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MGMT 957

CURRENCY FUTURES AND FUTURES MARKETS

> *The best thing about the future is that it comes only one day at a time.*
>
> Abraham Lincoln

CURRENCY FUTURES AND FUTURES MARKETS

Additional notation used in this note

ΔV	Change in the value of your position. For example, $\Delta V^{\$/£}$ may denote the change in the value of your £ receipt from an export to UK, given a spot rate change $\Delta S^{\$/£}$.
$Fut_{t,T}^{d/f}$	Price at time t of a futures contract on currency f with maturity T.
$\Delta fut_t^{d/f}$	Percentage change in the futures price. $\Delta fut_t^{d/f} = Fut_{t,T}^{d/f} / Fut_{t-1,T-1}^{d/f} - 1$.

CURRENCY FUTURES AND FUTURES MARKETS

CURRENCY FORWARD CONTRACT

Forwards are pure **credit** instruments.

- Tailored. Provide perfect hedge by matching the **currency**, **size**, and **timing** of the underlying transaction

Cons

- Involved parties' credit standing is very important
- Less liquid than futures

> ❖ **Example**. Consider a U.S. distributor who imports wine from France and pays in €. Its position can be hedged by **buying € forward**.

(1) Position from **import** (say €1 million in 3 months)

-€1M

+€1M

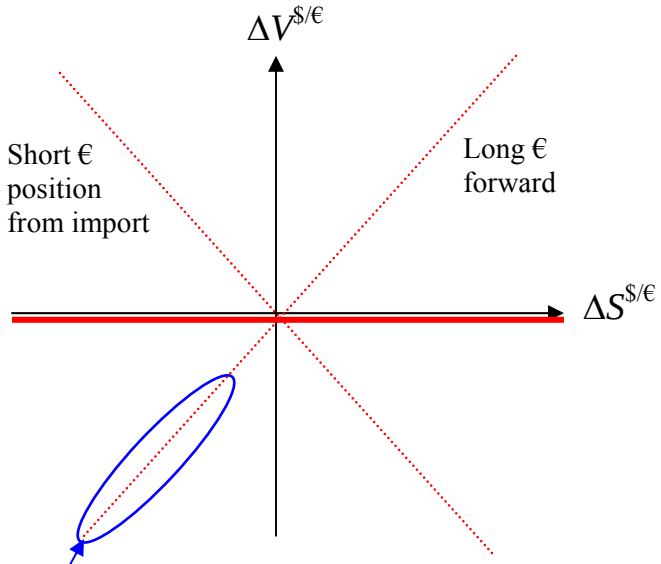
(2) **Buy € forward** (suppose at $1.14/€)

-$1.14M

(3) Net position

-$1.14M

The cost of wine is fixed in $ (at $1.14 million) and is not subject to FX changes.



- $\Delta V^{\$/€}$ is the change in the value of your position
- $\Delta S^{\$/€}$ is the spot exchange rate change

Consider the forward contract in Step (2). Who is the counterparty? A commercial bank.

- A **zero-sum game**; one party always lose against the other.
- If the € spot rate **falls**, the **U.S. distributor** has an incentive not to fulfill the forward contract obligation (buy € more cheaply in the open market).
- Contrarily, if the € spot rate **rises**, the **bank** is losing.

