1. (2 points) How would you expect a fall in a country’s population to alter its aggregate money demand function? How will that affect exchange rate?

**ANSWER 1:**

(1 point) Intuitively, a fall in population implies a reduction in the number of households and in output. Therefore, it reduces the aggregate volume of transactions. As a result the aggregate money demand falls.

(1 point) A fall in money demand will lower interest rate. According to the uncovered interest parity, lower interest rate will cause exchange rate to depreciate.

2. (3 points) The velocity of money, $V$, is defined as the ratio of real GNP to real money holdings, $V = Y/(M/P)$ in the notation used in class. Use the money market clearing condition to derive an expression for velocity and explain how velocity varies with changes in $R$ and $Y$. (Hint: the effect of output changes on $V$ depends on the elasticity of aggregate money demand with respect to real output. Economists believe that this elasticity is less than unity.) What is the relationship between velocity and the exchange rate.

**ANSWER 2:**

(1 point) Money market clearing condition states that real aggregate money supply is equal to aggregate real money demand:

$$\frac{M}{P} = L(R, Y).$$  \hfill (1)

Substituting the condition into the definition of velocity given above gives the relationship between velocity and aggregate money demand:

$$V = \frac{Y}{L(R, Y)}.$$  \hfill (2)
When interest rate $R$ rises, the opportunity cost of holding money increases and therefore aggregate demand for money $L(R,Y)$ falls. Equation (2) implies that a fall in aggregate demand will raise the velocity of money.

According to Equation (2), an expansion in output $Y$ increases both the numerator and the denominator. However, the denominator $L(R,Y)$ will increase less than the numerator $Y$, because the elasticity of aggregate money demand with respect to output is less than unity. Therefore, the velocity of money will rise.

The answers in the previous part of this equation tell us that velocity rises when interest rate rises or when output expands. So, it is logical to consider the effects of a rise in interest rate and output expansion on exchange rate. In fact, output expansion also results in a rise in interest rate because it increases aggregate money demand. We know from the uncovered interest parity that a rise in interest rate will cause exchange rate to appreciate. Consequently, a rise in velocity coincides with exchange rate appreciation.

3. In our discussion of exchange rate overshooting, we assumed that real output was given. Assume instead that an increase in the money supply raises 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 1: Effects of a permanent money expansion when output expands in the short run.

(1 point) Figure 1 describes money market and foreign exchange market before and after a permanent money expansion. Initially, the equilibrium in money market is at Point 1, and that in foreign exchange market is at Point 1’. Initial exchange rate is $E_{1s}/E$.

The money expansion shifts the money supply curve from $M_1^s/P$ to $M_2^s/P$. However, the output expansion in response to money expansion shifts the aggregate money demand curve from $L^1(Rs,Y)$ to the right hand side. The degree of the shift depends on the responsiveness of output to money expansion. We do not know precisely how far the shift is, but we are certain the new aggregate money demand must lie on the right hand side of the old one, for example, as the curve $L^2(Rs,Y)$.

In this case, the short run equilibrium in money market is Point 3, unlike the standard case discussed in class where the short run equilibrium was at Point 2. In the short run, interest rate falls from $R_1$ to $R_3$. The corresponding equilibrium in foreign exchange market is Point 3’, not Point 2’ as in the standard case. Note that $E_{3s}/E < E_{2s}/E$ because $R_3 > R_2$. Therefore, short run depreciation is smaller with output expansion.
In the long run, the real money supply shifts back to the original level gradually as price level rises. Assume that the increase in output is temporary and in the long run output and aggregate money demand return to their original level too. The long run equilibrium in money market is Point 4, which is identical to Point 1. The corresponding equilibrium in foreign exchange market is Point 4’. Note that the upward shift of the expected return on euro assets is due to the increase in expected depreciation following money expansion, i.e. $E_{\$/€}^{e,2} > E_{\$/€}^{e,1}$.

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

Short run response = $E_{\$/€}^{3} - E_{\$/€}^{1}$

Long run response = $E_{\$/€}^{4} - E_{\$/€}^{1}$

→ Overshooting (with output expansion) = $E_{\$/€}^{3} - E_{\$/€}^{4} > 0$

For comparison, the overshooting of the standard case can be computed in a similar way.

