Practice questions: Set #2

What should you do with this set?

To help students prepare for the exams and group cases, several problem sets with solutions shall be handed out. They shall not be graded: the number of "points" for a question solely indicates the time/difficulty of that question.

Students are strongly encouraged to try hard to solve them and to use office hours to discuss any problems they may have doing so. The best self-test for a student of his or her command of the material before an exam is whether he or she can handle the questions of the relevant practice sets. To reflect this close association between practice sets and exams, the final exam shall include at least a part of a question from the relevant practice sets.

Question 1. (5 points)

In April 2007, the 3-month interest rate in Switzerland stood at about 2.3%. The equivalent rate in England was about 5.5%. All these figures are annualized. What should have been, at the time, the annualized 3-month forward discount or premium at which the Swiss franc would sell against the pound? Explain, intuitively and formally.

Question 2. (5 points)

In the Spring of 2000, the direct spot quote for the Canadian $ in New York was $0.76 and the 180-day forward rate stood at $0.74.

a. What accounts for the difference between the 2 rates? Explain.

b. In the absence of any other information, what do you expect was the direct spot quote for the Canadian $ in New York, 6 months later (in Fall 2000)? Explain briefly.

Question 3. (10 points)

Suppose that you are a trader of JP Morgan allowed to do arbitrage. From a phone call to a trader at Daiwa Bank, you learn that Daiwa will let customers:

- lend and borrow ¥ at 0.5%-0.625% for 6 months (annualized rates)
- lend and borrow $ at 5.375%-5.5% for 6 months (annualized rates)
- buy and sell ¥ spot at 100.00-50 ¥/1$

A trader at Barclays is simultaneously quoting bid and ask 6-month swap rates of –300 points (i.e., he will buy and sell ¥ 6-month forward at 97.00-50 ¥/1$).

a. Can you make money out of these quotes? Explain thoroughly.
b. Suppose you must borrow $1m for JP Morgan. What would be your total borrowing cost (i.e., what is the total number of $ you would pay on your $1m loan)?

(Hint: what are your borrowing choices?)

**Question 4. (10 points)**

It is December 18, 2004. You are an analyst for a bank, and are asked to predict the spot rate of the € against the $ on March 14, 2005. Your boss needs the information in 5 minutes.

a. Suppose the only thing you have at hand within the next 5 minutes is the WSJ. However, the page of the Journal with the interest rates data is missing, and somebody dropped coffee on the page with the spot rates: you can only read the spot rate for the €, not the 90-day forward rate. Fortunately, you find the page that contains the quote for the March € futures: can you save the day? Argue briefly.

(Hint: the last day of trading for 2005 March futures was the 3rd Wednesday of March, 3-16-05)

b. Suppose you had all the interest rates data you could possibly want. Would you still need the futures data? Explain.

**Question 5. (5 points)**

As an analyst for a bank, you are asked to predict tomorrow's exchange rate of the Euro against the dollar. Are you better off knowing only today's exchange rate or the exchange rates for the past 100 or even 1,000 days? Argue briefly.

**Question 6 (5 points)**

(i) What will happen to the margin put up on a Yen futures contract if the embedded future exchange rate does not change from the date of entering the contract until the date of reversing the trade (= offsetting the contract)?

a. It will be refunded
b. It will be kept by the broker
c. It will be kept by the counterparty in the futures market

(ii) Suppose that the JPY/USD exchange rate is more volatile than the EUR/USD. Intuitively, the dollar value of the initial margin requirement on the should be __________ for CME Yen futures ____ CME Euro futures.

a. higher...than for
b. lower...than for
c. the same...as
**Question 7. (10 points)**

Starting in early 1989, Japanese interest rates were about 4% lower than U.S. rates for similar maturities. This wide difference prompted quite a few US real-estate companies at the time to borrow in ¥ to finance US developments. Likewise, between 2004 and 2007, many Hungarian individuals and firms financed real estate and other investments by borrowing in Swiss Francs at low interest rates (low, compared to the Forint rates). In a similar vein, many Japanese retail investors today engage in carry trades -- borrowing in Yen at very low interest rates and investing in other currencies at higher rates. In most cases, these investors did not or do not hedge their forex exposures. Comment on these strategies.