CURRENCY FUTURES AND FUTURES MARKETS

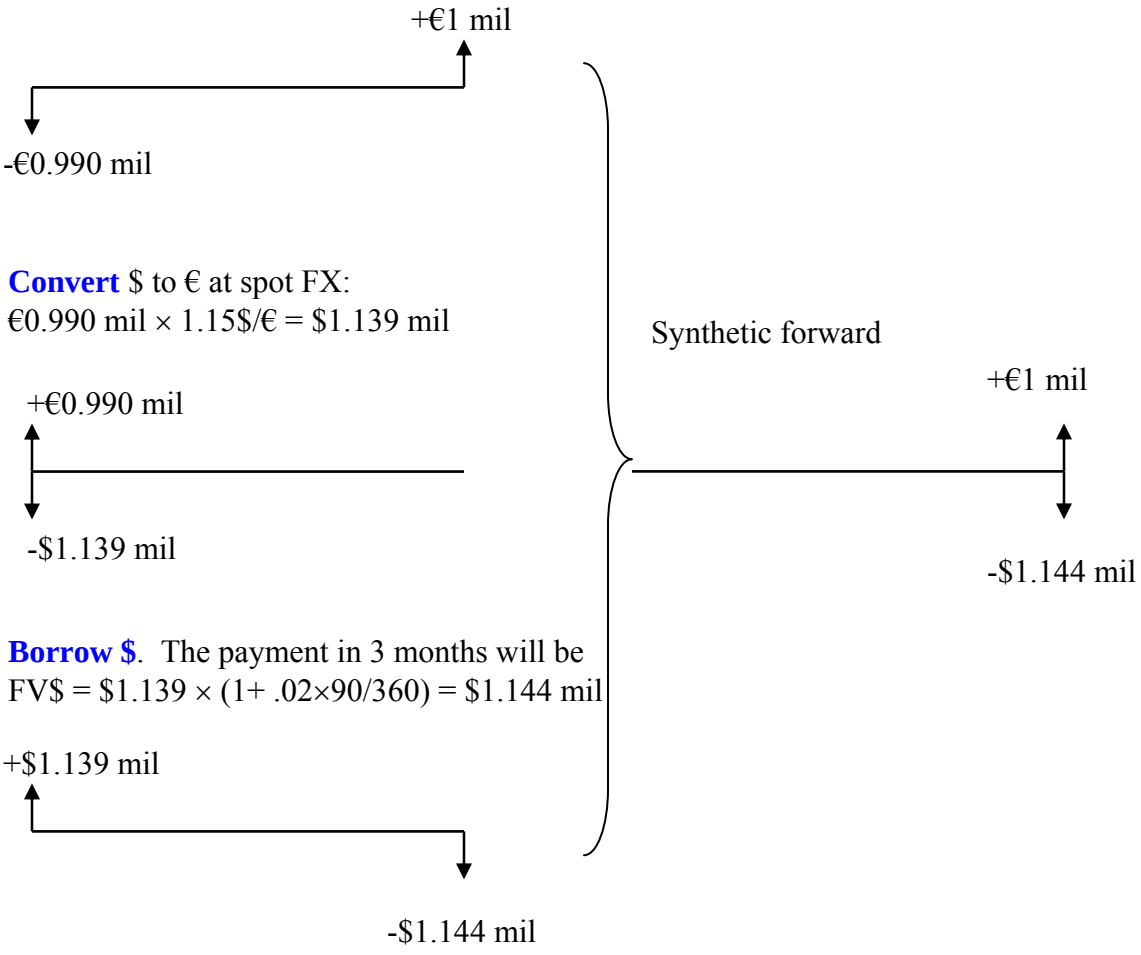
MONEY MARKET HEDGE

- The idea is the following:
  Importer: underlying exposure is **short** FC ⇒ **Invest** in FC (create an **asset**)
  Exporter: underlying exposure is **long** FC ⇒ **Borrow** in FC (create a **liability**)

> ❖ **Example – cont'd**. In the previous wine importer example, suppose the 3-month Eurodollar interest rate is 2%, the "Euroeuro" (Euribor) interest rate is 4%, spot FX is $1.15/€.

This is an **importer**—the underlying position is **short** in €. So, we want to **create an asset (invest)** in €. Work backward:

0) (Objective) We want to **pay** €1 million in 3 months.
1) **Invest in €**. PV of €1 mil at 4% is
   PV€ = €1 mil / (1+ .04×90/360) = €0.990 mil



2) **Convert** $ to € at spot FX:
   €0.990 mil × 1.15$/€ = $1.139 mil
3) **Borrow $**. The payment in 3 months will be
   FV$ = $1.139 × (1+ .02×90/360) = $1.144 mil

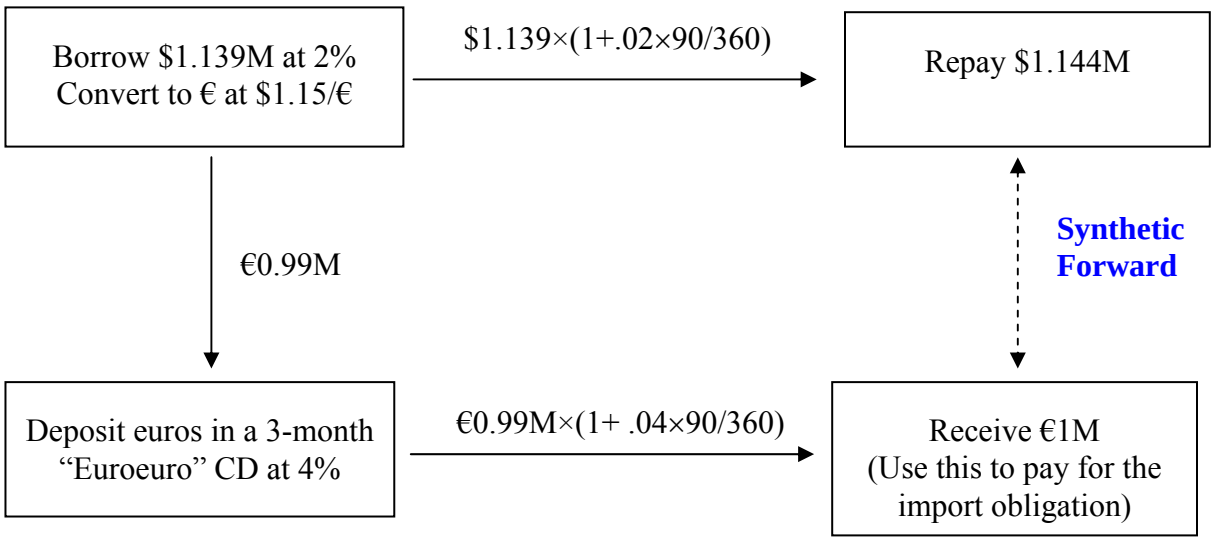
❖ **Example–cont'd**. Calculate the **synthetic forward rate**. How does it compare to **IRP**?

