Practice questions: Set #7

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. (10 points)

You work for an investment bank advising a Pittsburgh-based company, H.J. Heinz, that would like to issue 5-year zero-coupon bonds in SF, for a total face value of SF 50m, at a maximum effective interest rate in SF of 5%.

H.J. Heinz, however, does not want to issue SF-denominated bonds in Switzerland: it would rather go to the Euromarkets. Unfortunately, the Swiss authorities have in effect prohibited the issuing of SF Eurobonds.

a. Assume that the company could effectively borrow in SF at the maximum effective interest rate in SF of 5%. How much cash would it require to receive now, from the sale of SF 50m worth of 5-year zero-coupon bonds?

b. Heinz does not want to irritate the Swiss authorities by breaking the "ban" on SF-Eurobond. As a financial analyst at H.J. Heinz, you have the following pieces of information:

- 5-year borrowing rate, $-denominated bonds : 10%
- 5-year borrowing rate, SF-denominated bonds (issued in Switzerland) : 5%
- SF/$ spot rate (European terms) : 1.5SF/1$

Explain how you would advise the company to circumvent the ban without breaking it. (Hint: borrow in dollars and sell bonds together with FX contracts, using the appropriate forward rate).
Question 2. (15 points)

We are in 1993. Your company, General Rubber, is considering building its first plant in Brazil. Most of your output would be sold on the Brazilian market. The Brazilian government is willing to provide a loan of $10m at 5% to General Rubber. The loan would be paid off in five installments of $2m, starting at the end of the first year.

a. If the market interest rate for such an investment is 14%, what is the before-tax value of the interest subsidy?

b. The government offers the alternative of loaning General Rubber Cruzeiros 243,100 m at 4%. The current Cr/$ exchange rate is Cr24,310/1$. If you expect PPP to hold, and the terms of the two loans are otherwise the same, which loan should you take? Explain.

c. At the moment, the Brazilian government is clinging to state businesses in areas ranging from steel to timber and is running a sizable deficit (relative to GNP). Moreover, trade restrictions and other barriers further hamper the smooth adjustment of the economy to changing relative prices. Based on this information, you feel that the convertibility of the Cruzeiro is unlikely to last. Suppose that you therefore expect the Cruzeiro to appreciate against the $ at a rate of 10% per year in real terms for the next five years. Does your answer in b change?

Question 3 (Preparation for the final). (15 points)

We are in 2000. Your company, General Beef, is considering buying its first plant in Argentina. The Argentine government requires, as part of the deal, that GB deposit $10m on a government escrow account, to be paid back to GB in 1 year. The government will pay GB 5% interest on that deposit.

a. If the market interest rate for such a dollar investment currently is 8%, what is the opportunity cost, in today's dollar, of having to make that deposit?

b. The government offers the alternative of depositing an equivalent amount of Peso 10m at a rate of 4%. The spot exchange rate is Peso 1 / $1, and the peso is presently pegged to the dollar. If you expect PPP to hold, and Argentina's inflation rate to exceed the USA's by 10%, which deposit should you make? Explain thoroughly.

(Hint: if PPP holds and inflation rates are expected to differ significantly in both countries, do you expect the peg to hold?)

c. If you expect the Argentine government to make good on its promise to keep pegged the Peso to the dollar, does your answer in b change? Explain.
Question 4. (10 points for part a.; NOTE that parts b. & c. are NOT exam material)

Suppose the current rate of exchange between the $ and the £ is 1£ = 2$. Again working for an investment bank, you are advising the English affiliate of Global Industries, G.I. Ltd., which is contemplating raising $12m by issuing bonds denominated either in $ or in £. The $ bonds would carry a coupon rate of 10%, and the £ bonds would carry a coupon rate of 13%. In either case, the bonds would have annual interest payments and would mature in 5 years.

a. Suppose G.I. Ltd. is interested only in minimizing its expected financing costs. In the absence of taxes, what annual rate of £ devaluation (or revaluation) would leave G.I. Ltd. indifferent between borrowing either £ or $? What would be the expected exchange rate at the end of year 5, given these currency changes?

