1. The following Table lists some (current) exchange rates. Answer all questions as if there were no arbitrage costs.

<table>
<thead>
<tr>
<th>Currency</th>
<th>Exchange Rate (as US$ per foreign currency, except for Japan)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada (dollar)</td>
<td>$.64/Can$</td>
</tr>
<tr>
<td>Euro</td>
<td>$.88/Euro</td>
</tr>
<tr>
<td>British Pound</td>
<td>180-day forward rate, $1.43/£</td>
</tr>
<tr>
<td>Japanese Yen</td>
<td>180-day forward rate, 123.3¥/$</td>
</tr>
</tbody>
</table>

a) The spot rate of the Yen in terms of the Canadian dollar can be determined as follows: determine how many yen per US dollar, how many Canadian dollars per US $, and divide. From the table, one Canadian $ = $.64 US, or equivalently: $1US = $1.5625 Canadian. Thus: \( \frac{123.3¥}{1.5625Can} = 78.9¥/Canadian$. 

b) The semi-annual US interest rate is 2.5%; since the forward and spot rates on the British £ (vs. the US $) are equal, the British (6 month) interest rate is also 2.5%. The Japanese yen is at a forward premium versus the US $; thus, anyone holding (covered) yen will earn a capital gain, meaning he/she can accept a lower Japanese interest rate and still be willing to hold yen. Formally, let \( e^s \) denote the spot rate (Yen/$), \( e^f \) the forward rate (Yen/$), and \( r^j \) the (6 month) Japanese interest rate. Then covered interest arbitrage requires:

\[
\left(1 + r^j\right) = \frac{e^f}{e^s} \left(1 + r^{as}\right) = \frac{1205}{1233} (1025) = 10017 \text{ so } r^j = .0017 = .17\%.
\]

{Japanese interest rates are, in fact, very low}. Another way to think of this is to calculate the forward appreciation of the yen, which is approximately

\[
\left(\frac{1233-1205}{1205}\right) = 2.32\%.
\]

Thus, to receive a total yield of 2.5% requires an interest rate of only: \( \{2.5-2.32\} = .18\% \) (the difference between .17 and .18 is rounding error)

c) Suppose your research department forecasts that, in 180 days, the spot price of the British pound will $1.65. On the basis of this information, you buy 1 million British pounds forward.

i. If your research department is correct, you will make $.22 per pound, or $220,000 from this speculative purchase.
ii. If enough people have the same beliefs (or your purchases are large enough), this will cause the forward rate of the British pound to appreciate. As a result of this appreciation in the forward rate, through covered interest arbitrage people will wish to buy British pounds spot, and invest in British interest bearing assets. Consequently, one of the following must happen: US interest rates increase, British interest rates decrease, and/or the spot British pound appreciates. Further, movements in either interest rate (as indicated) will cause the spot British pound to appreciate (unless Britain increases its money supply). Hence, speculation (beliefs) on forward rates will affect spot rates.

2. Use the covered interest arbitrage relationship to explain how the following are likely to affect the spot $/Euro rate. In answering, explain your reasoning (and, in particular, what variables you are holding fixed):

   a) An increase in US interest rates: to know exactly what happens, you need to know why U.S. interest rates increased. However, through the covered interest arbitrage relationship, we must have: Euro interest rates increase, the forward dollar depreciates or the spot dollar appreciates. Thus, if we take as given the forward exchange rate and Euro interest rates, the spot rate of the dollar will appreciate. (It is key in all of these to specify what is fixed; not part of the question, but behind the scenes, is the issue of why, for example, US interest rates increased. A consistent explanation here would be a temporary decrease in the US money supply)

   b) As in question 1, a change in the forward rate affects the covered interest arbitrage relationship. Thus, if people expect a (future) depreciation of the dollar, that will lead to a depreciation (of the dollar) in the forward market, thereby leading to a spot depreciation of the dollar and/or higher US interest rate (or lower Euro interest rates).

   c) An increase in Euro interest rates will work much like part (a): US interest rates must increase, or the Euro depreciate on forward markets, or appreciate on spot markets (to maintain covered interest arbitrage). Holding US interest rates and the forward rate constant, this would imply a spot appreciation of the Euro (depreciation of the dollar). Again, a temporary decrease in Euro money supply might be the cause.