(Hint 1: what might account for the difference between interest rates in different countries?)
(Hint 2: what risk do these developers/investors expose themselves to?)

**Question 8. (15 points; NOT Exam Material)**

Suppose that the SF forward price for March 16, 2005 delivery is: $0.7100-7127/1SF. At the same time, the price at the IMM of a March 2005 SF futures is $0.7145/1SF (including all transactions costs). The IMM March futures this year requires delivery on March 16.

**a.** Assume that all relevant interest rates are known. Can you profit from these prices? Is there any risk involved in doing so? (Assume that you can trade up to 125,000 SF)

**b.** Now suppose that future interest rates are stochastic. Does your answer in a. change:

1. if domestic interest rates movements and futures price changes are positively correlated?
2. if domestic interest rates movements and futures price changes are negatively correlated?

Explain briefly in each case. (Explain how you would try to profit from those prices, if at all. Explain whether there is any risk involved.)
**Practice set #2 & solutions**

**Question 1. (5 points)**

The 3-month interest rate in Switzerland is currently (04-2007) about 2.3%. Meanwhile, the equivalent interest rate in England is about 5.5%. All rates are annualized. What should be the annualized 3-month forward discount or premium at which the Swiss franc will sell against the pound? Explain, intuitively and formally.

**Answer**

Intuitively, we know from covered interest rate parity that the Swiss franc should sell at a premium against the pound sterling approximately equal to the interest rate differential between the two countries, i.e., 5.5%-2.3% = 3.2% per year or 0.8% per 3 months.

Formally, let $f$ and $s$ represent the SF spot and forward prices of 1£. Then, to rule out arbitrage, the forward premium should equal:

\[
\frac{f - s}{s} = \frac{\text{interest rate in Switzerland} - \text{interest rate in England}}{1 + \text{interest rate in England}}
\]

\[
= \frac{0.023 - 0.0055}{1.055}
\]

\[
= -0.028
\]

Put differently, the £ should trade at an annualized 2.8% forward discount against the Swiss franc (you need fewer Swiss francs to buy a £ forward than you need to buy it spot).

**Question 2. (5 points)**

In the Spring of 2000, the direct spot quote for the Canadian $ in New York was $0.76 and the 180-day forward rate stood at $0.74.

a. What accounts for the difference between the 2 rates? Explain.

**Answer**

Given the swap rate, the 6-month outright forward quote is C$1 = USD (0.76 – 0.02) = USD 0.74. From IRP, we know that a country’s currency (here, the U.S. $) will sell at a forward premium when interest rates in that country are lower than in the other country (here, Canada). In this question, you need more C$ to buy forward US$ than you do spot: thus, it must be that 6-month interest rates are higher in Canada than in the U.S.

b. In the absence of any other information, what do you expect was the direct spot quote for the Canadian $ in New York, 6 months later (in Fall 2000)? Explain briefly.

**Answer**

Based on the available info, the best you might say is: $0.74. This is because, under the assumption that markets are efficient and that there is no risk premium, the forward rate should be an unbiased predictor of the future spot rate.
This being said, to the extent that you are asked to make a prediction for 6-month hence, the forward is likely to be a bad forecasting tool. As discussed in class, uncovered IRP (i.e., using the forward to predict future spot rates) works much better at fairly long-term horizons (see also the paper by Meredith & Chinn on the Online Library) than at horizons of less than a year. A key reason is the existence of a time-varying (and hard to predict) risk premium embedded in the forward rate: \( F_{t,T} = E_t[S_T] + \text{risk premium} \). Given this empirical reality, you might reasonable make an argument that the best 6-month forecast is not (unlike what many older finance textbooks might have suggested) the forward rate but, instead, the current spot rate of $0.76.

**Question 3. (10 points)**

Suppose that you are a trader of JP Morgan allowed to do arbitrage. From a phone call to a trader at Daiwa Bank, you learn that Daiwa will let customers:

- lend and borrow ¥ at 0.5%-0.625% for 6 months (annualized rates)
- lend and borrow $ at 5.375%-5.5% for 6 months (annualized rates)
- buy and sell ¥ spot at 100.00-50 ¥/1$

A trader at Barclays is simultaneously quoting bid and ask 6-month swap rates of –300 points (i.e., he will buy and sell ¥ 6-month forward at 97.00-50 ¥/1$).