Note: the assumption that taxes are irrelevant is not ludicrous. First, it is patently relevant for tax-exempt institutions (including international development organizations). Second, neglecting taxes may also be reasonable for companies that have large losses and cannot be reasonably expected to take advantage of the tax deductibility of interest charges.

b. Suppose that the British tax rate is 45%, and that exchange losses on foreign currency principal repayments are not tax deductible but that all interest expenses, including exchange losses, are tax deductible. Would your answer change?

(Hint: rework part a. on an after-tax basis)

c. Suppose that the British Parliament passes a law that makes all FX losses (gains) -- including those on principal repayments -- tax deductible (taxable). How would that law affect G.I. Ltd.?
Practice set #7 & Solutions

Question 1. (10 points)

You work for an investment bank advising a Pittsburgh-based company, H.J. Heinz, that would like to issue 5-year zero-coupon bonds in SF, for a total face value of SF 50m, at a maximum effective interest rate in SF of 5%.

H.J. Heinz, however, does not want to issue SF-denominated bonds in Switzerland: it would rather go to the Euromarkets. Suppose that the Swiss authorities have stated a displeasure with the idea of HJH’s issuing SF Eurobonds.

a. Assume that the company could effectively borrow in SF at the maximum effective interest rate in SF of 5%. How much cash would it require to receive now, from the sale of SF 50m worth of 5-year zero-coupon bonds?

Answer.

It would require proceeds of at least SF 50m/(1.05)^5 = SF 39,176,308.

b. Heinz does not want to irritate the Swiss authorities by breaking the "ban" on SF-Eurobond. As a financial analyst at H.J. Heinz, you have the following pieces of information:

5-year borrowing rate, $-denominated bonds : 10%
5-year borrowing rate, SF-denominated bonds (issued in Switzerland) : 5%
SF/$ spot rate (European terms) : 1.5SF/1$

b. Explain how you would advise the company to circumvent the Swiss “ban” without breaking it. (Hint: borrow in dollars and sell bonds together with FX contracts, using the appropriate forward FX rate).

Answer.

For Heinz to circumvent the ban without breaking it, you must find a combination of financial instruments that together reproduce the pattern of cash-flows that Heinz would obtain if it were able to float SF Eurobonds. Hence, the preliminary step required to find a solution to Heinz's problem, is to determine the cash-flows the company desires.
They are as follows (observe that \( SF\ 39,176,308 = SF\ 50m/(1.05)^5 \)), the present value of
50m SF at the SF interest rate of 5%:

<table>
<thead>
<tr>
<th></th>
<th>possible</th>
<th>wanted</th>
</tr>
</thead>
<tbody>
<tr>
<td>( t=0 )</td>
<td>+$ 26,117,539</td>
<td>+SF 39,176,308</td>
</tr>
<tr>
<td>( t=5 )</td>
<td>-$ 42,062,557</td>
<td>-SF 50,000,000</td>
</tr>
</tbody>
</table>

Heinz wants to obtain at least SF 39,176,308 now in exchange for a repayment of SF 50 m
in 5 years. Given the Swiss "ban" on SF-denominated Eurobonds, Heinz would be better off
floating 5-year dollar-denominated zero-coupon bonds (at an interest rate of 10%), converting the
proceeds at the current spot rate, and bundling the $ bonds thus floated together with $/SF
forward contracts at the appropriate forward rate. The latter is simply the forward rate given by
interest rate parity. At maturity, Heinz would then redeem the dollar bonds at their face value,
using SF 50m to do so.

At the current spot rate, \( SF\ 39,176,308 = $ 26,117,539 \). Suppose that Heinz were to float
$-denominated zero-coupon bonds that would yield proceeds of $ 26,117,539. Given that the 5-
year borrowing rate for dollar-denominated bonds is 10%, Heinz would have to float dollar-
denominated zero-coupon bonds with a face value of $ 42,062,557.

Now suppose Heinz floats $-denominated bonds at 10%, and sells them together with
forward contracts with a forward rate of $0.84125/1SF. This is the $/SF 5-year forward rate
implied by interest rate parity: $0.666666/1SF x (1.1/1.05)^5 = $0.84125/1SF.

