Chapter 5
FX Derivatives

A. FX Futures and Forwards

FX Risk

Example: Spec's, the Texas liquor store chain, imports wine from Europe. Spec's has to pay **EUR 5,000,000** on July 2. Today, June 4, the exchange rate is S_t = 1.10 USD/EUR.

Situation: Payment due on **July 2**: **EUR 5M**.
$S_{t=June\ 4}$= **1.10 USD/EUR**.

Problem: S_t is difficult to forecast ⇒ Uncertainty.
Uncertainty ⇒ Risk.
Example: on July 2, $S_{t=June\ 4}$ > or < 1.10 USD/EUR

At $S_{t=June\ 4}$, Spec's total payment would be:
EUR 5M * **1.10 USD/EUR** = **USD 5.50M**.

At $S_{t=June\ 4}$ = **1.10 USD/EUR**, Spec's total payment = **USD 5.50M**.

On July 2 there are two potential scenarios, relative to June 4:

If $S_{July\ 2} \downarrow$ (USD appreciates) ⇒ Spec's will pay less USD.

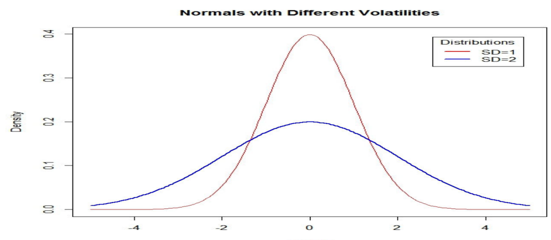
If $S_{July\ 2} \uparrow$ (USD depreciates) ⇒ Spec's will pay more USD.

⇒ Second scenario introduces *FX (Currency) Risk*.

The relevance of FX risk for a firm depends on the *volatility* of S_t:

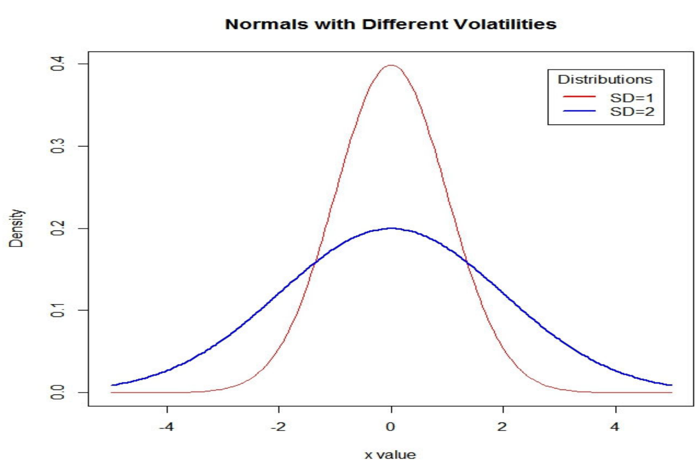
If $S_{July\ 2} \in$ [1.08, 1.12], payable will not move a lot. No big deal.

If $S_{July\ 2} \in$ [0.80, 1.40], payable can move a lot ⇒ Concern!



Higher Volatility ⇒ Concern!

Graph: Below, we compare two normal distributions for (changes of) S_t. The "blue" distribution, with higher standard deviation (SD = volatility), is riskier, in the sense that extreme values are more likely.



Futures or Forward FX Contracts

Definition: A forward contract is an agreement written today, between two parties (one party is usually a bank), to exchange a *given amount* of currencies at a given *future date* at a *pre-specified exchange rate,* $F_{t,T}$.

Given amount: *Size*

Future Date: Maturity = *Delivery Date* = *T*

Forward markets: Tailor-made contracts (& illiquid).
Location: None.
Reputation/collateral guarantees the contract.

Futures markets: Standardized contracts (& liquid).
Location: Organized exchanges
Clearinghouse guarantees the contract.

FX Futures/Forwards: Basic Terminology

Two parties:
- A *buyer,* with the ***long*** *FC* position;
- A *seller,* with the ***short*** FC position.

Short: Agreement to **Sell**.