**a. Can you make money out of these rates? Explain thoroughly.**

**Answer**

There are two ways to carry out arbitrage (“arb”) strategies in this case:

1. either borrow $, convert them spot into Yen, deposit the Yen, and at the maturity of this deposit sell the Yen forward for $ in order to repay the dollar loan (in an attempt to make a small profit)

2. or borrow ¥, convert them spot into dollars, deposit the dollars, and at the deposit maturity sell the dollars forward for ¥ in order to repay the Yen loan (in an attempt to make a small profit)

The “brute-force” method to solving this problem is to try both ways, and see if either strategy generates a profit. However, because at most one (if any) strategy can yield a profit, the faster way is to try to assess whether strategy 1 or strategy 2 should be the profitable one.

It appears that you should be able to make small arbitrage (“arb”) gains, because covered IRP does not seem to hold in this case. To see this quickly, let us focus on the round numbers:

(i) the $ is selling at about a 3% 6-month forward discount to the Yen (the 3% figure is obtained by expressing the swap rate of 3 ¥/1$ (=97-100, focusing only on the “big” numbers) as a fraction of the bid spot rate (100.00 ¥/1$);
(ii) the interest rate differential, however, is smaller: again concentrating on round figures, the IR diff is about 5% per year annualized (= 5.5%-0.5%), or 2.5% per six months.

Put differently, it looks as though the dollar is trading at too steep a forward discount to the Yen given the observed interest rate differential. This suggests the “direction” of the possible arbitrage: you need to buy low (buy dollars forward) and sell high (i.e., sell Yen forward). In other words, strategy 1 seems like the way to go.

Assuming that this is the right way to go, you know what else you need to do: in order to get the Yen that you’ll be delivering forward, you need to invest Yen for 6 months today; you get those Yen spot, by purchasing them with dollars. You don’t have dollars, so you borrow them. In sum, the arb “loop” is to borrow dollars at 5.5%, convert them spot for Yen at 100 (or 0.01 $/1¥), deposit the Yen at 0.5%, and sell the Yen forward at 97.50 (or 0.010256 $/1¥).

To conclude, let us make sure that the cash-flows all work out:

<table>
<thead>
<tr>
<th>cash-flows today</th>
<th>cash-flows in 6 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. + 1$ (borrow 1$)</td>
<td>- 1.0275$ (loan repayment incl. 6-mo interest of 5.5%)</td>
</tr>
<tr>
<td>b. - 1$ (exchange $ spot for ¥) + 100¥</td>
<td>none</td>
</tr>
<tr>
<td>c. - 100¥ (invest ¥ at 0.5% for 6 mo)</td>
<td>+ 100.25 ¥</td>
</tr>
<tr>
<td>d. none (sell ¥ forward for $)</td>
<td>- 100.25 ¥ + 1.0282 $</td>
</tr>
<tr>
<td>total 0</td>
<td>+ 0.0007 $</td>
</tr>
</tbody>
</table>

The cost is nothing (0 net cash-flow today). For every dollar borrowed, however, the sure gains in six months are 0.0007$, i.e., a 0.07% profit margin.

**Note 1:** Another way of seeing what needs to be done is the following:

Formally, the forward rate implied by the interest rate differential and the spot rate is:

\[
f' = s \frac{k}{1+i} = (0.01 \ text{ $ / 1¥}) \frac{1+0.055}{1+0.005} = 0.010249 \text{ $ / 1¥}
\]

Now compare this with the 6-month forward rate quoted directly by Barclays: 0.010256 $ / 1¥. Clearly, you should sell Yen forward at 0.010256 $/1¥ and buy the Yen forward “synthetically” at 0.010249 $/1¥ (you create this “synthetic”, which replicates the cash-flow pattern of Barclays’ forward without entailing any actual forward transaction) by borrowing $ at 5.5%, buying ¥ spot with the borrowed dollars at 100¥/1$, and investing the ¥ at the rate of 0.5%).

**Note 2:** As an added exercise, you should prove that the reverse strategy (borrowing ¥ at 0.625%, converting the ¥ spot for $ at 100.50 ¥/1$, investing the $ at 5.375% and selling forward the anticipated $ proceeds for ¥ at 97.00 ¥/1$) would lead to a loss.
b. Suppose you must borrow $1m on behalf of your employer, JP Morgan. What would be your total borrowing cost (i.e., what is the total number of $ you would pay on your $1m loan)?