At maturity, what will happen? Heinz has SF 50m, but is short $ 42,062,557 (it needs to
redeem the $ bonds). However, it has a long position in $ / short position in SF from the $/SF
forward contract for a total SF amount of SF50m, with a forward rate of $0.84125/1SF. In other
words, it must deliver SF 50m in exchange for receiving SF 50m x $0.84125/1SF = $ 42,062,557.
The $ cash-ins and outs cancel out, leaving H.J. Heinz exactly where it would have been if it had
been able to float SF-denominated Eurobonds at a rate of 5%.

The table below sums up the pattern of cash-flows over time.

<table>
<thead>
<tr>
<th></th>
<th>$ Eurobonds</th>
<th>spot SF purchase</th>
<th>forward SF sale</th>
<th>total cash-flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>( t=0 )</td>
<td>+$ 26,117,539</td>
<td>-$ 26,117,539</td>
<td>+SF 39,176,308</td>
<td>+SF 39,176,308</td>
</tr>
<tr>
<td>( t=5 )</td>
<td>-$ 42,062,557</td>
<td></td>
<td>+$ 42,062,557</td>
<td>-SF 50,000,000</td>
</tr>
</tbody>
</table>

5
Question 2. (15 points)

We are in 1993. Your company, General Rubber, is considering building its first plant in Brazil. Most of your output would be sold on the Brazilian market. The Brazilian government is willing to provide a loan of $10m at 5% to General Rubber. The loan would be paid off in five installments of $2m, starting at the end of the first year.

a. If the market interest rate for such an investment is 14%, what is the before-tax value of the interest subsidy?

Answer.

Paying 5% interest rather than 14% would save 9% annually on the principal balance outstanding. The before-tax value of the interest subsidy is simply the net present value of the stream of the cash saved this way, where the discount rate used is 14% -- the market rate of interest for such a loan.

\[
\begin{array}{cccc}
\text{Year} & \text{principal} & \text{interest saving (9%)} & \text{PV factor (14%)} & \text{PV of int. savings} \\
1 & \$10m & \$900,000 & 0.8772 & \$789,480 \\
2 & \$8m & \$720,000 & 0.7695 & \$554,040 \\
3 & \$6m & \$540,000 & 0.6750 & \$364,500 \\
4 & \$4m & \$360,000 & 0.5921 & \$213,156 \\
5 & \$2m & \$180,000 & 0.5194 & \$93,492 \\
\hline
\text{_________} & \text{_________} & \text{_________} & \text{_________} & \text{_________} \\
\text{\$2,500,000} & \text{\$2,014,668} \\
\end{array}
\]

The cheap loan from the Brazilian government would thus enable General Rubber to save, in present terms, $2,014,668 on its interest payments.

b. The government offers the alternative of loaning General Rubber Cruzeiros 243,100 m at 4%. The current Cr/$ exchange rate is Cr24,310/1$. If you expect PPP to hold, and the terms of the two loans are otherwise the same, which loan should you take? Explain.

Answer.

As long as PPP holds, the $ should neither appreciate nor depreciate in real terms against the Cruzeiro. Loans, however, are contracts that give rise to fixed payments: hence, what matters is not the real rate of exchange but the nominal exchange rate change.

To see this, recall that General Rubber is an American company. Hence, if G.R. takes the $ loan, the real value of the interest and principal payments will decrease at the US inflation rate. On the other hand, if inflation is higher in Brazil than in the US -- which it is -- then, as PPP holds by assumption, the nominal Cruzeiro-dollar exchange rate will decrease, i.e., the Cruzeiro will depreciate against the $. Hence, if G.R. takes the Cruzeiro loan, it will repay fixed Cruzeiro amounts whose real value in dollars decreases at the US inflation rate times the rate of nominal Cruzeiro depreciation.

Intuitively, the $ loan has an annual 1% interest rate disadvantage over the Cr loan, and hence the $ should depreciate by about 1% per year for G.R. to be indifferent between the two loans. Assuming PPP holds, the answer to the question thus depends on the inflation differential between the two countries, since this differential determines the rate of nominal appreciation (or
depreciation) of the Cruzeiro against the dollar. In the case at hand, inflation would have to be at least 1% higher in the US than in Brazil for the company to prefer the dollar loan.