Synthetic forward rate = \$1.144/€1 = 1.144\$/€

IRP: $F^{\$/€} = S^{\$/€}(1 + i^{\$})/(1 + i^{€})$
$= 1.15\times(1 + .02\times90/360)/ (1 + .04\times90/360)$
$= 1.144\$/€$
Of course, the same.

Note: in reality, the synthetic forward rate is probably worse because you are incurring bid-ask spreads **three times**. That is, you will have to pay more than \$1.144 mil.

Notice the resemblance with the IRP Take 1 & 2 in the previous lecture note. The "box representation" of the above money market hedge is:

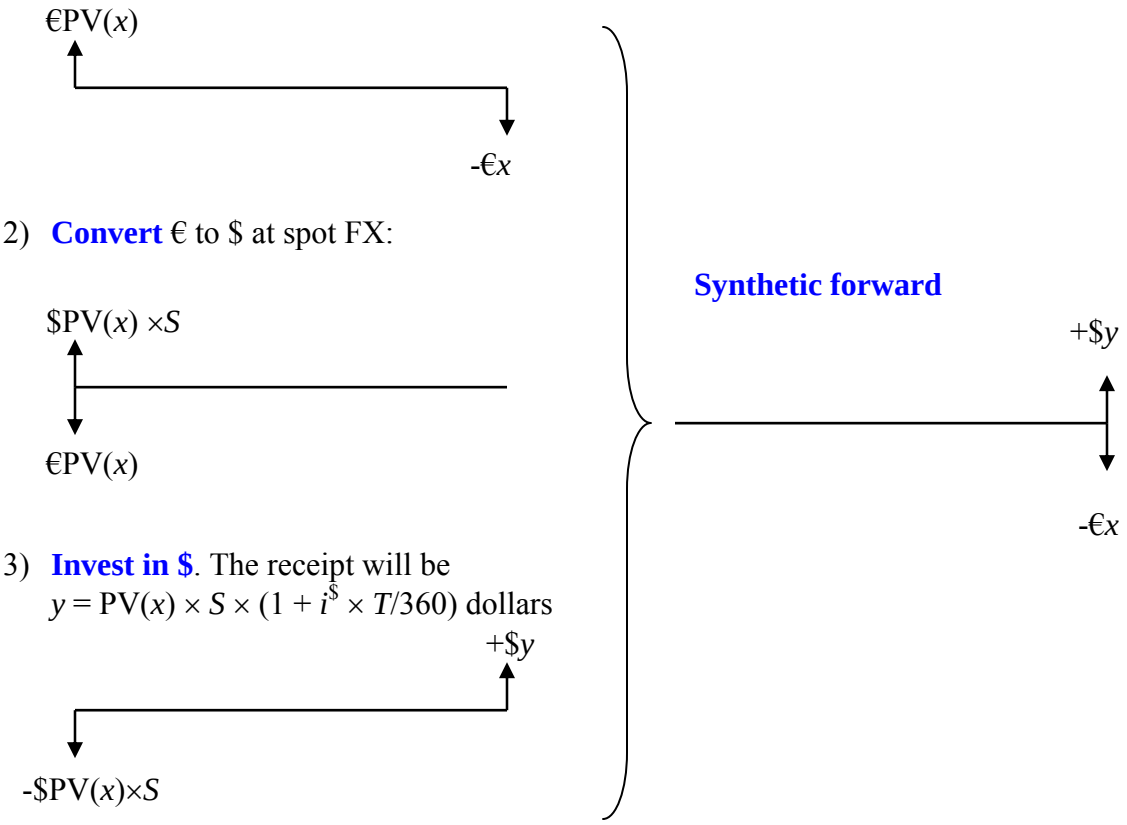


CURRENCY FUTURES AND FUTURES MARKETS

Exporter

0) (Objective) We will receive x euros in T days. Use them to repay the hedging liability.

1) **Borrow in €**. PV of x euros at rate $i^{€}$ is
$$PV(x) = x / (1 + i^{€} \times T/360)$$



2) **Convert** € to $ at spot FX:

3) **Invest in $**. The receipt will be
$y = PV(x) \times S \times (1 + i^{\$} \times T/360)$ dollars

❖ We will apply this in the Dozier case.

CURRENCY FUTURES AND FUTURES MARKETS

CURRENCY FUTURES CONTRACT

The futures contract "solution"

- A futures exchange **clearinghouse** takes one side of every transaction (and makes sure that its exposures cancel one another).
- Contracts are **marked-to-market** daily.
- Requires initial and maintenance **margins**.