3. The “Monetary Theory of Exchange Rate Determination” is the principal theory used to understand how exogenous events are likely to affect exchange rates. In applying the theory, a distinction is made between the “short-run”, when goods prices are held fixed, and the “long run”, when goods prices are assumed to change. Use the theory to explain how the following events are likely to effect the $/Euro exchange rate.

   a) A temporary increase in the U.S. money supply. Since the increase is assumed temporary, it will have no long run effects, and thus no impact on the forward rate. Thus, given goods prices in the short run, US interest rates have to fall to clear the money market. The decline in US interest rates makes US securities less attractive, and thus causes a spot depreciation of the dollar. People are now willing to hold dollars (covered interest arbitrage holds) since the temporary depreciation of the dollar means the dollar will appreciate over time (back to its original level), and this appreciation of the dollar makes people willing to hold dollar assets despite the lower US nominal interest rates. By assumption, there are no long run effects.
b) A permanent one-time increase in the U.S. money supply. Due to money neutrality, we know this will - in the long run - cause dollar prices to increase proportionately. Assuming purchasing power parity, we would thus expect a long run depreciation of the dollar equal to the proportionate increase in the money supply (hence, the forward rate depreciates). Since prices are sticky in the short run, this means US interest rates must fall (temporarily) to accommodate the increased money supply. The lower US interest rates, plus the forward depreciation of the dollar, both imply a spot depreciation of the dollar. **However, since in the long run, US interest rates must return to their original level** (the long run real interest rate is unaffected), this means that the spot exchange rate must depreciate by more than the forward rate - representing the *overshooting* of the exchange rate. Hence:

Long Run: \[ \frac{\Delta e}{e} = \frac{\Delta P}{P} = \frac{\Delta M}{M} \quad \Delta r = 0 \]

Short run: \[ \frac{\Delta e}{e} > \frac{\Delta M}{M} \quad \Delta P = 0, \quad \Delta r < 0 \]

c) An increase in the rate of monetary growth in Europe from 3% to 6%. Again, by money neutrality, assuming no change in real income growth, the increase in the Euro money supply growth rate from 3% to 6% will lead to a 3% increase in the inflation rate in Europe. Assuming, for simplicity, the Euro/$ rate had been stable prior to this increase in the Euro monetary growth rate, this implies the Euro will have to depreciate by 3% per year against the dollar to maintain purchasing power parity. To maintain real interest rates in the Euro zone (equal to US rates), this implies the nominal interest rate in the Euro zone will increase by 3% points. 

**Finally, the increase in nominal interest rates in the Euro zone will lead to an immediate depreciation of the Euro, followed by a continuing 3% per year depreciation rate.** Thus, in summary, the increase in the monetary growth rate leads to an immediate depreciation of the Euro (even before the money supply has actually changed) and an immediate increase in Euro prices and Euro nominal interest rates, followed by a continuing depreciation of the Euro (to match the money supply growth rate). The results come from the following formulas:

\[
M^{eu} = P^{eu} \cdot L^{eu} \left( Y^{eu}, r^{eu} \right); \quad M^{us} = P^{us} \cdot L^{us} \left( Y^{us}, r^{us} \right); \\
r^{eu} = r^{us} + \left( \frac{e^{f} - e^{s}}{e^{s}} \right) \quad \text{where: } e^{f} \text{ is the forward rate (Euro/$) and } e^{s} \text{ is the spot rate. Using purchasing power parity: } P^{eu} = e \cdot P^{us} \text{ we have:} \\

\[
\frac{M^{eu}}{M^{us}} = \left( \frac{P^{eu}}{P^{us}} \right) \left( \frac{L^{eu} \left( Y^{eu}, r^{eu} \right)}{L^{us} \left( Y^{us}, r^{us} \right)} \right) = e \cdot \left( \frac{L^{eu} \left( Y^{eu}, r^{eu} \right)}{L^{us} \left( Y^{us}, r^{us} \right)} \right)
\]

Thus, if the Euro money supply growth rate increases by 3%, the (continual) depreciation of the Euro will have to increase by 3% (i.e., in a steady state equilibrium, with no real income growth: \( \frac{\Delta e}{e} = \left( \frac{\Delta M^{eu}}{M^{eu}} \right) - \left( \frac{\Delta M^{us}}{M^{us}} \right) \)).

By covered interest arbitrage, that means the 3% increase in European monetary growth rates (causing the change in forward rates) increases Euro long-term nominal rates by 3%. Finally by the exchange rate determination equation, the higher nominal interest rates (due to the beliefs that monetary growth rate will increase in the Euro zone) lead to an immediate depreciation of the Euro (even though money supplies
have not yet changed).

d) A revised forecast in April 2001 indicating higher U.S. income levels for 2,002 than previously believed. From the exchange rate determination equation given in part (c), we know that, *ceteris paribus*, higher U.S. income levels will increase the demand for money and thus cause the dollar to appreciate in 2,002. Hence, if people believe this forecast for 2,002, they will expect the $ to appreciate in 2,002 - meaning the current forward rate of the $ will appreciate. Through covered interest arbitrage, this will make US securities look more attractive (compared to foreign securities), meaning U.S. interest rates will fall or the spot rate will appreciate (both will happen: the decline in US interest rates causes the spot appreciation). Thus, in this case lower U.S. interest rates are associated will a stronger (appreciating) dollar. On the other hand, for example, a temporary decrease in the U.S. money supply will cause higher interest rates and a (temporary) appreciation of the dollar. Thus, you cannot say that higher interest rates lead to an appreciation (or depreciation) of the dollar because interest rates, like exchange rates, are endogenous - determined by supply and demand. You have to explain why interest rates change in order to predict how the exchange rate will change (note the difference in the two examples cited).