Formally, one can use the following method to find out the inflation differential that would leave G.R. indifferent (money-wise) between the two loans.

<table>
<thead>
<tr>
<th>$ loan</th>
<th>principal outstanding ($)</th>
<th>interest payment @ 5% ($)</th>
<th>principal repayment ($)</th>
<th>total payment ($)</th>
<th>PV factor @ 14%</th>
</tr>
</thead>
<tbody>
<tr>
<td>year 1</td>
<td>10m</td>
<td>500,000</td>
<td>2m</td>
<td>2.5 m</td>
<td>0.8772</td>
</tr>
<tr>
<td>year 2</td>
<td>8m</td>
<td>400,000</td>
<td>2m</td>
<td>2.4 m</td>
<td>0.7695</td>
</tr>
<tr>
<td>year 3</td>
<td>6m</td>
<td>300,000</td>
<td>2m</td>
<td>2.3 m</td>
<td>0.6750</td>
</tr>
<tr>
<td>year 4</td>
<td>4m</td>
<td>200,000</td>
<td>2m</td>
<td>2.2 m</td>
<td>0.5921</td>
</tr>
<tr>
<td>year 5</td>
<td>2m</td>
<td>100,000</td>
<td>2m</td>
<td>2.1 m</td>
<td>0.5194</td>
</tr>
</tbody>
</table>

The PV of those payments is thus $7.99m.

We want to find out the inflation differential between the US and Brazil, say $d$, that will make G.R. indifferent between the two loans. That is, we want to find the annual inflation differential that makes the cash-outflows of the two loans have the same PV.

<table>
<thead>
<tr>
<th>Cr. loan</th>
<th>principal outstanding (Cr)</th>
<th>interest payment @ 4% (Cr)</th>
<th>principal repayment (Cr)</th>
<th>total payment (Cr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>year 1</td>
<td>243,100m</td>
<td>9,724m</td>
<td>48,620m</td>
<td>58,344m</td>
</tr>
<tr>
<td>year 2</td>
<td>194,480m</td>
<td>7,779.2m</td>
<td>48,620m</td>
<td>56,399.2m</td>
</tr>
<tr>
<td>year 3</td>
<td>145,860m</td>
<td>5,834.4m</td>
<td>48,620m</td>
<td>54,454.4</td>
</tr>
<tr>
<td>year 4</td>
<td>97,240m</td>
<td>3,889.6m</td>
<td>48,620m</td>
<td>52,509.6m</td>
</tr>
<tr>
<td>year 5</td>
<td>48,620m</td>
<td>1,944.8m</td>
<td>48,620m</td>
<td>50,564.8m</td>
</tr>
</tbody>
</table>

which, converted into $, gives rise to the following stream of cash-outflows:

<table>
<thead>
<tr>
<th>Cr. loan</th>
<th>total payment (Cr)</th>
<th>exchange rate @ d = inflation differential</th>
<th>total payment ($)</th>
<th>PV factor @ 14%</th>
</tr>
</thead>
<tbody>
<tr>
<td>year 1</td>
<td>58,344m</td>
<td>24,310 (1+d)</td>
<td>2.40m (1+d)</td>
<td>0.8772</td>
</tr>
<tr>
<td>year 2</td>
<td>56,399.2m</td>
<td>24,310 (1+d)^2</td>
<td>2.32m (1+d)^2</td>
<td>0.7695</td>
</tr>
<tr>
<td>year 3</td>
<td>54,454.4m</td>
<td>24,310 (1+d)^3</td>
<td>2.24m (1+d)^3</td>
<td>0.6750</td>
</tr>
<tr>
<td>year 4</td>
<td>52,509.6m</td>
<td>24,310 (1+d)^4</td>
<td>2.16m (1+d)^4</td>
<td>0.5921</td>
</tr>
<tr>
<td>year 5</td>
<td>50,564.8m</td>
<td>24,310 (1+d)^5</td>
<td>2.08m (1+d)^5</td>
<td>0.5194</td>
</tr>
</tbody>
</table>

The value of the depreciation rate $d$ that makes these two loans produce the same PV of future cash outflows ($7.99m) is $d = -1.09\%$. Put differently, the inflation rate in the U.S. must be 1.09% higher than it is in Brazil to leave G.R. indifferent between the two loans.