→ Overshooting (without output expansion) = $E_{\$/€}^{2} - E_{\$/€}^{4} > 0$

Since, $E_{\$/€}^{3} < E_{\$/€}^{2}$, then:

Overshooting (with output expansion) < Overshooting (without output expansion).

It is also possible that the shift in the aggregate money demand curve can be further away to the right. For example, it can shift to $L^{3}(R_{\$}, Y)$, and the short run equilibrium in money market and foreign exchange market is Point 5 and Point 5’, respectively. In this case, the exchange rate depreciation in the short run is even lower than the long run depreciation, i.e. $E_{\$/€}^{5} < E_{\$/€}^{4}$. This situation is the opposite from exchange rate overshooting and called undershooting. It is also consistent with the conclusion that output expansion in response to money expansion always reduces the degree of overshooting.

4. (3 points) Suppose the Federal Reserve announced that the money supply would be doubled next month. Describe the effect of the announcement on today exchange rate. Depict an appropriate diagram. Does exchange rate overshoot? Show also the time path of exchange rate.

**ANSWER 4:**

(1 point) Figure 1: Effects of a preannounced permanent money expansion

(1 point) Figure 1 describes money market and foreign exchange market before and after a preannounced permanent money expansion. Initially, the equilibrium in money market is at Point 1, and that in foreign exchange market is at Point 1’. Initial exchange rate is $E_{\$/€}^{1}$. 

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Once the Federal Reserve announced a future change in monetary policy, people uses that information to update their expectation right away. News about future increase in money supply increases expected inflation and then expected depreciation. The expected return on euro assets increases as the expected depreciation increases from $E^{e,1}_{\$/\text{€}}$ to $E^{e,2}_{\$/\text{€}}$. The foreign exchange market equilibrium is at Point 2’ right after the announcement. The corresponding money market equilibrium is Point 2. Since there is no change in money supply at this point, Point 2 is identical to Point 1.

When money supply actually increases in the next month, the money supply curve shifts from $M^s_1/P$ to $M^s_2/P$. The short run equilibrium points are Point 3 and 3’. Note that people no more adjust their expectation, because they have already done that after the announcement. In the long run, price level rises and the real money supply curve shifts back. The economy then gradually moves toward the long run equilibrium Point 4 and Point 4’. We can see that exchange rate does overshooting in the short run and the degree of overshooting remains the same. However, the volatility is smaller than the case without a preannouncement.

(1 point) Figure 2: Time path of exchange rate

Figure 2 describes time path of exchange rate. At the time of of announcement $t_A$, exchange rate jumps from $E^{1}_{\$/\text{€}}$ to $E^{2}_{\$/\text{€}}$. It stays at that level until money supply increases at time $t_0$. At $t_0$, exchange rate jumps from $E^{2}_{\$/\text{€}}$ to $E^{3}_{\$/\text{€}}$. It falls during the transition period and arrives at its long run level $E^{4}_{\$/\text{€}}$ at $t_1$.

(Optional note) You can see from Figure 2 that the degree of overshooting is the same but the volatility of exchange rate is smaller with a preannouncement. Indeed, signaling future monetary policy changes is often used by the Fed in practice through commentary and interviews for this purpose. The goal of signaling is to allow the public to adjust expectation early on, and that will reduce volatility in exchange rate and other macroeconomic variables. In this question, none of macroeconomic variables except for exchange rate adjust at $t_A$, because we assume away output adjustment and the role of inflation expectation in interest rate determination, for simplicity.
Ans 3, Fig 1

Real Qty of Money

M1/P
M2/P
M/P

E$/€
Ans 4, Fig 2

$E_s/\epsilon$ vs Time

E3
E4
E2
E1

At time $t_A$, $E$ increases to $E_2$. At time $t_0$, $E$ increases to $E_3$. At time $t_1$, $E$ decreases to $E_1$. The graph shows the variation of $E$ with time.
Question 4 - Figure 1: Announcement and exchange rate overshooting

Question 4 - Figure 2: Time path of exchange rate

ta = After the announcement
t0 = When money supply is increased permanently.
t1 = When the price level increases to its long run level.