4. Using the aggregate demand-aggregate supply model of Chapter 16:

a) Show how a permanent increase in the money supply affects the exchange rate and income levels in the short run and in the long run.

The key here is identifying what variables can change, and what are fixed, in each “time period”. *By assumption*, in the short run prices are fixed, but real income levels can change; in the long run, prices may adjust, but income will equal its full employment level (and thus is not affected by policy).

*Working backward*, in the long run prices and the exchange rate will increase in proportion to the money supply increase, but income levels and interest rates will not change. Thus, for the **long run**: \[
\frac{\Delta P}{P} = \frac{\Delta E}{E} = \frac{\Delta M}{M}
\]

In the short run, prices are fixed; thus, interest rates must change (decrease) to absorb the additional money supply. In addition, the forward exchange rate depreciates; thus, the spot exchange rate must depreciate, and **by more** than in the long run (because of the temporary decrease in the interest rate due to the price rigidity). The lower interest rate (in the short run) means that the money supply increase temporarily increases income.
In the figure above, \( K \) represents the original equilibrium, and \( Y^* \) represents the equilibrium (full employment) level of income. **Given prices**, the money expansion shifts the money market curve (AA) out to (A’A’), reflecting the short run depreciation of the currency. **Given prices**, this depreciation makes domestic goods relatively cheaper, and leads to higher income in the short run. The point \( L \) marks the short run impact of the monetary expansion.

Over time, **prices of goods increase**; this shifts the \( A’A’ \) curve downward, to \( A^*A^* \) (higher prices reduce real money balances) and shifts the aggregate demand curve \( DD \) upward to \( D^*D^* \) as, given the exchange rate, higher prices reduce demand for domestic goods. Thus, in adjusting to the long run equilibrium, the exchange rate appreciates and income declines (relative to the short run effect); the long run equilibrium is at \( M \). The dotted line from \( L \) to \( M \) shows this adjustment, and reflects the “overshooting” phenomenon discussed in Chapter 14.

b) Show how a temporary increase in government spending affects the exchange rate and income level in the short run. What is the short run effect of a permanent increase in government spending? Why?

Again, the distinction between short run and long run depends on whether prices (or income) are held fixed, whereas the distinction between temporary and permanent depends on whether the forward exchange rate changes (which is crucial in determining how the spot rate and interest rates change).

**With a temporary increase**, the forward exchange rate does not change. The increased fiscal spending increases demand and hence leads to an appreciation of the real exchange rate; since prices are fixed, this must come about due to a spot appreciation of the nominal exchange rate \( (E) \). In the money market, the spot appreciation, coupled with an unchanged future exchange rate, means domestic interest rates rise (as they must to accommodate the increased income levels). This is all shown in the diagram below; the
AA curve **does not shift** (since prices, money supply and the forward exchange rate are all fixed), while the DD curve shifts down due to the fiscal expansion; the equilibrium temporarily moves from $L$ to $M$. The temporary policy leads to a (temporary) increase in income and appreciation of the exchange rate.

Finally, a **permanent** increase in fiscal policy will cause a permanent increase in the real exchange rate. In the long run, real income will be unchanged (by the assumption of full employment) and the nominal interest rate will be unchanged (since, in the long run, spot and forward exchange rates will be equal). But, from money market equilibrium, this implies that the long run domestic price level **will not change** from its current level (otherwise real money balances would change, which would be inconsistent with money market equilibrium). **Thus, the long run impact** of the permanent fiscal expansion is to lead to an appreciation of the nominal (and real) exchange rate, but no change in the price level or in income levels. But since price levels do not change, the short run and long run impacts are identical! **Permanent fiscal policy has no impact on equilibrium income, even in the short run.**

This result can be represented in a diagram like that above; the only difference is, since the forward rate appreciates, the AA curve shifts down (to $A'A'$). And since the short run and long run are the same, the new equilibrium income must be the same as the old equilibrium. Hence, in the diagram, the equilibrium jumps immediately from $L$ to $N$. 