

## 1. Exogenous variables

List all of the exogenous variables in the IS-LM-FX model.

Price level  $P$  (we assume  $P$  is fixed in the short run due to sticky prices)

Expected future exchange rate  $E^e$

Government policy variables:  $G, T, M$

Foreign variables:  $Y^*, T^*, i^*, P^*$

Breaking these down according to which curve each one shifts:

IS equation/curve:  $G, T, P, P^*, Y^*, T^*$

LM equation/curve:  $M, P$

FX:  $i^*, E^e$

## 2. Shifting the curves.

## a. List everything you can think of that would cause the IS curve to shift to the right.

Remember: the IS curve is all combinations of  $Y$  and  $i$  that are consistent with goods market equilibrium ( $Y = C + I + G + TB$ ) and FX market equilibrium ( $i = i^* + \text{expected depreciation}$ ).

Anything that causes  $C$  or  $I$  or  $G$  or  $TB$  to rise, other than a fall in the interest rate, will shift IS to the right. Such things include:

- Expansionary fiscal policy  
An increase in  $G$  would increase the demand for goods and services, shifting up the  $D$  curve in the  $KC$  diagram and causing IS to shift right. Similarly, a decrease in  $T$  would give consumers more disposable income (take-home pay), which would cause higher consumer spending, shift up the  $D$  curve in the  $KC$  diagram, and shift the IS curve to the right.
- Exogenous increase in  $C$  or  $I$   
An increase in consumption or investment not caused by something within the model. An exogenous increase in  $C$  would likely result from an increase in households' wealth (due, e.g., to a stock market boom or inflation of housing prices) or a reduction in households' worries about the future. An exogenous increase in investment would likely result from a change in business' expectations about future prospects, or the introduction of a new technology that raises the marginal product of capital. Note that a change in tax policy that encourages investment would increase the after-tax return to investment and hence increase investment demand.
- Increase in demand for U.S. exports  
An increase in foreign income  $Y^*$  or decrease in foreign taxes  $T^*$  would increase the disposable income of consumers in other countries, which would increase their demand for U.S. exports. This would increase  $TB$ , and shift upward the  $D$  curve in the  $KC$  diagram. As a result, each value of the interest rate would be associated with a higher value of income.

- Increase in the expected foreign return  
An increase in  $i^*$  or  $E^e$  would shift up the FR curve, causing  $E$  to rise, which, in turn, would increase  $TB$  and shift  $IS$  rightward. Intuition: An increase in  $i^*$  or  $E^e$  would raise the return to U.S. residents of buying foreign bonds. This would cause capital outflows, as savers seek higher returns abroad. In order for U.S. residents to buy foreign bonds, they must first buy foreign currency in the FX market. This increases the demand for foreign currency and hence bids up its price,  $E$ . The increase in the exchange rate (price of foreign currency) makes imports more expensive to U.S. residents and makes U.S. exports cheaper to people in other countries, causing  $TB$  to rise. As a result, demand for goods and services rises, and each value of the interest rate will now be associated with a higher value of income than before.

b. List everything you can think of that would cause the LM curve to shift to the right.

Recall that the LM curve shows all combinations of  $Y$  and  $i$  that result in money market equilibrium.

The LM curve would shift to the right if any of the following occurred:

- Increase in  $M$  – in the money market diagram, shifts money supply curve to the right, causing the interest rate associated with each value of income to fall
- Decrease in  $P$  – increases the real money supply ( $M/P$ ) and has the same effects as an increase in  $M$
- Exogenous decrease in money demand, that is, a fall in the demand for money not caused by a change in income or interest rates. For example, the introduction of ATMs reduced the cost of withdrawing funds from bank accounts, so people didn't need to hold as much money as before, because ATM machines made it more readily accessible. Another example: when the current economic crisis ends and people perceive the banking system to be healthier, they will be more comfortable leaving their funds in banks, so they will hold less money than before (as a fraction of their financial wealth). In the money market diagram, an exogenous decrease in money demand is represented by a leftward shift of the money demand curve; the result is a fall in the interest rate associated with each value of income, and hence a rightward shift in the LM curve.

## 3. Using the IS-LM-FX model

In each of the following scenarios, tell me what (if anything) would happen to  $Y$ ,  $i$ ,  $C$ ,  $I$ ,  $TB$ , the government's budget surplus/deficit,  $E$ .

Assume flexible exchange rates unless otherwise specified.

## a. Businesses lower their forecasts of future GDP and, as a result, reduce their investment expenditure.

This scenario describes an exogenous decrease in investment – that is, a decrease in investment due not to a change in the interest rate but to something that the model doesn't determine – expectations of future GDP.