WSJ Futures Indication (WSJ 7/29/2006 p. B15, trades on 7/28/06)

Currency Futures

	OPEN	HIGH	LOW	SETTLE	CHG	LIFETIME HIGH	LIFETIME LOW	OPEN INT
Japanese Yen (CME)-¥12,500,000; $ per 100¥								
Sept	.8697	.8790	.8680	.8778	.0083	.9435	.8540	184,69
Dec	.8823	.8896	.8793	.8889	.0083	.9600	.8644	20,343
Canadian Dollar (CME)-CAD 100,000; $ per CAD								
Sept	.8823	.8879	.8808	.8848	.0035	.9175	.7970	84,641
Dec	.8851	.8901	.8836	.8875	.0035	.9184	.8310	2,831
British Pound (CME)-£62,500; $ per £								
Sept	1.8599	1.8690	1.8565	1.8660	.0069	1.9060	1.7282	104,82
Dec	1.8631	1.8720	1.8603	1.8697	.0069	1.9060	1.7342	52

Exchange

Contract size

Change from previous settle

Limited expiration dates

Mark-to-market works as follows. Consider the Dec 06 CA$ futures contract. The price change from the previous settle is US$0.0035/CA$. Thus, a party **long** one contract gets

$$\text{CA\$100,000} \times \text{US\$0.0035/CA\$} = \text{US\$350}$$

credited in his margin account. A party **short** one contract will have this amount subtracted from her margin account.

CURRENCY FUTURES AND FUTURES MARKETS

WSJ Spot and Forward Indication

Currencies

October 29, 2007

U.S.-dollar foreign-exchange rates in late New York trading

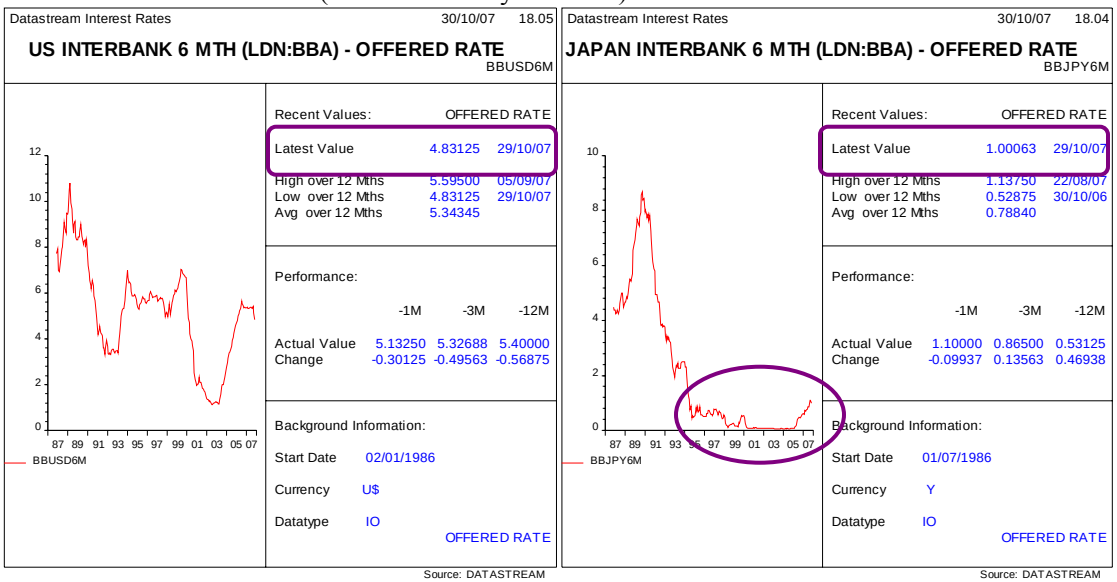
Country/currency	Mon — in US$	Mon — per US$	US$ vs. YTD chg (%)
Americas			
Argentina peso	.3168	3.1566	3.2
Brazil real	.5677	1.7615	-17.5
Canada dollar	1.0494	.9529	-18.3
1-mos forward	1.0495	.9528	-18.2
3-mos forward	1.0498	.9526	-18.1
6-mos forward	1.0493	.9530	-17.8
Chile peso	.002029	492.85	-7.4
Colombia peso	.0005006	1997.60	-10.8
Ecuador US dollar	1	1	unch
Mexico peso	.0933	10.7135	-0.8
Peru new sol	.3323	3.009	-5.8
Uruguay peso	.04570	21.88	-10.3
Venezuela bolivar	.000466	2145.92	unch
Asia-Pacific			
Australian dollar	.9212	1.0855	-14.3
China yuan	.1338	7.4750	-4.3
Hong Kong dollar	.1290	7.7504	-0.4
India rupee	.02542	39.339	-10.8
Indonesia rupiah	.0001100	9091	1.1
Japan yen	.008724	114.63	-3.7
1-mos forward	.008754	114.23	-3.6
3-mos forward	.008814	113.46	-3.5
6-mos forward	.008892	112.46	-3.3

