1. (2 points) As a matter of fact, population in Japan grows at a lower rate than that in the U.S. Does this imply that money demand in the U.S. grows faster than that in Japan? Explain your reason.

**ANSWER 1:** (1 point) Consider this simply relationship between the aggregate money demand and the number of households.

\[
\text{Aggregate money demand} = \text{Number of households} \times \text{Money demand per household}
\]

Since population growth increases the number of households demanding money, the aggregate real money demand must increase with population growth.

(1 point) However, this does not necessarily imply that money demand in Japan will grow faster than that in the U.S. The reason is that, the households in the two countries may have different preferences. Even the number of households in Japan is growing faster than the U.S., the money demand per household in the U.S. may be increasing so much that it causes the aggregate money demand in the U.S. to grow faster than that in Japan.

2. (2 points) Discuss the impact of a permanent reduction in money supply on exchange rate. Will that result in exchange rate overshooting? Explain using a diagram. Show also the time paths of price level and exchange rate.

**ANSWER 2:** (1 point) The effects on interest rate and exchange rate will be the opposite from those following a permanent money expansion in the textbook. In Figure 2.1, the equilibrium in money market is initially at Point 1, and that in foreign exchange market is at Point 1'. Initial exchange rate is \(E^1_{\$/C}\). the money reduction shifts the money supply curve from \(M_1^s/P\) to \(M_2^s/P\). As a result, the interest rate increases from \(R_1^s\) to \(R_2^s\). Also, people know that in the long run the price level will fall as a result of money reduction and that will make the currency...
appreciate in the long run. So, market participants in the foreign exchange market revise their expectation such that $E^{s,1}_{s/E}$ falls to $E^{s,2}_{s/E}$. That results in the downward shift of the dollar return on Euro deposits. As a result, exchange rate appreciates from $E^{1}_{s/E}$ to $E^{2}_{s/E}$ in the short run, at Point 2'.

In the transition period, the price level slowly falls and the real money supply curves gradually goes back to its original level. That causes interest rate to falls back slowly too. However, the market participants no more revise their expectation about exchange rate because this policy change is permanent. In the long run, exchange rate will arrive at the new equilibrium level $E^{3}_{s/E}$, at Point 3'.

The degree of overshooting is summarized by the difference between short run and long run response of exchange rate.

\[
\text{Short run response} = |E^{2}_{s/E} - E^{1}_{s/E}| \quad \text{Long run response} = |E^{3}_{s/E} - E^{1}_{s/E}|
\]

Obviously the short run response is larger than the long run one. So, we conclude that there is an exchange rate overshooting here. Exchange rate overshooting arises when there is a permanent change in monetary policy and price is sticky, as in this case. The time paths of price level and exchange rate are given in Figures 2.2 and 2.3. (1 point for Figures 2.1, 2.2 and 2.3.)

3. (2 points) In the previous question, we assumed that real output was given. Assume instead that a reduction in the money supply reduces real output in the short run. How does this affect the extent to which the exchange rate overshoots? Describe using a diagram.

**ANSWER 3:**

(1 point) Figure 3.1 describes money market and foreign exchange market before and after a permanent money reduction.

(1 point) Initially, the equilibrium in money market is at Point 1, and that in foreign exchange market is at Point 1'. Initial exchange rate is $E^{1}_{s/E}$. The money reduction shifts the money supply curve from $M^{1}_s/P$ to $M^{2}_s/P$. However, the output falls in response to money expansion. That shifts the aggregate money demand curve from $L^{1}(R_s,Y)$ upward. The degree of the shift depends on the responsiveness of output to money reduction and the elasticity of money demand to output. We do not know precisely how far the shift is, but we are certain the new aggregate money demand must lie above the old one, for example, as the curve $L^{2}(R_s,Y)$.

In this case, the short run equilibrium in money market is Point 4, unlike the standard case in Question 2 where the short run equilibrium was at Point 2. In the short run, interest rate rises from $R^{1}_s$ to $R^{4}_s$. The downward shift of the expected return on euro assets takes place too, due to the falls in the expected depreciation following money reduction as in Question 2. The corresponding equilibrium in
foreign exchange market is Point 4', not Point 2' as in Question 2. Note that \( E_4^4/A > E_2^2/A \) because \( R_4^4 < R_2^2 \). Therefore, short run appreciation is smaller with output reduction.

In the long run, the real money supply shifts back to the original level gradually as price level falls. The increase in output returns to the long run and that causes aggregate money demand return to its original level too. The long run equilibrium in money market is Point 5, which is identical to Point 1. The corresponding equilibrium in foreign exchange market is Point 5'.