Such a decrease in investment would, in the KC diagram, shift the  $D$  curve downward, reducing  $Y$ . The  $IS$  curve would shift to the left – each value of the interest rate  $i$  is associated with a lower value of  $Y$ . The leftward  $IS$  shift causes the interest rate to fall, which, in turn, has two effects. First, it stimulates investment – thus mitigating the initial drop in investment. Second, it reduces the return on domestic assets, which, in the  $FX$  market diagram, shifts the horizontal  $DR$  curve downward. Financial capital flows out of the country in search of higher returns abroad, which causes the country's exchange rate to depreciate ( $E$  rises). The depreciation of the dollar stimulates net exports: a cheaper dollar makes U.S. exports cheaper for people abroad, and a higher price of foreign currency makes imports more expensive to U.S. residents. So,  $NX$  and  $TB$  rise. The rise in investment (from falling interest rate) and rise in net exports (from exchange rate depreciation) mitigate the fall in income – i.e., income doesn't fall as much as it would otherwise have fallen.

In summary:  $Y$  falls,  $i$  falls,  $E$  rises,  $C$  falls (because  $Y$  is lower),  $I$  falls (though the fall in  $i$  reduces the size of the drop in  $I$ ),  $TB$  rises (due to higher  $E$ ), the budget deficit is unchanged (because neither  $T$  nor  $G$  have changed).

How do we know that investment is lower in the new equilibrium? It's not obvious. On one hand, we have the exogenous drop in investment that started this whole process. On the other, we have an increase in investment from a fall in the interest rate. Which of these two effects "wins"? We can find the answer here:

$$TB = S - I$$

We know for sure that  $TB$  is higher, because  $E$  is higher. What about  $S$ ?  $S = Y - C - G$ .  $G$  has not changed, but  $Y$  and  $C$  both fall. Since  $MPC < 1$ , the fall in  $Y$  is greater than the fall in  $C$ , so we can be sure that  $S$  falls. The only way  $TB$  can rise in the face of a fall in saving is if investment falls by an even greater amount. For example, if  $S$  falls by 100 and  $TB$  rises by 50, then it must be the case that  $I$  falls by 150. This reasoning proves that investment falls, despite the lower interest rate.

- b. Homeowners see their net worth fall as house prices fall, and, as a result, reduce consumption.

This scenario represents an exogenous drop in consumption – that is, a decrease in consumption not caused by one of the model's other variables (such as income or taxes).

Again, the D curve of the KC model shifts down, and the IS curve shifts left. In the IS-LM diagram, the interest rate falls. In the FX market diagram, the DR curve shifts down as capital flows out of the country seeking higher returns abroad. E rises (meaning the exchange rate depreciates), causing TB to rise.

- c. Expansionary fiscal and monetary policy in Europe increases incomes in all European countries.

Here, foreign income  $Y^*$  rises, which increases foreign demand for U.S. exports. At the initial value of E, exports and hence TB rise. In the KC diagram, the D curve shifts up. In the IS-LM diagram, the IS curve shifts right, causing  $i$  and  $Y$  to rise. In the FX market diagram, the increase in  $i$  causes the DR curve to shift up: U.S. assets now pay a higher return, making them more attractive to foreign savers, who buy U.S. dollars in order to acquire some of these higher-paying U.S. assets. This increase in the demand for dollars causes an exchange rate appreciation and a fall in E (the amount of dollars that trade for one unit of foreign currency). The fall in E causes the trade balance to fall, because imports are cheaper to U.S. residents and U.S. exports are more expensive to foreigners.

In summary:  $Y$  rises,  $i$  rises,  $C$  rises (because of the increase in  $Y$ ),  $I$  falls (because of the rise in  $i$ ), and  $E$  falls (because the rise in the U.S. interest rate causes capital inflows which increase the demand for and price of dollars in the foreign exchange market).

What about the trade balance? On one hand, the increase in foreign incomes cause TB to rise at the initial value of the exchange rate. On the other hand, E falls, which would cause TB to fall. Which of these two effects wins?

Again, we find our answer here:  $TB = S - I = (Y - C - G) - I$ .

We know that  $I$  falls (due to higher  $i$ ). That, by itself, would make TB rise.

We know that  $Y$  is higher, which also makes TB rise.

But  $C$  is higher, which reduces TB.

Since the marginal propensity to consume is less than one, the increase in  $C$  is less than the increase in  $Y$ , so we can state unambiguously that TB rises, though the fall in  $E$  reduces the size of the increase in the trade balance.