Long: Agreement to **Buy**.

Contract Size: Number of units of FC in each contract.

CME Expiration dates: **Mar**, **June**, **Sep**, and **Dec** + Two nearby months (on the third Wednesday of expiration month)

Margin account: Funds deposited with a broker to cover possible losses involved in a futures/forward contract.

Initial Margin: Initial level of margin account.

Maintenance Margin: Lower bound allowed for margin account.

Settlement: FX futures can be cash-settled or physically delivered.

• Margin Account

A margin account is like a checking account you have with your broker, but it is *marked to market*. At the end of the day, if your contracts make (lose) money, money is added to (subtracted from) your account

Example: March GBP/USD CME futures (contract size = **GBP 62,500**)
Today, a traders starts a **long 2 March GBP** contract position (= GBP 125,000).

Tomorrow, the March GBP futures increases by **USD 0.01**, then, USD 1,250 (=**USD .01** * 125,000) are added to the trader's margin account.

If in 2 days, the March GBP futures decreases by **USD 0.02**, then, USD 2,500 (= **-USD .02** * 125,000) are subtracted from the trader's margin account. ¶

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

⇒ you have to add funds to restore the account to the initial level.

Example: GBP/USD CME futures (contract size = **GBP 62,500**)

Initial margin:	USD 2,800
Maintenance margin:	USD 2,100

If losses do not exceed **USD 700** ⇒ no margin call.

If losses accumulate to **USD 850** ⇒ margin call: add **USD 850** to account. ¶

Comparison of Futures and Forward Contracts

	Futures	Forward
Size	**Standardized**	*Negotiated*
Delivery Date (T)	**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

Using FX Futures/Forwards

• Iris Oil Inc. will transfer **CAD 300 million** to its USD account in 90 days. To avoid FX risk, Iris Oil decides to *short* a USD/CAD Forward contract.

Data:

S_t = .8451 USD/CAD

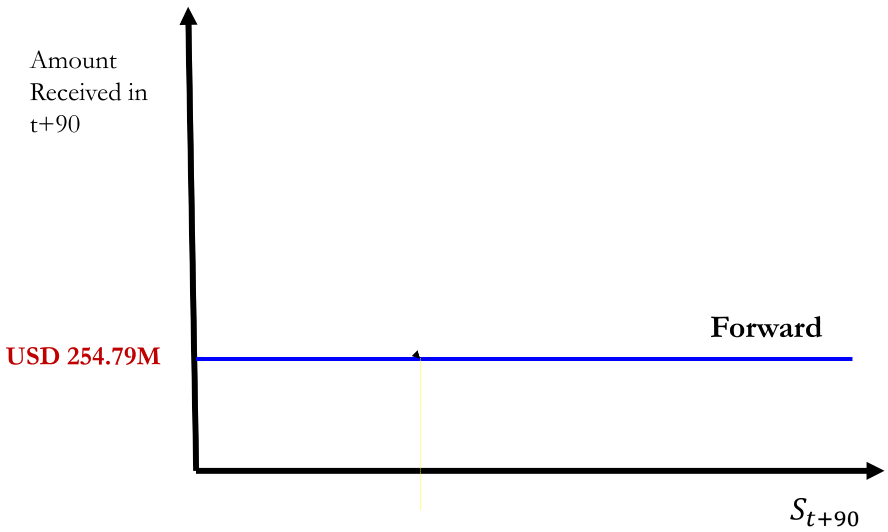
$F_{t,90\text{-day}}$ = .8493 USD/CAD

In 90-days, Iris Oil will receive with certainty:

(**CAD 300M**) * **.8493 USD/CAD** = **USD 254,790,000**.

Note: The exchange rate at in 90 days (S_{t+90}) is, now, irrelevant.

The payoff diagram makes it clear: Using futures/forwards can completely isolate a company from FX uncertainty.



Hedging with FX Futures Contracts

• FX Hedger

FX Hedger reduces the exposure of an *underlying position* to currency risk using (at least) another position (*hedging position*).