However, as said above, it is very likely that the inflation rate is higher in Brazil than in the US. Hence, G.R. is most likely strictly better off taking the Cr loan than the $ loan.
c. At the moment, the Brazilian government is clinging to state businesses in areas ranging from steel to timber and is running a sizable deficit (relative to GNP). Moreover, trade restrictions and other barriers further hamper the smooth adjustment of the economy to changing relative prices. Based on this information, you feel that the convertibility of the Cruzeiro is unlikely to last. Suppose that you expect the Cruzeiro to appreciate against the $ at a rate of 10% per year in real terms for the next five years. Does your answer in b change?

**Answer.**

In part b., we showed that, when PPP holds, US inflation had to be 1% higher than Brazilian inflation for G.R. to be indifferent between the two loans.

When the $ depreciates by 10%/year against the Cr in real terms, this is not the case anymore: **intuitively, as long as inflation in Brazil is at most 9% (10%-1%) higher than inflation is in the US, G.R. will prefer the $ loan, and vice-versa.**

A formal analysis would require all the analysis you did in part b.

**Question 3 (Preparation for the final). (15 points)**

Easier than the one solved in class (Q5) 😊

**Question 4. (10 points for part a.; NOTE that parts b. & c. are NOT exam material)**

Suppose the current rate of exchange between the $ and the £ is 1£ = 2$. Again working for an investment bank, you are advising the English affiliate of Global Industries, G.I. Ltd., which is contemplating raising $12m by issuing bonds denominated either in $ or in £. The $ bonds would carry a coupon rate of 10%, and the £ bonds would carry a coupon rate of 13%. In either case, the bonds would have annual interest payments and would mature in 5 years.

a. Suppose G.I. Ltd. is interested only in minimizing its expected financing costs. In the absence of taxes, what annual rate of £ devaluation (or revaluation) would leave G.I. Ltd. indifferent between borrowing either £ or $? What would be the expected exchange rate at the end of year 5, given these currency changes?

**Answer.**

This question takes one-period IRP and carries it to the next natural stage: evaluate multi-period loans.

Intuitively, for G.I. Ltd. to be indifferent between the two financing sources, the £ had better be expected to depreciate against the $ at an annual rate roughly equal to the interest rate differential between the two countries -- the £ loan carries a 13% coupon and the $ loan, a 10% one.
Formally, given the current exchange rate of $s_0 = \frac{2}{1\£}$, the company faces either borrowing £ 6m at 13% and converting these into $, or borrowing $ at a 10% interest rate. These two loans give rise, respectively, to the following stream of cash-flows:

<table>
<thead>
<tr>
<th></th>
<th>year 0</th>
<th>year 1 (-)</th>
<th>year 2 (-)</th>
<th>year 3 (-)</th>
<th>year 4 (-)</th>
<th>year 5 (-)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>£ loan</strong></td>
<td>6,000,000</td>
<td>780,000</td>
<td>780,000</td>
<td>780,000</td>
<td>780,000</td>
<td>6,780,000</td>
</tr>
<tr>
<td><strong>$ loan</strong></td>
<td>12,000,000</td>
<td>1,200,000</td>
<td>1,200,000</td>
<td>1,200,000</td>
<td>1,200,000</td>
<td>13,200,000</td>
</tr>
</tbody>
</table>

Discounting the £ cash-flows at 13%, we see immediately – and naturally – that the British loan has an NPV equal to 0: it brings in £6m today, while the PV of the five annual interest payments and of the year-5 principal repayment is -£6m.