Country/currency	Mon — in US$	Mon — per US$	US$ vs. YTD chg (%)
Europe			
Czech Rep. koruna	.05345	18.709	-10.2
Denmark krone	.1936	5.1653	-8.6
Euro area euro	1.4430	.6930	-8.5
Hungary forint	.005746	174.03	-8.6
Malta lira	3.3608	.2975	-8.5
Norway krone	.1373	5.3390	-14.4
Poland zloty	.3982	2.5113	-13.5
Russia ruble	.04049	24.698	-6.2
Slovak Rep koruna	.04339	23.047	-11.7
Sweden krona	.1566	6.3857	-6.7
Switzerland franc	.8586	1.1644	-4.5
1-mos forward	.8606	1.1620	-4.4
3-mos forward	.8636	1.1579	-4.2
6-mos forward	.8673	1.1530	-3.9
Turkey lira	.8412	1.1887	-16.0
UK pound	2.0637	.4846	-5.1
1-mos forward	2.0617	.4850	-5.0
3-mos forward	2.0576	.4860	-4.8
6-mos forward	2.0509	.4876	-4.5
Middle East/Africa			
Bahrain dinar	2.6528	.3770	unch
Egypt pound	.1810	5.5246	-3.3
Israel shekel	.2513	3.9793	-5.6

Note: Forward contracts are custom made. These show only typical maturities

- Note, there is **no indication of traded exchanges** because forward contracts are **over-the-counter** instruments.

LIBOR from DataStream (for the same day as above)



CURRENCY FUTURES AND FUTURES MARKETS

- **Exercise (Forward premium/discount)**. What is the 6 month forward premium for the JP¥/US$ quote? Compare this to interest rate differential ($i^{JP¥} - i^{US\$}$). Is US$ in forward discount or premium against JP¥? (Is JP¥ in forward discount or premium against US$?)

Recall (approximate) IRP: $\mathrm{FP}_{t,T}^{Y/\$} \approx i^{Y} - i^{\$}$

- Forward premium:

$$FP = \frac{\square}{\square} - 1 =$$

- (Prorated) Interest rate differential:

$$i^{¥} - i^{\$} = \square - \square =$$

- **Exercise (IRP)**. See the JP¥ spot rate on WSJ and the LIBOR indication from DataStream. Use the IRP to compute the implied 6-month JP¥ forward rate. How does it compare to the 6-month forward rate on WSJ? What can be causing the difference, if any?

Recall IRP: $F_{t,T}^{Y/\$} = S_t^{Y/\$} \frac{1+i^{Y}}{1+i^{\$}}$

$$\text{6mo: } F = \square \times \frac{\square}{\square} =$$

CURRENCY FUTURES AND FUTURES MARKETS

Financial futures exchanges are usually associated with a **commodity futures** exchange.

Top 5 futures exchanges, 2002 volume (million contracts)

Eurex - Eurex (Germany & Switzerland)	536.0
CME - Chicago Mercantile Exchange (U.S.)	444.5
CBOT - Chicago Board of Trade (U.S.)	276.3
Euronext - (Amsterdam, Brussels, Lisbon, Paris, London)	221.3
NYMEX - New York Mercantile Exchange (U.S.)	107.4
BM&F - Bolsa Mercadorias & de Futuros (Brazil)	95.9

COMPARISON BETWEEN FORWARDS AND FUTURES

	Forwards	**Futures**
Counterparty	Bank	CME Clearinghouse
Maturity	Negotiated	Mon before the 3rd Wed of the month (US) Most futures expire in Mar, Jun, Sep, & Dec
Amount	Negotiated	Standard contract size (integer multiple of)
Fees	**Bid-ask spread**	**Bid-ask spread, commissions**
Collateral	Negotiated	Margin account
Settlement	At maturity	Most positions closed early
Margin	---	Daily, **marked-to-market**
Implementation	**Tailored**	**Standardized** in currency, maturity & size

- Because of **mark-to-market**, futures contracts are like a bundle of forward contracts, canceled and re-contracted every day.

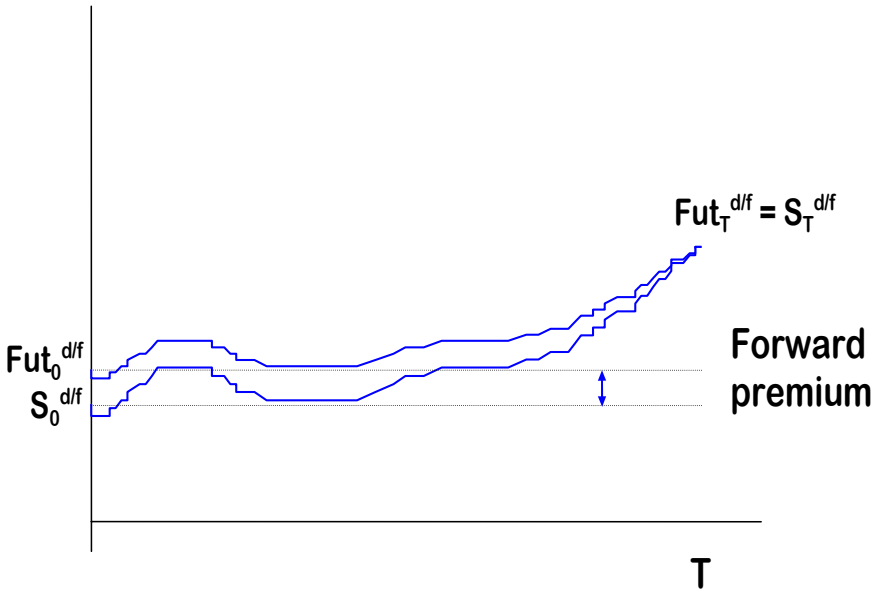
CURRENCY FUTURES AND FUTURES MARKETS

Forward and futures prices are (almost) identical through the **interest rate parity**:

$$F_{t,T}^{\mathrm{d/f}} = Fut_{t,T}^{\mathrm{d/f}} = S_t^{\mathrm{d/f}} \frac{1+i^{\mathrm{d}}}{1+i^{\mathrm{f}}}$$

- Futures price **converges to the spot price** at maturity (otherwise there will be an arbitrage).