## 4. Picking the right mix of fiscal and monetary policy

Monetary and fiscal policy affect output by affecting the aggregate demand for goods and services. Policy is expansionary if it increases aggregate demand. Expansionary fiscal policy involves either increasing  $G$ , reducing  $T$ , or a combination of the two. Expansionary monetary policy involves increasing the money supply. Policy is contractionary if it reduces aggregate demand.

Contractionary fiscal policy involves reducing  $G$ , increasing  $T$ , or a combination of the two.

Contractionary monetary policy involves reducing  $M$ .

Tell me which policy or mix of policies would be most likely to achieve the goals described in each part of this question. Briefly explain your answer. Assume flexible exchange rates unless otherwise specified.

## a. Goals: raise output and reduce the trade deficit

Policymakers could raise output either with expansionary fiscal policy (increase  $G$  and/or reduce  $T$  to shift IS curve to the right) or expansionary monetary policy (increase  $M$  to shift LM to the right). However, fiscal policy would raise the interest rate, causing capital inflows and appreciating the domestic currency ( $E$  falls), causing a fall in  $TB$  and an increase in the trade deficit. On the other hand, increasing the money supply and shifting LM rightward would cause the interest rate to fall, which would cause capital outflows and a depreciation of the exchange rate (and an increase in the price of foreign currency,  $E$ ). This would make exports cheaper to people abroad and would make imports more expensive here, thus reducing the trade deficit. Hence, the answer is: expansionary monetary policy.

## b. Goals: raise output while keeping the exchange rate unchanged

Keeping  $E$  unchanged requires keeping the domestic interest rate (and hence the DR curve) unchanged. Expansionary fiscal policy would raise  $i$ , but expansionary monetary policy would lower  $i$ , so policymakers should do both: shift the IS and LM curves to the right so that they intersect at the same interest rate as before.

## c. Goals: keep output constant in the face of a drop in foreign income (and hence drop in foreign demand for home country exports)

A drop in foreign income would reduce exports and shift the IS curve to the left. Policymakers could either use fiscal policy to shift IS back to the right, or use monetary policy to shift LM to the right. Either would counter the effects of the decrease in exports.

In the face of the Southeast Asian Crisis of 1997, which sharply reduced U.S. exports, the Federal Reserve under Alan Greenspan increased the money supply and shifted the LM curve to the right, essentially keeping output fixed in the face of this drop in foreign income.

- d. Goals: boost output while keeping investment constant at its initial level

In our model, investment depends on the interest rate (and possibly exogenous factors like expectations and confidence, what Keynes called “animal spirits”). To boost output without changing the interest rate, policymakers would have to shift the IS and LM curves to the right, such that the new intersection of IS and LM occurs at the same interest rate (but higher output) as before. Note that this would also keep the exchange rate from changing (see part b).

This exercise points out a flaw in the model. Even if the interest rate were constant, an increase in income in the real world would likely spur an increase in investment spending – as firms observe the economy improving, they perceive a higher payoff from investment projects, so they undertake more such projects. In the real world, investment is highly procyclical, meaning investment moves in the same direction as GDP over the course of the business cycle. The flaw is that the model’s investment demand function assumes investment depends only on the interest rate, which does not automatically make investment procyclical. We could correct this flaw by using a fancier investment function that makes investment depend positively on current income (in addition to the interest rate).

- e. Goals: maintain a fixed exchange rate in the face of a negative shock to investment

A negative shock to investment means that firms are cutting back on their investment spending, not because of any change in the interest rate, but because of some exogenous reason, such as a decrease in businesses’ confidence or expectations about the future. This would reduce aggregate demand for goods and services, causing (in the KC diagram) the D curve to shift down, and causing the IS curve to shift leftward. The leftward IS shift would reduce the interest rate and, in the FX market, shift the DR curve downward, causing E to rise as capital flows out of the country in search of higher returns abroad.

To prevent E from falling, policymakers would need to shift IS or LM in such a way that prevents the interest rate from falling. Or, put differently, when the investment shock causes the interest rate to fall, the policy response should increase the interest rate.

There are several policy options to increase the interest rate: reducing the money supply (which shifts LM to the left), increasing government spending (which shifts IS right), and cutting taxes (which shifts IS right). Which of these is best?

Since the negative shock to investment reduces output, policymakers should probably NOT shift the LM curve left, which would keep E from changing but would reduce output further. Instead, policymakers should shift IS to the right, by increasing G and/or cutting T, as fiscal policy in this scenario can achieve the goal of keeping E constant while also arresting the decline in GDP.