For the two loans to be comparable, the $ loan translated in £ must also have 0 NPV when the £ depreciation is taken into account. For simplicity, let us assume that the $ appreciates against the £ at a constant rate of $d$ (%) each year for the next 5 years. Then we must have:

\[
\frac{12,000,000}{s_0} - \sum_{t=1}^{5} \frac{1,200,000}{s_0} \left(\frac{1+d}{1.13}\right)^t - \frac{12,000,000}{s_0} \left(\frac{1+d}{1.13}\right)^5 = 0
\]

where: 
- $s_0$ is the current exchange rate of $2/\£$
- $d$ is the annual rate of appreciation of the $ against the £
- $\frac{s_0}{(1+d)^t}$ is the expected exchange rate in period $t$ in American terms
- $\frac{1}{s_0} (1+d)^t$ is the expected exchange rate in period $t$ in European terms.

The first term on the left-hand side of equation (1) is the £ value of the proceeds from floating the $ bonds. The second term on the left-hand side gives the PV of the interest payments on the $ loan when converted into £ at the exchange rate expected given the yearly £ depreciation. The third term on the left-hand side is the PV of the principal repayment on the $ loan converted into £ at the exchange rate expected 5 years from now. Notice that the $ cash-flows, once converted into £, are discounted at 13%, the appropriate discount rate for £ cash-flows.

A quick Excel computation shows that the solution to equation (1) is $d = 2.727\%$. That is, **G.I. Ltd. will be indifferent between the two loans if it expects the $ to appreciate at a constant rate of 2.727% annually for the next 5 years**. If it expects the $ to appreciate by more (less) than 2.727% per year against the £, then the company should pick the £ ($) loan.

**Note:** the assumption that taxes are irrelevant is not ludicrous. First, it is patently relevant for tax-exempt institutions (including international development organizations). Second, neglecting taxes may also be reasonable for companies that have large losses and cannot be reasonably expected to take advantage of the tax deductibility of interest charges.
b. Suppose that the British tax rate is 45%, and that exchange losses on foreign currency principal repayments are not tax deductible but that all interest expenses, including exchange losses, are tax deductible. Would your answer change?

(Hint: rework part a. on an after-tax basis)

**Answer.**

Under European accounting standards, all cash-flows related to a loan in foreign currency must be booked in the company's local currency. The exchange rate used to convert foreign currency amounts into local currency is, for all these cash-flows, the spot exchange rate of the day when the loan was recorded in the company's books.

In the case at hand, G.I. Ltd. is a British company and therefore keeps its books under UK law. It must therefore translate into £ the proceeds of, the interest payments on, and the principal repayments of, the $ loan using the current spot rate: $2/£. FX gains and losses on interest payments and principal repayments (i.e., the differences between the amounts actually paid and those that would have been paid in the absence of FX rate changes) are booked in a separate account of the statement of profits and losses.

In the UK, interest expenses are tax deductible provided they are booked at the spot exchange rate on the day the loan is recorded in the company's books. Even though --as we just explained -- they are booked separately, FX losses (gains) on interest payments are also tax deductible (taxable).

In a nutshell, the tax deductibility of interest payments means that interest payments on the £ loan must be calculated using the after tax rates of interest, i.e., 13% x (1 - tax rate)= 7.15%. The appropriate discount rate, therefore, is now also 7.15%. Discounting the loan's cash-flows at a discount rate of 7.15% gives, naturally, a zero NPV to the £ loan.

Specifically, the £ loan gives rise to the following after-tax stream of cash-flows:

<table>
<thead>
<tr>
<th>£ loan</th>
<th>year 0 (+)</th>
<th>year 1 (-)</th>
<th>year 2 (-)</th>
<th>year 3 (-)</th>
<th>year 4 (-)</th>
<th>year 5 (-)</th>
</tr>
</thead>
<tbody>
<tr>
<td>after-tax (£)</td>
<td>6,000,000</td>
<td>429,000</td>
<td>429,000</td>
<td>429,000</td>
<td>429,000</td>
<td>6,429,000</td>
</tr>
<tr>
<td>(13% loan)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To evaluate the $ loan in the presence of taxes, we first need to calculate the after-tax stream of cash-flows of the $ loan once converted into £. Let us again assume that the $ appreciates against the £ at a constant rate of \( d \) (%) each year for the next 5 years. Given the current spot exchange rate is \( s_0 = $2/£ \), we have the following cash-flow table:
Notice that, as is often useful in complex problems, I have broken down this potentially complex task into smaller, more manageable pieces: each column represents one of these pieces.