(Another way to think about this is: since i^{d} and i^{f} are interest rates between time t and T, they converge to 0 as $t \to T$ in the above formula.)



CURRENCY FUTURES AND FUTURES MARKETS

- I hope it makes sense. If not, think again before complaining: Farmers—in the 18'th century—in Japan—understood it!

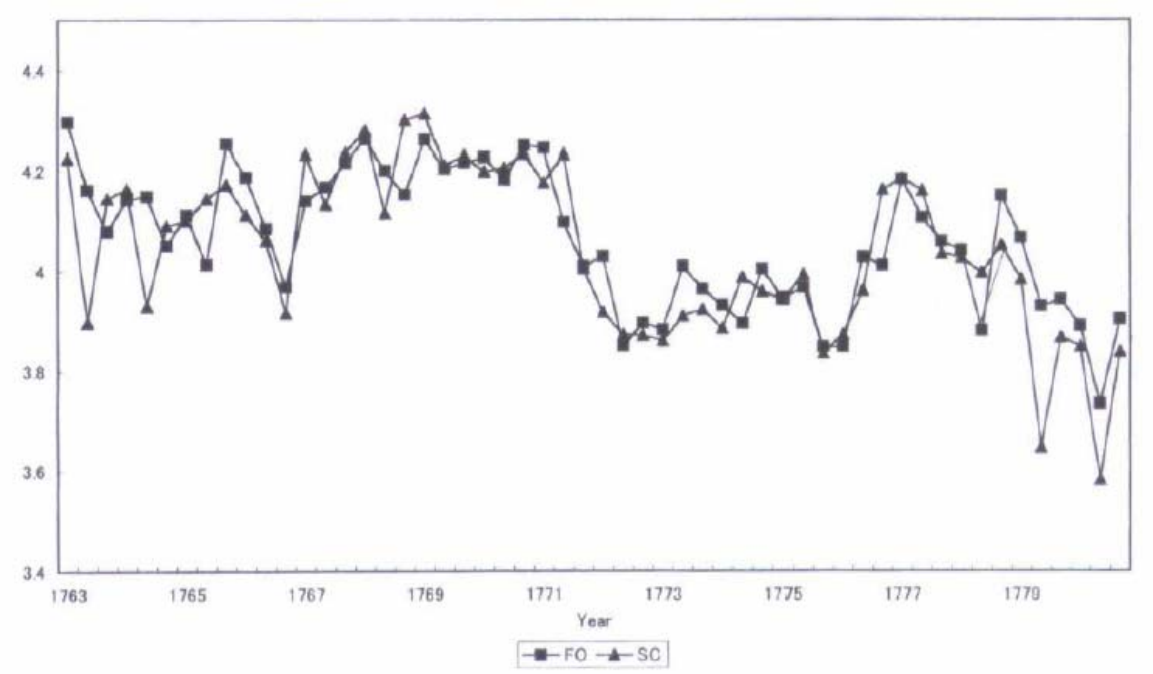


FIGURE 1
FO and *SC* (1763–1780).

Futures price at the beginning of (FO), and the spot price at the end of (SC), a harvesting period, 1763-1780, Dojima Grain Exchange, Osaka, Japan.

From Hamori, S., N. Hamori, and D. Anderson, 2001, An empirical analysis of the efficiency of the Osaka rice market during Japan's Tokugawa era, *Journal of Futures Markets*, 21 (9), 861-874.

- Indeed, this figure suggests that a *much stronger* condition might have held in the 18th Japan than the picture on the previous page. What is the relevant parity condition here?

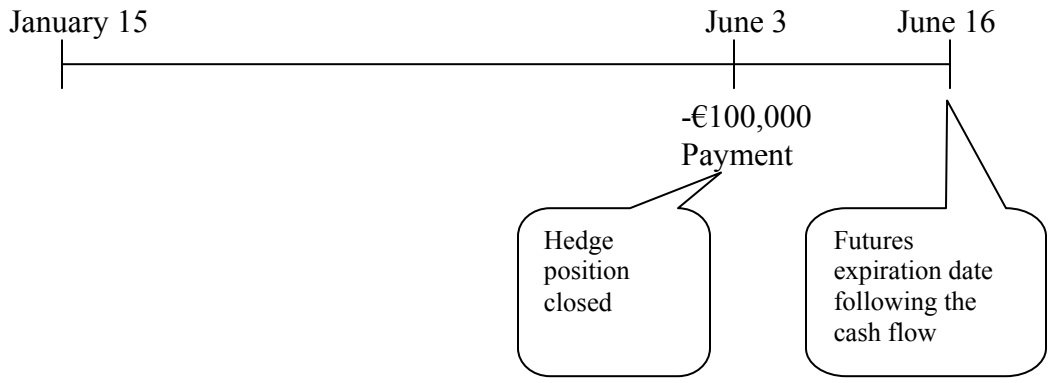
MATURITY MISMATCHES AND BASIS RISK

- If there is a **maturity mismatch**, futures contracts may not provide a perfect hedge
- The **basis** of a hedge using futures contracts is broadly defined as

  Basis ≡ Futures price – Spot price of asset to be hedged.