(Hint: what are your borrowing choices?)

**Answer**

Your borrowing choices are the following:

(1) either **borrow $ from Daiwa** at 5.5%: the total **$ cost** in 6 months of this plain-vanilla dollar loan would be **$27,500**.

(2) or create a similar pattern of cash-flows, borrowing in ¥ with Daiwa, converting the ¥ into $ spot using Daiwa’s quote, and locking in the $ cost of the ¥ loan through a forward contract with Barclays. Here, the cost would be as follows:

- you need $1m today, to get them, you borrow ¥100.5m and sell them spot for $1m;
- in 6 months, you will need to pay back ¥100,814,063 (100.5m Yen at the 0.625% annualized borrowing rate); you can lock in today the $ cost of this repayment by buying $1,039,320 for six-month forward delivery (¥100,814,063 purchased with USD at the cost of 97JPY/1USD). The net total **$ cost** would thus be: **$39,320**.

Since borrowing directly in $ is cheaper ($27,500 vs. $39,320), you should pick solution (1), i.e., the plain-vanilla dollar loan from Daiwa.

**Question 4. (10 points)**

It is December 18, 2004. You are an analyst for a bank, and are asked to predict the spot rate of the € against the $ on March 14, 2005. Your boss needs the information in 5 minutes.

a. Suppose your bank is lousy, and the only thing you have at hand within the next 5 minutes is the WSJ. However, the page of the WSJournal with the interest rates data is missing, and somebody dropped coffee on the page with the spot rates: you can only read the spot rate for the €, not the 90-day forward rate. Fortunately, you find the page that contains the quote for the March € futures: can you save the day? Argue briefly.

(Hint: the third Wednesday of March in 2005 was 03-16)

**Answer**

The obvious solution is to get on the phone with someone who has access to a Bloomberg terminal, and get quotes for the 3-month forward rate. Under the assumption that markets are efficient, this forward rate should be an unbiased predictor of the future spot rate. (But see * below). In that case, you’d simply use the 3-month forward as your best predictor of the spot.

Less facetiously, let us suppose that you don't have a phone or have no such person to contact. Remember that futures prices are roughly equal to forward prices for the same delivery date. In this case, the last day of trading for 2004 March futures is 03-16, which is about 3 months from now. The respective prices of comparable forward and futures contracts should be
almost the same. But then, you are done: using the futures as your estimate will be as good (or as bad) as using the forward!

*Note:* As discussed in class, at short maturities (such as the three months envisioned here) the forward is a pretty bad predictor of the expected future spot rate. It (or, rather, the interest rate differential between two countries) is a much better predictor at longer maturities, such as five or ten years. Still, in the absence of any other information, it'd be good to take the forward rate into consideration.

**b.** Suppose you had all the interest rates data you could possibly want. Would you still need the futures data? Explain.

**Answer**

Nope: by using interest rates parity, you could calculate the forward rate implied by the current spot rate and by the interest rates differential between the Euro zone and the U.S.A. Of course, this method is subject to the same caveat as the forward rate (see Note * above).

**Question 5. (5 points)**

As an analyst for a bank, you are asked to predict tomorrow’s exchange rate of the Euro against the $. Are you better off knowing only today’s exchange rate or the exchange rates for the past 100 days? Argue briefly.

**Answer.**

Today's Euro/$ exchange rate is just the price of a Euro in terms of $. If markets are efficient, current prices will incorporate all the information available to investors until today – including the information that was contained in the exchange rates prevailing each of the previous 100 days. Since empirical evidence broadly supports market efficiency, arguably you should only worry about today's exchange rates – today’s spot and 1-day forward rates.