Since the cash-flows on the last column of the table above are £ amounts, the appropriate discount rate is the after-tax rate for £ cash-flows: 7.15%. We must now solve for the rate of $ appreciation, $d$, that makes the $ loan have a zero NPV. Put differently, we must find the value of $d$ that makes the 6 terms in the last column of the table sum up to 0. A quick spreadsheet calculation gives $d = 1.564$ -- i.e., if only exchange losses on interest payments are tax deductible, G.I. Ltd. is indifferent between the two loans if it expects the $ to appreciate against the £ at an annual rate of 1.564%. If the company expects the $ to appreciate by more (less) than 1.564% per year against the £, then it should pick the £ ($) loan.

### c. Suppose that the British Parliament passes a law that makes all FX losses (gains) -- including those on principal repayments -- tax deductible (taxable). How would that law affect G.I. Ltd.?

**Answer.**

Intuitively, because G.I. Ltd. expects the $ to appreciate against the £ -- and thus expects to book a FX loss on the principal repayment 5 years down the line -- the new law will make the $ loan more attractive to the company. As a result, the company will have to expect the $ to appreciate against the £ by "way" more (less) than the 1.564% per year found in part b. before it picks the £ ($) loan.

Formally, we simply adjust the answer in part b. to take into account the FX gain or loss on the year-5 principal repayment. The latter is equal to:
\[
\frac{12,000,000}{s_5} - \frac{12,000,000}{s_0} = £ \ 6,000,000 \ [(1+d)^5 - 1]
\]

The first term on the left-hand side is the principal repayment that the company expects to make in year 5, and the second term is the amount that would have been repaid in the absence of FX rate changes (\(s_5 = s_0\)).

The 5-year $ loan's cash-flow schedule is therefore now given by:

<table>
<thead>
<tr>
<th>$ loan</th>
<th>$, pre-tax (10% loan)</th>
<th>£, pre-tax, converted at (\frac{1}{s_t} = \frac{1}{s_0} (1+d)^t)</th>
<th>£, after-tax, converted at (\frac{1}{s_t} = \frac{1}{s_0} (1+d)^t) (all FX losses deductible)</th>
</tr>
</thead>
<tbody>
<tr>
<td>year 0</td>
<td>12,000,000</td>
<td>6,000,000</td>
<td>6,000,000</td>
</tr>
<tr>
<td>year 1</td>
<td>-1,200,000</td>
<td>-600,000 ((1+d))</td>
<td>-600,000 ((1+d))</td>
</tr>
<tr>
<td>year 2</td>
<td>-1,200,000</td>
<td>-600,000 ((1+d)^2)</td>
<td>-600,000 ((1+d)^2)</td>
</tr>
<tr>
<td>year 3</td>
<td>-1,200,000</td>
<td>-600,000 ((1+d)^3)</td>
<td>-600,000 ((1+d)^3)</td>
</tr>
<tr>
<td>year 4</td>
<td>-1,200,000</td>
<td>-600,000 ((1+d)^4)</td>
<td>-600,000 ((1+d)^4)</td>
</tr>
<tr>
<td>year 5</td>
<td>-13,200,000</td>
<td>-6,600,000 ((1+d)^5)</td>
<td>-6,330,000 ((1+d)^5) + 6,000,000 ([(1+d)^5 - 1])</td>
</tr>
</tbody>
</table>

Notice that only the year-5 cash-flow in column 3 is affected by the new law.

The appropriate discount rate remains the after-tax rate for £ cash-flows: 7.15%. Solving for the rate of $ appreciation, \(d\), that makes the $ loan have a zero NPV gives \(d=2.486\%\) -- i.e., if only exchange losses on interest payments are tax deductible, G.I. Ltd. is indifferent between the two loans if it expects the $ to appreciate against the £ at an annual rate of 2.486%. If it expects the $ to appreciate by more (less) than 2.486% per year against the £, then the company should pick the £ ($) loan.