Basic Idea of a Hedger

A change in value of an underlying position is compensated with the change in value of a hedging position.

Goal: Make the overall position insensitive to changes in FX rates.

Hedger has an overall portfolio (OP) composed of (at least) 2 positions:
(1) Underlying position (UP)
(2) Hedging position (HP) with negative correlation with UP

Value of OP = Value of UP + Value of HP.

⇒ Perfect hedge: The Value of the OP is insensitive to FX changes.

• Types of FX hedgers using futures:

i. ***Long*** *hedger*: UP: *short* in the foreign currency.
HP: ***long*** in currency futures.

ii. ***Short*** *hedger*: UP: *long* in the foreign currency.
HP: ***short*** in currency futures.

Note: Hedging with futures is very simple: Take an opposite position!

• The Basic Approach: Equal hedge

Equal hedge:

Size of UP = Size of HP.

Example: Long Hedge and Short Hedge

(A) ***Long*** *hedge*.

A U.S. investor has to pay **NOK 2.5M** (Norwegian kroners) in 90 days

⇒ UP: Short **NOK 2.5M**.
HP: ***Long*** 90 days futures for **NOK 2.5M**.

(B) ***Short*** *hedge*.

A U.S. investor has **GBP 1M** invested in British gilts.

⇒ UP: Long **GBP 1M**.
HP: ***Short*** futures for **GBP 1M**.

Define:
V_t: value of the portfolio of foreign assets measured in GBP at time t.
V_t^*: value of the portfolio of foreign assets measured in USD at time t.

Example (continuation): Calculating the ***short*** *hedge*r's profits.
It's September 12 (t=0). The investor in (b), with a **long GBP 1M position**, is uncertain about $S_{t=Dec}$. Decides to hedge using Dec futures.

Situation: UP = **GBP 1M** in British bonds.
Data:
- $F_{Sep\ 12,Dec}$ = **1.55 USD/GBP**
- Futures contract size: **GBP 62,500**.
- $S_{Sep\ 12}$ = **1.60 USD/GBP**.
- Number of contracts = ?

HP: Investor shorts (sells) Dec futures
GBP 1M / (**62,500 GBP**/contract) = 16 contracts.

Example (continuation): Calculating the *short hedge*r's profits.
• On October 29, prices (S_t & $F_{t,T=Dec}$) have changed. Now we have:

	Sep 12	Oct 29	Change
V_t (GBP)	**1,000,000**	**1,000,000**	0
V_t^* (USD)	1,600,000	1,500,000	**-100,000**
S_t	1.60	1.50	0.10
$F_{t,T=Dec}$	**1.55**	1.45	0.10

USD change in UP ("**long** GBP bond position"):
$V_t^* - V_0^* = V_t\, S_t - V_0\, S_0 = V_0 * (S_t - S_0)$ ($V_t = V_0 =$ **GBP 1M**)
USD 1.5M – USD 1.6M = **-USD 0.1M**.

USD change in HP ("**short** GBP futures position"):
$-V_0 * (F_{t,T} - F_{0,T})$ = Realized gain
(**-GBP 1M**) * USD/GBP (1.45 – **1.55**) = **USD 0.1M**.

USD Change in OP = USD Change of UP + USD Change of HP = 0
⇒ This is a *perfect* hedge! ¶

Note: In this example, we had a perfect hedge. The value of OP did not change. But, we were lucky!

Q: Why were we lucky? Because V_t did not change & the *basis* ($F_{t,T}$ – S_t) remained constant.

$V_{Sep\ 12} = V_{Oct\ 29}$ = **GBP 1M**
($\mathbf{F}_{\mathbf{Sep\ 12,Dec}}$ – $\mathbf{S}_{\mathbf{Sep\ 12}}$) = ($F_{Oct\ 29,Dec}$ – $S_{Oct\ 29}$) = USD .05

An equal position hedge is not a perfect hedge if:

(1) V_t changes. ($V_t \neq V_0$)

(2) The *basis* ($F_{t,T}$ – S_t) changes.