**Question 6 (5 points)**

(i) What will happen to the margin put up on a futures contract if the contract price does not change from the date of entering the contract until the date of offsetting the contract?

a. **It will be refunded:** is the answer – no margin was ever called, so no default could have happened
b. **It will be kept by the broker.**
c. **It will be kept by the counterparty in the futures market.**

(ii) If the JPY/USD exchange rate is more volatile than the EUR/USD, then the dollar value of the initial margin should be ___ for the CME’s Yen futures ___ for the CME’s Euro futures.

a. **higher...than:** is the answer – Because margins are set to protect futures brokers and clearing houses against the risk of default by futures position holders, and because the
risk of default increases with the magnitude of daily price movements in the underlying asset, the margin on the more volatile currency (the Yen) should be greater than that on the less volatile currency.

b. lower...than
c. the same...as

Question 7. (10 points)

Starting in early 1989, Japanese interest rates were about 4% lower than U.S. rates for similar maturities. This wide difference prompted quite a few US real-estate companies at the time to borrow in ¥ to finance US developments. Likewise, between 2004 and 2007, many Hungarian individuals and firms financed real estate and other investments by borrowing in Swiss Francs at low interest rates (low, compared to the Forint rates). In a similar vein, many Japanese retail investors today engage in carry trades -- borrowing in Yen at very low interest rates and investing in other currencies at higher rates. In most cases, these investors did not or do not hedge their forex exposures. Comment on these strategies.

(Hint 1: what might account for the difference between interest rates in different countries?)
(Hint 2: what risk do these developers/investors expose themselves to?)

Answer

In order to judge the soundness of that strategy, we would need to know what accounts for the 4 difference in nominal interest rates (4% in the US-Japan case in the late 1980’s).

It is likely that all the gain the developers anticipate on the interest payments will be eaten up by an appreciation of the ¥ against the $ (remember, the ¥ loan must be repaid in ¥, and similarly the interest payments will be in ¥).

That is, the expected cost of the two loans should be about the same when measured in the same currency. Notice also that, by borrowing in foreign currency, the U.S. developers are exposing themselves to fluctuations in the exchange rate, over and above what is predicted by inflation differentials.

Question 7. (15 points; NOT Exam Material)

Suppose that the SF forward price for March 16, 2005 delivery is: $0.7100-7127/1SF. At the same time, the price at the IMM of a March 2005 SF futures is $0.7145/1SF (including all transactions costs). The IMM March futures this year requires delivery on March 16.

a. Assume that all relevant interest rates are known. Can you profit from these prices? Is there any risk involved in doing so? (Assume that you can trade up to 125,000 SF)
If interest rates are deterministic, then, despite the different timing of cash-flows, one can show that in this case forward and futures prices should be equal.1

Here, they are not, so there is room for arbitrage. "Buy low, sell high". Buy 125,000 SF forward, delivery on 03-16, at an asked price of 0.7127$/1SF. Simultaneously sell 1 March futures contract (125,000 SF total). Count your blessings on 03-16, when you will have pocketed in a total gain of $225 = $125,000 * (0.7145-0.7127).

The only risk is that your counterpart in the forward contract may default.

b. Now suppose that future interest rates are stochastic. Does your answer in a. change:

1. if domestic interest rates movements and futures price changes are positively correlated?
2. if domestic interest rates movements and futures price changes are negatively correlated?

Explain briefly in each case. (Explain how you would try to profit from those prices, if at all. Explain whether there is any risk involved.)

In addition to default risk on the forward position, there is interest-rate risk: the cash-flows generated by the short futures position are now reinvested/financed at uncertain rates.

Now for arbitrage opportunities. As in part a., the question is whether the pricing difference observed on the market (0.7145-0.7127) simply reflects a natural pricing difference between futures and forwards in this stochastic environment. That is, are the apparent arbitrage opportunities true bargains?

1. In theory, if the correlation between futures and domestic interest rates is positive, then futures prices should be slightly higher than forward prices. This is because, whenever the futures price goes up, the holder of a long futures position make an immediate gain which she can invest at a higher-than-average rate of interest, and, whenever the price of the futures goes down, she can finance the resulting loss at a lower-than-expected rate of interest (since interest rates have gone down at the same time as the futures price).

The observed difference between $0.7145/1SF and $0.7127/1SF may just reflect that fact, so that the apparent "arbitrage opportunity" may be a mere fiction.

2. The contrary is true if the correlation is negative. In this case, economic intuition tells us that futures prices should be lower than forward prices. Yet, we are told in the question that the futures is priced higher than the forward. This means that the difference between $0.7145/1SF and $0.7127/1SF is a true arbitrage opportunity.

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1 For proof, read the article by Cox, Ingersoll & Ross in Journal of Financial Economics, 1981.