.2, there is no uncertainty whatsoever about this amount: S_{t+90} does not affect the amount to receive in 90 days. (No uncertainty, no volatility => No FX risk).

Figure 5.2: CFs under an FX Futures



Hedging Note:

- Underlying position: Short EUR 5 M.
- Hedging position: Long 90 days futures for EUR 5 M. ¶

Example: A U.S. investor has GBP 1 million invested in British gilts (UK government bonds).

Problem: Uncertain about future value of USD/GBP in December.

Solution: Sell GBP Dec futures.

Situation: It is Sep 12.

Underlying position: British bonds worth GBP 1,000,000.

$F_{Sep\ 12,Dec}$ = 1.55 USD/GBP

Futures contract size: GBP 62,500.

$S_{Sep\ 12}$: 1.60 USD/GBP.

number of contracts = ?

Hedging position: The investor sells GBP 1,000,000/(62,500 GBP/contract) = 16 contracts.

Note: If the U.S. investor decides to sell her British gilts in December she will receive exactly USD 1.55M. No uncertainty whatsoever about this amount.

But, if she decides not to sell the gilts, there will be a cash flow from the difference between S_{Dec} - $F_{Dec,Dec}$. ¶

Hedging Note:
- Underlying position: Long GBP 1 M.
- Hedging position: Short futures for GBP 1 M.

From both hedging notes ⇒ Hedging is very simple: Take an opposite position!

We call the hedger with a long FX futures/forward position, the *long hedger.* Similarly, we call the hedger with a short FX futures/forward position, the *short hedger.*