  In a FX context, this is proportional to the ratio $\frac{1+i^{d}}{1+i^{f}}-1 \approx i^{d}-i^{f}$ (recall IRP). Thus, often "the basis" simply refers to the **interest rate differential** $i^{d}-i^{f}$.
- **Basis risk** is the uncertainty about the basis, i.e., $i^{d}-i^{f}$. This is a risk because it **changes the relation** between futures and spot prices through IRP.
- When there is a **maturity mismatch**, basis risk makes a futures hedge riskier than a forward hedge.

> ❖ **Example**–cont'd. In the above example of the U.S. wine importer, suppose today is January 15, the payment date is June 3, and the futures expiration date following the cash flow is June 16. There is a **maturity mismatch** in this case.



- This is the reason why most futures contracts are **not** held until expiration.

CURRENCY FUTURES AND FUTURES MARKETS

DELTA HEDGE

- Unlike a forward hedge, a futures hedge will not be perfect even if there is no size mismatch, because of the **basis risk** (or **maturity mismatch**). You might want to correct for this by **adjusting the size of the futures position** in your hedge.
- **Delta** is the **sensitivity** of the change in the value of a position being hedged (e.g., receipt or payment of a foreign currency associated with **export** or **import**) with respect to the change in the value of the hedging device (e.g., futures contract).
- This can be measured by a **regression slope**, β (assuming the relationship does not change over time):

$$\Delta s_t^{d/f} = \alpha + \beta \cdot \Delta fut_t^{d/f} + \varepsilon_t,$$

where

$\Delta s_t^{d/f}$ = percentage change in the spot rate

$\Delta fut_t^{d/f}$ = percentage change in the futures price.

- To hedge your exposure, buy or sell β units of currency f in its futures contract depending on your position and the contract size. For example, if

$$\Delta s_t^{£/€} = \alpha + 1.03 \cdot \Delta fut_t^{£/€} + \varepsilon_t,$$

and if you have £2 million short (from import), buy

£2 million × 1.03 / £62,500 (contract size) = 32.96 ≈ 33 contracts

of GBP futures.

- **Hedge quality** is measured by R^2 of the regression.
  - **Q1**. Why?
- The higher the correlation between $\Delta fut_t^{d/f}$ and $\Delta s_t^{d/f}$, the better the hedge quality.
  - **Q2**. Why?

- You can also use the **theoretical delta** if data are unavailable. By IRP, **delta of a futures contract** is $\frac{1+i^d}{1+i^f}$. Thus, **beta** in the above regression should be close to its reciprocal, $\frac{1+i^f}{1+i^d}$.

Suggested answers to questions

Q1. Because R^2 measures the **proportion of variation** in $\Delta s_t^{d/f}$ explained by $\Delta fut_t^{d/f}$.

Q2. In a simple regression in which there is only one independent variable, R^2 equals the **square of the correlation** between the dependent and independent variables. Thus, the higher the correlation, the higher R^2.

CURRENCY FUTURES AND FUTURES MARKETS

PRACTICE PROBLEMS WITH SOLUTIONS

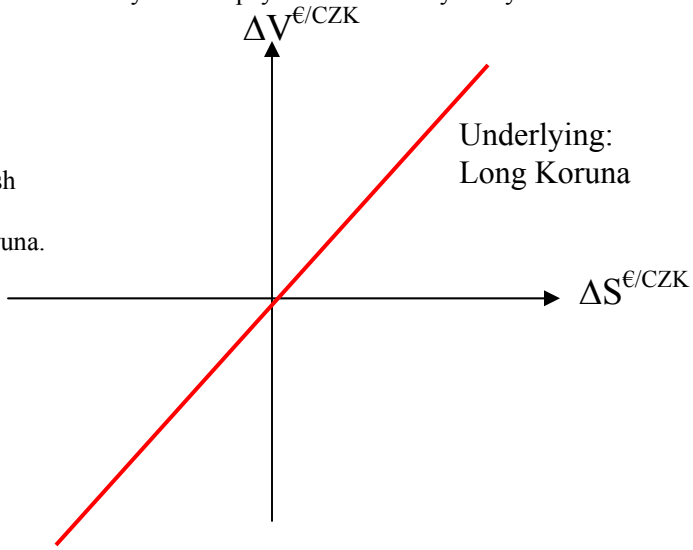
Solve the following end-of-chapter problems from *Butler*:

4.14 b-d (note: Kor40/€ in the text is a typo for CZK40).