To see the degree of overshooting, we can compare the short run with the long run response of exchange rate.

\[
\text{Short run response} = |E_4^4/A - E_1^1/A| \quad \text{Long run response} = |E_5^5/A - E_1^1/A|
\]

As a result,

\[
\text{Overshooting with output reduction} = E_5^5/A - E_4^4/A > 0
\]

Compare this with Question 2,

\[
\text{Overshooting with output reduction} < \text{Overshooting without output reduction}
\]

It is also possible that the aggregate money demand curve shifts further upward. For example, it can shift to \( L^3(R, Y) \), and the short run equilibrium in money market and foreign exchange market is Point 6 and Point 6', respectively. In this case, the exchange rate appreciation in the short run is even smaller than in the long run, i.e. \( E_6^6/A > E_5^5/A \). This situation is the opposite from exchange rate overshooting and called undershooting. In other words, exchange rate undershooting is a situation where the short run response of exchange rate is smaller than its long run response. It is also consistent with our conclusion that output reduction in response to money reduction always reduces the degree of overshooting.

4. (2 points) Assume that one percent increase in money supply increases price immediately by 0.25 percent. How will this assumption change your answer in Question 2 and 3. Describe using a diagram.

**ANSWER 4:** (1 point) Figure 4.1 describes money market and foreign exchange market before and after a permanent money reduction.

(1 point) The equilibrium in money market is initially at Point 1, and that in foreign exchange market is at Point 1'. Initial exchange rate is \( E_1^1/A \). Since a one percent increase in money supply raises price level by 0.25 percent, a one percent decrease in money supply must reduces price level by 0.25 percent. The money reduction
in this case will shift the sl real money supply curve up by 75 percent of that in Question 2, because the deflation offsets the sl nominal money supply reduction by 25 percent. The real money supply curve shifts to $M_3^s/P$, where $M_3^s/P$ lines below $M_2^s/P$ in Question 2. As a result, the increase in interest rate in the short run will be smaller than that in Question 2 too. However, this short run price response does not change the long run level of price. So the expectation of future exchange rate is the same as in Question 2. The long run exchange rate is also the same. So, the immediate price adjustment in this Question reduces the degree of overshooting in Question 2. The degree of overshooting in Question 3 will also reduced by the short run price response with the same reason.

5. (2 points) Is it true that a central bank can reduce the extent to which the exchange rate overshoots by announcing its policy in advance? Explain your reason using a diagram.

**ANSWER 5:**

(1 point) Figure 5.1 describes money market and foreign exchange market before and after a *preannounced* permanent money reduction.

(1 point) Initially, the equilibrium in money market is at Point 1, and that in foreign exchange market is at Point 1’. Initial exchange rate is $E^{1}_s/\€$. When a central bank announces a future change in monetary policy, people immediately update their expectation. News about a future reduction in money supply decreases expected inflation and then expected exchange rate. The expected return on euro assets decreases as the expected exchange rate decreases from $E^{e,1}_s/\€$ to $E^{e,2}_s/\€$. The foreign exchange market equilibrium is at Point 6’ right after the announcement. The corresponding money market equilibrium is Point 6. Since there is no change in money supply at this point, Point 6 is identical to Point 1.

When money supply actually decreases later on, the real money supply schedule shifts from $M_1^s/P$ to $M_2^s/P$. The short run equilibrium points are Point 7 and 7’. Notice that Point 7’ is the same as Point 2’ in Question 2. Note also that people no more adjust their expectation, because they have already done that after the announcement. In the long run, price level falls and the real money supply curve shifts back. The economy then gradually moves toward the long run equilibrium Point 8 and Point 8’. In fact, Point 8 is the same as Point 6. Exchange rate does overshooting in the short run and the degree of overshooting which is the same as in Question 2. However, the volatility is smaller than the case without a preannouncement.

(Optional) The time path of exchange rate is given in Figure 5.2. At the time of of announcement $t_A$, exchange rate jumps from $E^{1}_s/\€$ to $E^{6}_s/\€$. It stays at that level until money supply decreases at time $t_0$. At $t_0$, exchange rate jumps from
$E_8^6$ to $E_8^7$. It rises during the transition period and arrives at its long run level $E_8^8$ at $t_T$. We can see that the volatility of exchange rate is smaller with a preannouncement, although the degree of overshooting is the same.
Figure 2.1: Unanticipated permanent money reduction

Figure 2.2: Time path of exchange rate

t₀ = When money supply is decreased permanently.
tₜ = When the price level arrives at its long run level.
Figure 2.3: Time path of price level

$t_0 = \text{When money supply is decreased permanently.}$

$t_T = \text{When the price level arrives at its long run level.}$

Figure 3.1: Unanticipated permanent money reduction with output response
Figure 4.1: Unanticipated permanent money reduction with short-run price response

E
E1
E3
3' Long run

$ return
Money demand

M2/P
M3/P
M1/P
1 =3, Long run

R$1
1'
Figure 5.1: Pre-announcement and exchange rate overshooting

Figure 5.2: Time path of exchange rate with pre-announcement

ta = After the announcement

t0 = When money supply is decreased permanently.

tT = When the price level arrives at its long run level.