11.6. Replace the sentence "You want to fix the amount you must pay in dollars…" by "… you will **receive** in dollars"

Solutions

4.14 b. The contractual payment is a *positive* cash flow in koruna, so Hippity Hops is *positively exposed* to the value of the koruna.



c. The expected cash flow in euros is

CZK40,000,000 × 0.025€/CZK = €1,000,000.

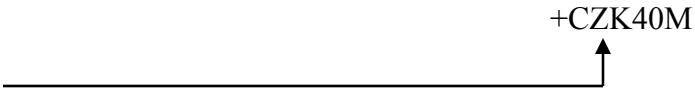
The actual euro cash flow is

CZK40,000,000 × 0.04€/CZK = €1,600,000.

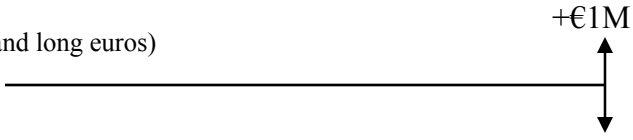
This leaves an unexpected gain of €600,000, or 60% of the expected value. As the value of the koruna rises by 60% from €0.025/CZK to €0.040/CZK, so too does the euro value of the koruna cash flow.

d. Sell 40 million koruna forward and buy €1,000,000 at the forward price of $F_1^{€/CZK}$ = €0.025/CZK, or $F_1^{CZK/€}$ = CZK40/€. The koruna is being *sold* forward, so Hops' exposure to the value of the koruna *in this forward contract* is *negative*. The negative exposure on the forward contract offsets the positive exposure on the underlying position. The net result is no exposure to the koruna.

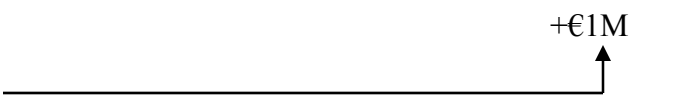
- Underlying position (long koruna)



- Sell koruna forward (short koruna and long euros)

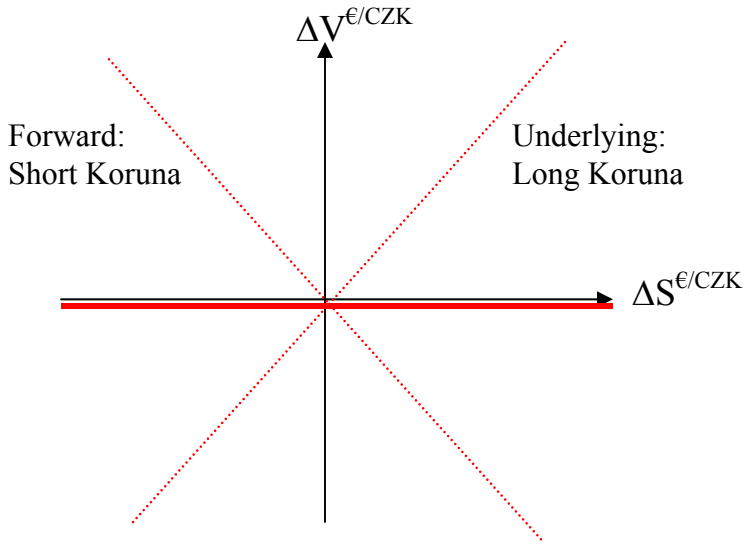


- Net position



CURRENCY FUTURES AND FUTURES MARKETS

- Net exposure



11.6 a. You are receiving £100,000 in one year, so sell £100,000 forward and buy dollars. In one year, you will receive £100,000 from your album sale. You can then convert this amount into (£100,000)($1.20/£) = $120,000 through the forward contract. You have eliminated your exposure to the value of the pound.

b. A money market hedge borrows in one currency, invests in another, and nets the transactions in the spot market. The result is the equivalent of a forward contract. The forward contract that you want to replicate is a forward sale of £100,000. This can be replicated as follows:

Borrow (£100,000)/(1+$i^{£}$) = £89,638 at the $i^{£}$ = 11.56% pound sterling interest rate.

+£89,638

-£100,000

Convert to (£89,638)($1.25/£) = $112,047 at $S_0^{\$/£}$ = $1.25/£.

+$112,047

-£89,638

Invest in dollars at the U.S. dollar rate of $i^{\$}$ = 9.82%.

+$123,050

-$112,047

The net result is a forward contract to buy dollars with pounds.

+$123,050

-£100,000

Note that this is on more favorable terms than the forward contract. Forward prices are not in equilibrium with the interest rate differential. In this situation, it is cheaper to hedge through the money markets than through the forward market.

c. These markets are not in equilibrium. $F_1^{\$/£}/S_0^{\$/£}$ = (\$1.20/£)/(\$1.25/£) = 0.96 < =0.98440 = (1.0982)/(1.1156) = $(1+i^{\$})/(1+i^{£})$, so you should buy pounds at the relatively low forward price, sell pounds at the relatively high spot price, invest in dollars at the relatively high dollar interest rate, and borrow pounds at the relatively low pound interest rate.